Sustainable Information Technology

Whitepaper – [redacted]

June 5, 2014

Executive Summary

This white paper is intended to provide examples of sustainable information technology (IT) and outline the challenges and possible best-of-breed solutions in use today throughout the world, domestically and within various sectors of our society.

Introduction

Over the past 40 years the advancement of increasingly advanced technology, notably computing resources, into the fabric of the operation of the public and private sectors has been immense. However, built into technology, strictly by definition, is obsolescence, in which advances constantly overtake previously deployed and in use ones, and to keep pace with the demands of the public, customers, users and even other organizations, it must be upgraded and/or replaced over time. With those changes, waste, in various forms is generated, inefficiencies practiced, and a number of other consumption based offshoots which make these advancements over at least 2/3rd's of that time period are unsustainable in the long run.

Changes to this march of perceived progress will include thinking about various aspects of the information technology (IT) lifecycle, including physical resources, but also some less overt areas such as business processes and human resource management.

Reduce, reuse and recycle.

Methods

Manufacture, Acquisition & Disposal

Sourcing

In order to procure and acquire technology, it has to be made or manufactured. However, that is but one of the steps that must be taken in order to get the latest smartphone or next big server to support cloud technologies to the consumer. At the base, raw materials must be found, processed, refined, shipped, formed, packaged, and shipped many more times before they reach the end destination. Each step consumes resources and combined, that consumption is almost exponential at a per item rate. To remain sustainable, analysis of these steps must be completed to find efficiencies, less overall environmental impact, and ways of reducing the consumption of raw materials through recycling, re-use or design that promotes extending the cycle before a return to raw materials must be made.

Materials

The selection of materials for the composition of products is a well-known avenue to creating and maintaining sustainability among consumers of information technology solutions. This is usually the first vector into the minds of users, by noting that components they are using were made from post-consumer waste, or can be, broken down via natural or man-assisted means, into recyclable materials that can be used in other products. The power of the consumer is greatest in its influence at this point, at which they can select the provider of products and solutions that best mesh with their ethos for supporting various levels of sustainability.

The materials sourcing sustainability aspect can be addressed in the initial acquisition of those initial raw materials, be it from mining, harvesting, or other capture means. For those requiring extraction, issues such as landscape modification or destruction, chemicals and run-off, and transport from those harvesting areas to a post-processing location (including fuel, transport means, and process related byproducts) – each of those potential additions to the supply chain sustainability considerations. There are a number of projects, tracked via the United Nations Environment Program (UNEP)[1], which track efforts around the world in these segments. Since the sourcing of materials for products act on a global scale, this is one of the few resources that act as library of efforts to address these concerns.

Core Components

Most of the technology that is deployed in business and for personal use tends to be built out of the same materials, but in general plastics and metals. Both are recyclable and depending on the composition, toxicity, and demand, will often see life in newer technology that replaces that which is recycled, or diverted towards other products. Some components, such as those used for insulation and motherboards, tend to not be easy to recycle or have hazardous materials in them that prohibit a clean reuse. In that case, reducing the amount of their use in products becomes part of a manufacturers sustainability program and moves towards allowing a consumer to be more aware of how "green" their technology is progressing towards the model of complete sustainability. The success of this effort can be seen, slowly, in the amount and type of e-waste that shows up at disposal and recycling centers, and in certain cases, the manufacturers offer their own buy-back or recycling programs to recapture, both in materials, but a savings in cost due to cutting out purchasing the post-processed materials for re-use.

Power

One of the most difficult components to recycle and reuse are often the power components, and more specifically for electronics, are batteries and other power sources. These often have various metals and materials that are often hazardous and difficult to separate into recyclable base components, especially after their useful life has reached and end and certain electro-chemical processes have taken hold. With the push towards technologies such as mobile and even electric vehicles, the proliferation of these power sources only continues and puts downward pressure on innovation needs for handling to post-consumption waste. Innovative sustainability efforts in the consumer technology market, such as charging and swap stations[2], mark the possible way forward to create a more virtuous cycle for a resource in demand and complex recycling and disposal issues.

Manufacturers

Supply Chain / Delivery

One of the most impactful costs on the environment of technology is often not the materials that make up the technology, but often the emissions and energy consumed transporting the raw materials as well as the finished products to distribution points and eventually to consumers. Because of the dispersed nature of where component materials are extracted from the environment, some of these costs can not be easily reduced; however, material inputs can be shorted by recycling efforts of waste of technology and other products (recycled plastic for parts, recycled paper for packaging). Analysis of these "flow networks"[3] can

[1] http://www.unep.org/
[2] http://betteryinc.com/
[3] http://nootrol.com/

help make the lifecycle of the product more efficient on the front end of production, and in cases where time sensitivity for just-in-time delivery (JITD) and balance the over production of some goods may be best optimized by placing data from the flow networks within the logistics chain of the entire product lifecycle.

