Key for "Enterprise Technology Roadmap"

VM Clusters / Grid Computing - While not exactly interchangeable, virtualization (the V in VM) and grid computing are intertwined in that they scale computing resources over "atomic" computing elements. The grid concept spreads the workloads on a single intensive computing task among a number of nodes to speed up (and/or gain efficiencies) that would not be achieved on a single processing unit, such as a really big computer. These computing atomics that make up the grid are often loosely coupled, heterogeneous and geographically dispersed (much like a basic cloud model). Virtual machines are a software abstraction of a "real" machine that would typically be deployed, one-to-one on a given piece of hardware. In the cases of VMs, these computing containers can be extracted, deployed, upgraded/expanded (scaled), and shut down as demand allows, saving resources over having under or over utilized systems that were previously dedicated just for that one system instance. The side effect of virtualization technologies which is now utilized by cloud infrastructure, is the ability to move the machine around, for high-availability, in the case of underlying hardware failure or maintenance. In both cases, grid and virtual, these machines can be highly tuned and optimized for certain tasks rather than have the overhead associated with most dedicated service deployments.

Big Data - This is the embodiment of needing to process, analyze and visualize data sets that are so large, that traditional means (such as relational databases) can not effectively support it. DOI is rich with such challenges, ranging from geospatial to instrumentation feeds to historical data - all of which, due to demands from OMB via Data.Gov, require much of it to be shared with citizens and taxpayers. As a further tax on handling and managing this data, comes with the USG government requirement to properly tag and classify such data as it pertains to sensitivity and public safety. On top of the initial capture and storage challenges are developing and supporting tools that can analyze, correlate, and display and visualize these massive data sets into human- (and often machine-) understandable formats. With the addition of "smart things", more and more data will be generated and at the fingertips of consumers, and in order to make all of this useful, techniques and technologies need to developed to make sense of it. In certain cases, stitching together cloud computing technologies with the 'social web" will be the next big leap in this space, offering bridging technologies to blend human and machine interactions to solve problems.

Cloud - This is the general expression used to describe the computing concepts that have blossomed out of virtualization and grid computing that help extended the componentization of various subparts of the afore mentioned base technologies. The use of virtualized machines, over an elastic and redundant high-speed interconnected network, results in the ability to offer expandable, reliable and cost-effective technology services to consumers, including enterprises. The upshot of this, versus typical VM and grid solutions, is that the virtualization aspects has

allowed for these resources to become commodities that the market has consolidated into service offerings. Essentially, a consumer can subscribe to what they want and not be bothered with who supports it, upgrades it or expands the features - as long as it remains up, accessible and at a cost that is cheaper for them to perform the same task themselves - in other words, leveraging the "economies of scale" with converged infrastructure and shared services.

MaaS - *Management as a Service* is essentially outsourcing the management of IT assets and services to an outside provider, sometimes confused with the hiring of contractor to perform the work in-house to an organization, but more closely resembles placing the NOC or SOC for an enterprise into the hands of a 3rd party to cover shift work or even to fill in areas of expertise, including "hands on", that an organization does not have or will be willing to acquire.

TaaS - *Testing as a Service* is designed around the model of providing application and system and service testing capabilities for periodic or ongoing development projects. This is best leveraged by organizations that do not have nor desire in-house development capabilities, and leverage pre-launch or periodic testing of systems during the lifecycle of a system. These can be QA level testing harnesses to those which require testing by auditing for more substantial requirements before a system or service is deployed for use. In some cases, this will also include security and vulnerability testing, such as penetration tests, which can be useful to providing data for newly developed and deployed or previously deployed applications.

SaaS - *Software as a Service* is considered as the delivery of software components to users on a flexible "demand" basis via cloud and other technologies to create efficiencies. These efficiencies can revolve around cost and licensing, to the ability to manage and maintain deployed applications. These solutions can range from providing full desktop-centric client-server applications to providing those supporting web and mobile technologies that remain platform independent. These solutions are also developed around the ability to select software that has "hooks" or APIs into other SaaS and similar providers which allow plug-and-play with current in-house services and architectures, while leveraging the shared cost of maintenance and development of an external developer.

PaaS - *Platform as a Service* allows for a complete "stack" of components be provided as a "single acquisition" item for organizations who need a solution that conforms to a set of standards or technology requirements (such as LAMP - Linux, Apache, MySQL, PHP, etc.). Often the provider of the platform will offer components guaranteed to be integrated together as an "ala carte" offering to build the stack, which is hosted and managed by the provider, into the platform on which a developed or purchased application or service can be deployed. This offers, often, easier scaling based on demand, but, like SaaS solutions, allows for backend upgrading, patching and uptime support (including backups) to be turnkey without the organization needing to perform it.

IaaS - *Infrastructure as a Service* is essentially the "base" on which most other services and applications can be built upon, whether it be real or virtual, this can include networks, hardware/machines or other atomics in computing, such as storage or computer "blocks". These are designed around providing the building block components to more advanced services that organizations don't want to or do not have the capabilities (or skills) to effectively build, deploy or manage on their own. Traditionally, this has been marketed as the "cloud" part of the cloud services, such as Amazon's EC2, Google's Compute Engine and other components that can be subscribed to. The low-level stitching together of these components is offered by the providers, and allows for much flexibility to build nearly anything on top of them, provided it supports the underlying architecture.

VDI - Virtual Desktop Interface, is, essentially, desktop virtualization that allows for a user (or set of users) to access and interact with a standard paradigm as if they had a local full-fledged computer in front of them, but without having to individually manage each and every accessing device, such as a mobile phone, personally owned equipment, or other technology. This, much like virtual machines, allow for the up-scaling of resources on demand based on user preferences or system demand (such as using memory intensive applications). The other upshot, as noted earlier, is the centralization of the hosting of the desktop image on and within a controlled environment, but the ability to interact (and maintain state or session) and a number of accessing technologies. In certain instances, services from a users virtualized desktop can be parceled out