While architecting how supplies and materials for information technology-centric projects are procured, there are several techniques that should be leveraged, wherever possible, to help uncover various sustainability gains. Some services exist to “score” suppliers, based on a number of factors including water, waste, carbon output, hazardous materials, ethics, and packaging – all of which contribute to being able to maintain an understanding the impacts of decisions in the project delivery process. Because the chain is often very complex and varied from solution to solution, auditors and organizations outside those engaged in the acquisition and procurement are leveraged[4]. Often if the procuring organization is not placing a direct demand on their suppliers, there’s often no direct impetus for that supplier to actively address their sustainability requirements.

Product Design

Recently Google announced the development of a modular phone, in which the base platform allowed for upgrades, modification, and additional features by simply adding smaller function-specific modules. Not only does this reduce potential overall cost buy having devices tailored to specific needs, but also reduces the impact of waste by extending the usable life of the base device several times longer than a traditional non-modular counterpart. The additional added benefit is that users of the technology can always have the most cutting edge of innovation without sacrificing cost prohibitive upgrades, but also keeping a platform they’ve become used to and reducing their own personal footprint. This design methodology is the antithesis of what was commonly used in tech sectors as a “kitchen sink” mentality, that of which is putting every conceivable piece of kit into a device, even if most of it wasn’t ever utilized by the end user, at least it was there if they needed it, versus the much more measured and reductionist approach Google and others have now started to take as an eye towards sustainability.

In other cases, design can center around multi-purpose use, such as moving away from a dedicated printer to a multi-function device, or having one device work in consort with other systems in its environment (a “universal remote” for technology). Other applications of such a design methodology can take the form of how the product can be reused or recycled into the support of another activity (downcycling), such as using an old computer case as furniture, or breaking off components after a device has been exhausted and, by design, can be leveraged for non-traditional uses, such as utensils, tools, or other implements[5]. One of the movements towards sustainable design, called "cradle to cradle"[6] emphasizes a waste-free framework for consideration of all components that go into developing, using and eventual reuse or recycling of the product after its planned end-of-life.

Decommissioning

If something exists in a physical form, and reaches the end of its planned life or use cycle, it eventually will require disposition as either elements to recycle or waste. One of the more troubling factors for typical waste associated with technology is a number of harmful chemicals, metals and plastics that are used in the manufacture of the products typically used. As technology refresh cycles shorten, the amount of this waste

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[4] http://scpclearinghouse.org/
[5] http://mashable.com/2013/05/16/crazy-business-cards/
[6] http://www.c2ccertified.org/product_certification/c2ccertified_product_standard

increases at greater and greater rates in each successive year, so an eye towards recycling and reuse is paramount towards supporting and effort of sustainability.

E-Waste

Waste and materials from the use of information technology has its own special term coined for the collection of plastics, metals and other refuse that is left over from the manufacture, use and eventual disposal of those products. Many of the materials are highly recyclable, namely the plastics and metals, however, materials in printed circuit boards, solders and other subassembly contents are highly toxic or in some cases, prove too difficult or expensive to recover. Some manufacturers of the technology have implemented recycling or buy-back programs for organizations and individuals to return products after they are used, and for those who have technology not from those manufacturers, many municipalities and organizations offer e-waste recycling efforts[7], to help centralize and collect the waste. In some cases, laws and regulations are pushing manufacturers to create and maintain such processing programs, as well as influencing consumers upon time of purchase, knowing they have a disposal method post use.

Examples

- Resource Conservation and Recovery Act (RCRA)
- National League of Cities - Sustainable Cities Institute[8]

Built-In vs. Legacy (aka "Design for End-of-Life")

Within the past decade plus, not only has obsolescence been built into much of the technology in use today, but so has the ability of it to be recycled into component materials. However, technology originating before this period still is in use and exists in many forms throughout the information technology landscape, and it hasn't been designed for easy re-use and disposition. This includes potential carcinogens and heavy metals. Designing for the "end of life" of a product considers not just the useful length of the product in the hands of the consumer, but also what happens post use, how that product will be broken down and possibly recycled, or in some cases, augmented in order to extend its originally planned "in—service" lifespan. Designers can combine functions of components within the assembly, reduce the number of assembly operations by using subassemblies or modules, and plan the internal layout of components to reduce layering. They can also choose to use quick, finger-release fasteners, or common fasteners when possible and stick to either the English or metric standard and one head type, or minimize the use of permanent fastening methods like adhesives or welding. Finally, when developing and identifying materials for a product, choose recyclable materials and reduce the number of dissimilar materials, especially within a category (e.g., plastics, metals).

Power & HVAC

Power

All modern technology requires some sort of power source to assist it with operation, from wind to fossil fuels, natural or stored energy must be captured and converted into a form suitable for consumption by those electric-powered devices. Some sources are considered free and clean energy, others include byproducts from the harvesting and conversion of these fuels into their more usable formats, but each retain challenges of being efficient and sustainable over a long period of time. In the cases of large scale computing,

[7] http://www.sustainablecitiesinstitute.org/Documents/SCI/Report_Guide/Guide%20-%20E-Waste%20Best%20Management%20Practices%20SF.pdf

[8] http://www.sustainablecitiesinstitute.org/topics/materials-management/electronic-and-appliances-waste-management

seen at data centers and office buildings, in order to accommodate continuity of operations (COOP) and disaster recovery plans, the primary source of power, regardless of it being from a renewable or sustainable source, is often supplemented by an out-of-band provider, usually from an easily obtainable or quickly replenish-able. This is also a concern during the use of UPS, or uninterruptible power supplies, which are essentially often batteries or other fuelled cell electrical storage device. As they need to be effectively constantly charged and kept ready, their draw on the operations of a computing facility are often overlooked, but place a significant cost once considered as an integrated component that is judiciously used based upon evaluated need (i.e., does every device need to be on a UPS).

Examples

- EPA's Green Power Leadership Club[9]
- Alternative Energy Sources (Geothermal, Solar, Wind, Biomass, Waste processing)
- Power Management (Demand Response, AC/DC circuit design & voltage conversion)

Lighting

There have been a few revolutionary technologies in regards to lighting that have advanced over the past two decades which include the compact fluorescent light (CFL) and light-emitting-diode (LED) lights, which are much more efficient in providing lumens per power input than the traditional incandescent bulbs. In fact, in 2014, the sale of incandescent bulbs, en masse, has ceased (except for special requirements). One of the other economic benefits of the switch to CFL and LED lighting come from the extended lifespan of many of these bulbs and their low power consumption. However, some of the materials that are used for these low-power and extended life lighting options often contain hazardous materials, in the case of CFLs, mercury. Other issues regarding heat dissipation of the DC power supplies and spectrum exposure effects on vision have also been reported for LED lighting, which still leaves options far from perfect, but when analyzed as an option versus older technologies, they still prove to be more viable.

Other options include, where available, is the leveraging of "natural light redirection" technology through the use of capture devices, no unlike solar panels, which are linked to fiber option cables and reflective dissipaters for use in windowless or internal spaces without direct access to sunlight. This often, as a passive technology, doesn't create heat, nor requires electricity, but is beholden to the available light outside a facility for it to be effective, including cases where the natural phase of the sun provides adequate amounts during the day time cycles. Other technologies also attempt to address the power consumption and light quality issues, such as ESL (electron simulated luminescence) lights and other technologies such as active-matrix organic and organic LEDs (AMOLED/OLED) which can be used for dynamic lighting situations as well as high definition displays.

Data Center Location

Due to the en masse deregulation of many energy markets in the United States, beyond the selection of possible alternative power sources, the providers of these options are also subjected to market pricing of generated electricity. In some cases, a data center may reside, due to need or proximity to operations, in a location where a service provide operates no generation facilities, and has to rely on contracted generation. This requires the purchasing organization to be cognizant of these concerns and think upon the desire for the data center physical accessibility and the costs of operation. This is in particular concern in locations such as

[9] http://www.epa.gov/greenpower/partners/index.htm

Washington, D.C., where PEPCO, due to business decisions in the late 1990s and early 2000s, has no local generation facilities and acts merely as a contract resale power provider, and in turn, organizations who do not plan long term or have alternative providers, see swings in prices and even delivery capability during high demand times and such a provider struggles to provide adequate service.

HVAC

The heating, ventilation and air conditioning, commonly known by the acronym HVAC, along with power, are often the first items on organizations lists on how to conserve and reduce their use. Much has been developed, both in management tools, but also techniques on efficient use of HVAC in data centers and offices, including power management, insulation, building architecture and layout, and the use of natural or climate assisted methods. One of the issues with large hardware installations, especially those in a dense configuration, is how to maintain the manufacturer warrantied operation thresholds for temperature, humidity and air quality. Using climate assisted cooling efficient but is also difficult, as it doesn't remain constant throughout the day, and still requires assisted mechanical HVAC when the outside temperature and humidity waiver outside acceptable limits. Other techniques that have gained prominence in making data center HVAC systems more efficient include hot and cold aisles and curtains, not unlike those at grocery stores, to isolate and direct airflow within these facilities to use what conditioned air that has been put into the building, go more directly to the systems that need it. In office areas, HVAC is often placed on timers and is cycled periodically throughout the day based on external climate considerations but also occupancy, since bodies in that space also alter temperature and humidity and affect efficient operations of desktops and other IT systems.

Examples

- Weather/Climate Adaptive Heating/Cooling (adjust for seasonal shifts by not using artificial sources)
- Direct Expansion (DX) – evaporate assisted heat rejection air conditioning (climate conditional installs)
- Switch to central air handling (versus typical modular) – "battling of humidities"
- "Free Cooling" via Air-Side Economizer (climate and season specific)
- Thermal Storage
- Direct Liquid Cooling and Humidification

Environmental

Real Estate

There has been an innovation among several information technology and services organizations in the past half-decade, which has centered around carefully evaluating their real-estate options when exploring new or expanded operations. From rehabilitating buildings in a former warehouse district to create an open bohemian floor plan for offices to looking at old manufacturing facilities to place data centers in, the concept of reuse and recycle has seen one of its greatest advances in this area. The advantage to this is multi-faceted, which includes savings in time and resources for the organization, but also the impact on the surrounding area is reduced by not building something new and rehabilitating what may be already in the facility. If an organization decides to build a new facility, they are often looking forwards the U.S. Green Building Council's LEED[10] standards, which address sustainability in building construction and operation, including redevelopment of existing properties.

[10] http://www.usgbc.org/leed

Also important when an organization looks toward sustainability and their choices for real estate selection is how it affects their workforce. In many metropolitan areas, staff will commute from various locations, and choosing a facility that can utilize mass transit and other green forms of transportation is paramount to maintaining the long-term sustainability of that facility and the viability of the supporting workforce. In more remote or less space constrained areas, space and commuting can still be of a concern, as to not invite sprawl, either into the surrounding environment, but also not forcing or encouraging workers to have long commutes, even when mass transit options may not be readily available, which has an adverse affect in consuming fuel and other resources.

Examples

- Facility re-use and repurposing (Re-use of infrastructure (Google's "Finland paper plant"))
- Energy's Building Technologies Office[11]

Building & Architecture

According to the Department of Energy, data centers use up to 100 to 200 times more energy than a standard office space. Much of that is attributable to the dense packing of servers and other devices into a purpose built space, but also because of the supporting requirements of power distribution, lighting, and HVAC that drive up the overall consumption. Besides addressing the general issues above, such activities as grouping similar power consuming servers, as well as those with other environmental operating specifications (such as humidity) within a center can work to allow more efficient cooling design of the center itself. These efforts are best utilized during some data center consolidation efforts, such as FDCCI. Other areas where efficiencies and benefits can be gained in reducing consumption include air management around the data center, which can vary from implementing cable management to aisle separation and containment (hot and cold aisles, strip curtains).

Examples

- Building Open Data Initiative[12]
- Data Center Design[13]

Landscaping & Environmental Design

Water Management

Most facilities end up using water in some form or another, either through support of the staff through restrooms and food facilities, but also at times, for cooling. At some point the water reaches a state where it's considered waste or gray water, and is non-potable for human consumption, and requires treatment for re-use. In other cases, especially in arid climates, access to that water also poses a unique challenge and developing water capture and storage techniques can extend the overall sustainability of a facility or operation in those water starved environments.

Examples

- Gray water re-use
- Rainwater capture
- Recycling cooling fluids.

[11] http://energy.gov/node/773661/info/office/index.html
[12] http://energy.gov/eere/buildings/articles/white-house-highlights-two-energy-slashing-open-data-initiatives
[13] http://energy.gov/eere/buildings/data-centers-and-servers

Heat Dissipation

One of the offshoots of using computers and other hardware, is the generation of waste heat from the computing operations. From a laptop to racks of servers, the act of flipping gates on a CPU via electricity has a byproduct of heat, and a major concern by product developers is how to manage it and dissipate it away from the CPUs in order to keep them running at optimal efficiency. In most cases this heat is vented into the environment via internal fans or heat sinks, but as heat is often used to also generate electricity, attempting to recapture that heat to change the temperature in another area of facility that needs it, or even have it co-generate more electricity, are some of the new and novel ways organizations are using to create a sustainable resource cycle to save money and reduce the impact on the environment. In some cases, much like HVAC, facilities may also vent waste-heat into the environment and look for natural dissipation where re-use is difficult or impossible, such as subsurface or water-based cooling. As a facility expands or increases in use, the need for efficient heat management becomes a major concern and is often tied in with many previously mentioned considerations for maintaining the long term viability of and operation.

Examples

- Re-use of natural features (Google's "Finland paper plant")
- Waste Heat Capture and Co-Generation

Waste Management

Unfortunately, not everything can be recycled and reused (typically non-organic and non-metallic waste) from the use and utilization of information technology, and in some cases, the waste will need to be disposed of. Older traditional means of bury the waste in a landfill has become more troublesome as new storage facilities now face many new hurdles in order to be created or expanded. In some cases, the waste may be of recyclable materials, but due to the sensitivity of the data or contents that it may contain, less environmentally friendly means to dispose of the materials is required, and opportunities to innovate in this area are great. This is even of concern during the various stages of the supply chain, as by products from the manufacturing process may also not be entirely reusable, and have an impact of the long term viability of those various suppliers, often originating in areas that don't have programs or strong regulation to encourage good waste management techniques. In some cases, the waste can be incinerated and used as co-generation, and impact some of the considerations for energy use and conservation, however, even that ash will need to be handled and may be toxic depending on the source materials and chemical reactions that take place during the processing and incineration. However, even the byproducts from decomposition in a landfill can generate useful products, in some cases methane, which can also be used in a similar capture and generation process. However, as part of any waste management effort, a lifecycle analysis of all components of a system should be analyzed and considered if attempting to remain an ecologically friendly and sustainable activity, which can include adapting a method of avoidance by opting to repair rather than replace items that malfunction or break, thus reducing the amount of waste that is required to be handled and processed.

Software

Virtualization

The concept of virtualization equates to many benefits when it comes to utilizing sustainable information technology practices. Advantages vary from better resource utilization, but also some non-overt things such as location independent processing and efficient and modular scalability. One of the core off shoots of the uptick in virtualization is within cloud services, in which "compute" or "storage" units are sold, run, and managed at a more "atomic" unit level rather than a bulk, in which a customer is required to produce accurate expectations of resource utilization before provisioning of a service. This has the added benefit of being an “on-demand” or “just in time” solution that is applicable in much the same way that some companies use for physical inventory and product delivery.

Software Engineering

There is a movement towards “sustainable software”, that is software that, once authored is efficient, easily maintained, and able to be changed as business requirements and needs require it to do so. This does tie into the latter discussion of code re-use through standardized frameworks and modular libraries, but the software engineering behind sustainability requires architecture and frameworks that are developed to be flexible and agnostic to be able to adapt to changing technology. One of the adages that pushed the proliferation of Java, was “write one, use anywhere”, also applies into how a flexible framework allows for the software and systems it supports to grow with new demands, ecosystems, and environments and still remains a high quality solution. This push towards rapid, "living" updates and changes meshes well with the agile methodologies that are often in use in many organizations, which also requires developers to leverage tools such as automated testing and version control that help find and document flaws and bugs so that they can be fixed and the software continuously improved[14].

Code Re-use

What may appear to be digital recycling is exactly what it is, however, the savings come two-fold in how this capability is applied. First, the time spent coding new components, if software is architected and built in a modular design, will gain efficiencies from a shared standard code repository of tested and verified methods, libraries and procedures and reduce the extra hours of developers using computing resources crafting new code. This also reduces the amount of resources in manpower, test and verification, and basic CPU time since trusted code only needs to be successfully integrated rather and created from scratch. In the long run, these uses of code begin to mature, trust is instilled, and if a problem or vulnerability does arise, the pedigree can be traced and changes and updates managed since there are those shared components in use. However, conversely, if reused code does become faulty or vulnerable, it can place many systems at risk rather than a unique custom solution, but seen from examples such as Heartbleed (OpenSSL), a structured and managed methodology can be developed to fix and patch shared code an libraries quickly because the use of the common core without great effort. These cases can best be exemplified by open source software projects, where distributed and community development and maintenance keep the code managed and properly architected, but also improved and fixed when new features are requested or bugs do crop up.

Digital Distribution

One of the greatest advances in the past decade is the almost ubiquitous nature of network connectivity throughout most of the United States. In many cases this is either high speed wired, wireless or both; enabling a very flexible use of information services and other media from nearly anywhere. One of the offshoots of this is “just-in-time” distribution, whereas applications and similar software are downloaded to a device or computer as the system or user needs it. It removes the need for physical transport, packaging, warehousing and other issues typically associated with physical products and delivery to the end user, reducing overall waste and resource consumption. The content can range from streaming media, for use in training and audio-video distribution scenarios, but also other data such as application software packages,

[14] http://blog.dolittle.com/2013/06/21/sustainable-software-development/

patches and updates, operating systems, data sets, and other organizational information, all possibly leveraging distribution and edge networks like Akamai, Speedera, Limelight Networks and CloudFlare.

Hardware

Infrastructure

Information Technology infrastructure is what most individuals envision when considering systems that require a solution to address their short and long term sustainability. Often referred to as “big iron”, it is usually composed of servers, desktop units, and networking equipment, but also UPSes, furniture, racks, printers, cable runs, audio/visual components and other support systems. These can be located in a data center but also in networking closets or in office spaces, as the organization sees fit. However, it’s one of the aspects of sustainability that is most up front, because individuals directly interact with it every day, and probably acts as the most tangible connection with the changes sustainability efforts may impose on the user. Addressing issues with materials and components used in the office, such as furniture can be teamed up with activities for power and HVAC to address the “whole space” in an office work area and it’s layout, or in the cases of data centers, the placement and orientation, as well as density (discussed above) plays into many aspects of resource conservation.

Examples

- Cabling (lead content in PVC jacket) and copper use (mining impact)
- Geometry of cable and wire runs (conservation of material use) – wireless?
- Redundant or duplicative (shadow) networks
- Thin clients/Mobile Clients/efficient CPUs
- Multifunction Devices (Printer/Copier/Scanner)
- Furniture (modular office systems) – CFC/HCFC emissions, Volatile Organic Compounds (VOC)
- Green Electronic Council (EPEAT)[15]
- ACPI (Advanced Configuration and Power Interface)

Management

There are many facets to leveraging innovative management techniques that will assist in developing strategies to address sustainability in relation to information technology, users, and the environments they operate in. One of the facets is purely technical, by ensuring devices and systems are leveraging all the “greening” capabilities that have been built into them while attempting to sacrifice usability and system response. This can include deciding to use low-power architectures in solutions that are processing intensive, such as mobile, which conversely extend battery life and their use cycle or power management extensions into a system that will turn off certain features that aren’t in use but still remain accessible, some of which include sleep modes for systems at rest that haven’t been powered down completely. In other cases choosing to issue one device per member of an organization, rather than two or three can reduce resource consumption from both a raw materials standpoint (supply chain to disposal) but also in power consumption, HVAC, and even the overhead required to have support staff for multiple platforms.

In some cases, using management, in a more traditional leadership sense, to drive decisions to select specialized systems instead of general, develop policies that are used to create and foster a culture of sustainable practices and to lead by example, with both soliciting as well as generating innovation to achieve those goals. In some cases, these are hard decisions, as they may change solutions, practices and other things

[15] http://www.epeat.net/

that organizations and their members have become accustomed to or see at other similar organizations and don't "buy in to" these sustainability efforts. Often the first in an area to take a chance of decide to lead are often looked upon with skepticism, and not until quantifiable results are produced from the effort will minds tend to change and trust fostered.

Examples

- Power Management
- ACPI (Advanced Configuration and Power Interface)
- Office Recycling Programs
- Technology Consolidation Efforts (FDCC, desktop/laptop/mobile device count reductions)

Architecture

Business Process Re-Engineering

The addressing of business processes, from a holistic and inclusive standpoint, can assist in developing not only sustainable IT use but also complete business mission sustainability. Since information technology is often one of many components organizations leverage in order to address mission needs, reviewing and analyzing how IT interacts with existing activities, finding economies and efficiencies, and developing a plan that allows for the use of IT to be dynamically leveraged in the support of the mission or business objectives is vitally important to maintain a reasonable expectation of long term sustainability. These process may include removing or adding steps to a process, including or removing use of technology, changing the nature of the work performed, and possibly by whom, and even in some cases, change the location where processes are performed due to their impact on the local environment, workforce or other concern.

Consumables Management

Management of consumables within a business process is one of the quickest and easiest ways to make steps towards overall sustainability. Addressing things such as paper and toner use within an office, changing the sourcing of those materials to recycled or sustainably sourced solutions, or attempting to be an "all-digital" organization, are examples of steps than can be taken to immediately address the effort. Often as organizations grow, and possibly due to unintended lax management, more opportunities to inefficiently consume similar resources grow, through the use of personal office printers rather than a centralized and/or multi-function solution (scan/copy/fax/print). Other ways to curb consumable use is to change human behavior, as noted before, going all-digital or asking or addressing via policy to reduce the amount of printing and other wasteful behaviors.

Examples

- Paper/Toner, etc.
- Centralized Print Management
- Font changes for defaults (less toner used)

E-Processes

Keying into consumables management is the development of "e-processes", those activities and tasks that can be solely performed on an information system, and stay in the digital realm completely. This ranges from communications, such as e-mail, library catalog access, and even billing, but can also include more interactive capabilities such as voice and video for training and meetings (such as telepresence). This not only has the added benefit of cutting down on typical consumables such as paper, toner, and plastics, but also reduces energy consumption by putting access to these features in an "on demand" and "per participant" level, consuming power at a lesser level, and in the cases of video conferencing, reducing resources required to travel, which ranges from fuel to bars of soap in a hotel room. Simply identifying the process that can best adapt to this model grows their sustainability, even if the underlying systems supporting them can not be directly adjusted.

Examples

- Electronic communications only (advice of pay, notifications, awards, etc.)
- Electronic transactions / Forms
- Remote/Virtual Training
- Video and Audio Conferencing/Telepresence
- Library material in electronic format (e-Journals and Databases)

Direct Consumption Billing

Charge on a consumption basis to curb habits and instill innovation and re-engineering voluntarily. It acts like a "consumption tax", and much like the use of water and electricity, if IT is handled much like a utility, receiving a direct bill, or a detailed breakdown of the consumption of specific resources or services, those individuals and groups interested in reducing costs will modify their behavior. This technique also has a benefit of deriving the "real cost" of delivering services and resources due the accounting and instrumentation required to acquire the data. This drives data driven decisions and results in less "gut check" choices and gives management solid statistics from which to derive savings and look to where investments are performing efficiently. This type of billing and analysis is not foreign to the public sector, as many less technology orientated services are already handled in such a fashion. Current cloud and virtualized technologies are billed on a consumption basis, either if by storage, compute, bandwidth or memory utilization, which keys well into the push for managed shared services as a way to consider sustainable IT practices. Conversely, consumers of the resource only pay for what they use rather than buying in bulk or over paying, which allows for greater costs savings once the data in analyzed and leveraged for technology decisions.

Integrated Budgeting

Like direct consumption billing, the concepts of integrated budgeting, in which IT services and resources are transparent to the consumer provides another way to allow IT to become more sustainable. Once individuals and organizations are aware, at whatever detail supports decision making, they can budget and plan for the future with an eye towards becoming and maintaining efficiency in operations and resource expenditures. This has an added effect of foster conservation, by organizations requesting and using only the resources they feel they need and prove to be essential to do business. Often the information technology component (often managed by a CIO) is seen as just being "there" like a utility, however expenses are treated as loss leading (sunk) cost center, like one would treat rents and real estate, since accounting for each year and making a change if the rents increased, too hard, so it's just paid for. In the integrated billing methodology, the costs are brought into each groups budget in an organization as a cost of performing their mission tasks, which can be paid for and shared as a lump cost for IT or broken down as a subscribed to service catalog[16], from which each group pays for services and resources off of a "menu" of capabilities.

[16] http://en.wikipedia.org/wiki/Service_catalog

Human Resource Management

Work Flexibilities

Often a missed opportunity, managing workers, can be an essential contributor to making information technology more efficient, scalable and sustainable. This includes flexible work schedules and telework to help make an impact on non-traditional aggregate contributors to resource consumption. Alternative transportation options or incentivizing workers to choose green commuting options also has a positive uptick in greening IT by making the workers less location and schedule dependent on where they perform their knowledge working. Other accommodations include, when tied into a flexible work schedule, is hoteling, in which office space is shared as an on-demand resource, which reduces overall employee footprints within buildings and other workspaces.

Behavior Modification / Culture

One of the lowest cost highest return sustainability efforts begin with the employee, volunteer or organization member – which is the change or modification of habitual behavior. Simple actions such as turning off the lights when leaving an office or other facility, adjusting the thermostat (when available) to a minimal comfort level, or curbing old habits of printing everything out and leveraging digital analogues such as e-paper compatible mobile devices or high resolution displays. Culture change issues can be lead by management, or be incentivized by competition through gamification[17], but often unique approaches will be necessary to change actions that are rote and habitual and done, often, without much thought. Other habits or misconceptions may be more difficult to change, such as built in selection biases, such as those against recycled paper or particular manufacturers of equipment. In many cases these can be addressed via procurement and acquisition policy and rules, but also requires leadership to follow through on small things that have greater impact when multiplied across multiple locations of operation and many people.

[17] http://en.wikipedia.org/wiki/Gamification

Locale

Domestic

Standards

LEED – U.S. Green Building Council

Sustainability Accounting Standards Board[18]

Sustainable Technology Environments Program (STEP Foundation)[19]

Laws

Executive Order 13423[20]

Executive Order 13514[21]

[18] http://www.sasb.org/techcomm-standards-download/
[19] http://www.thestepfoundation.org/
[20] http://www.gpo.gov/fdsys/pkg/FR-2007-01-26/pdf/07-374.pdf
[21] http://www.gpo.gov/fdsys/pkg/FR-2009-10-08/pdf/E9-24518.pdf

California – Public Contract Code (Sections 12400-12404)

California – "Buy Recycled" Law – Public Contract Code (Sections 12153-12156)

Massachusetts – Establishing and Environmental Purchasing Policy - Executive Order No. 515

Guidance

FedCenter Sustainability Clearinghouse[22]

Environmentally Preferable Purchasing (EPP) Programs (CA, NY, OR, CT, ME, MA, NH, RI, VT)[23]

Best Practices

Electronic Take Back Coalition[24]

U.S. Department of Energy – Best Practices Guide for Energy-Efficient Data Center Design[25]

International

Standards

IEEE 1680

ISO 14000

ISO 26000

ISO/IEC JTC 1/SC 39

Energy Star

TCO Certifications

International Green Construction Code (IgCC)[26]

Standards Map (ITC)[27]

Laws

Restriction of Hazardous Substances Directive (RoHS)

Conformité Européenne (CE)

Waste Electrical and Electronic Equipment Directive (WEEE)

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[22] https://www.fedcenter.gov/programs/sustainability/
[23] http://responsiblepurchasing.org/resources/state_profiles/
[24] http://www.electronicstakeback.com/home/
[25] http://energy.gov/sites/prod/files/2013/10/f3/eedatacenterbestpractices.pdf
[26] http://www.iccsafe.org/CS/IGCC/Pages/default.aspx
[27] http://standardsmap.org/

Guidance

BS EN 62075:2008

> Audio/video, information and communication technology equipment. Environmentally conscious design

European Commission Codes of Conduct (Information & Communication Technology)[28]

Best Practices

Sectors

Private

Large

McKesson (healthcare & IT)

Sun Microsystems (Oracle) – OpenWork

Dow Chemical (plant operations – process control automation)

HP/Hewlet-Packard – Intel

MeadWestvaco

Medium

Timberland

SAP

Small

Public

City/County/Municipal

City of San Jose

City of Phoenix

State

CA Dept. of General Services

Federal

Academia

Public

Private

[28] http://iet.jrc.ec.europa.eu/energyefficiency/ict-codes-conduct

***Stanford University*[29]**

Other

Challenges

Return On Investment (ROI) Time

Many sustainability activities often do not show the return on investment (time, resources, money, etc.) in the time span of most typical business cycles, and may require long term understanding that recovering any investment costs may only be recuperated slowly or progressively once some of the capital investment cycles roll, which for some projects can rage up to a decade or more. However, piecemeal activities that may not be constrained by a long-term investment that occurred before a sustainability effort was put underway can help satiate the desire to see that return and flatten the curve on expenditures versus savings that typically business and other organizations expect.

No Universal Solutions

Unfortunately, many sustainable efforts are not a "create once, use everywhere" solution, and often require tailoring for a particular environment, sector, population, or process. Changes may increase or decrease efficiency, introduce cost fluctuations, and even affect staffing of those required to actually perform the activity. Standards exist or are being developed, but the force of law doesn't cite these standards, and most will attempt to comply only voluntarily or if it may help address bottom line issues (public image, budget, etc.). In many cases, each path to sustainability is also individual to the organization attempting to achieve it, as their demands on suppliers, resources, staffing and environment varies greatly depending on mission or business.

Security

The security of outsourced solutions (logical and physical) poses a challenge for those who've typically built systems around a "castle wall" architecture and typically do not have policies in place for the handling and transfer of sensitive materials and operations to third-party providers, even if those activities in the long run prove to be more efficient and sustainable. This does require not only a novel approach to process re-engineering, but also establishment changes in culture and trust which often are not something that can be addressed in a wholesale "all at once" methodology. In many cases, contract language can be written to accommodate differences between practices by an outside provider and the current organization, however, auditing of compliance with these changes and new polices may create inefficiencies of their own and need to be considered when adapting such models.

Internet of Things / Sensor-Nets

With the push towards acquiring more data but also a more responsive environment based on user habits and needs, the push to instrument the world, through the application of "smart" devices in our lives has a tenuous balance to strike between consumption and conservation[30]. The drive towards smart informatics

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[29] http://sustainablestanford.stanford.edu/sustainable_it

[30] http://www.eiscaa.com/Files/Posts/Portal1/green.pdf

that collect and operate on the data from the environment they are deployed in plays towards a difficult balance of consumption to operate, but in turn, works to maintain conservation and smart usage of not only itself but the other objects in the environment nearby. Some sensors and instrumentation work on a passive architecture, and only will sample and provide data upon a direct read or interaction, such as those baring a barcode, RFID or other field energized transmitter, or low power wireless such as ZigBee.

Novel Approaches

- Re-purpose end-of-life equipment; for example, reuse PCs as thin clients
- Migrate to the Public Services Network (PSN) – an integrated 'network of networks' – to reduce network circuit and equipment duplication
- Adopt a clear 'waste hierarchy' to ensure surplus equipment is reused or refurbished
- Significantly reduce travel & consolidate staff

Conclusion

A good definition for a sustainable information technology system is one that is designed, installed, operated, maintained, rehabilitated, and reused/recycled with an emphasis throughout its life-cycle on using natural resources efficiently and preserving the global environment. In order to be a long term activity, the "cradle to grave" approach of being nearly a closed loop of raw resource to product through use and then disposition, it has to be able to conserve or reach near zero-waste or harm to the surrounding environment and users as time proceeds on. Think of it as a hoop rolling along, only touching the environment around it at a small point, leaving very little to no impact, but the hoop eventually reaches the destination, and no impact should have been felt due to it passing through. While that's an optimal goal, because of all the moving parts involved in producing, delivering using and disposing of technology, it takes a lot of detailed analysis and close monitoring to assure that those impacts are minimized. Some are handled via regulations and other laws, others are provided as guidelines and best practices, and depending on where the activity occurs, it's up to the organization implementing an IT solution to consider all of this and strive for the best and most efficient balance based on their needs and ability to achieve them.

In order to effectively apply these strategies and techniques into practical use, along the lifecycle, organizations should be active in measurement of goals and activities, monitor progress to those goals, manage the processes and ensure they are succeeding, in cases where some may be failing or not achieving goals, attempt to mitigate issues early on to avoid waste of resources, time and expense. It will be vitally important to work with partners as many sustainability efforts leverage outsourcing activities, such as cloud services, shared networking and other solutions that may be too complex or expensive for organizations whose core competencies are not in those areas.

Appendix

TBD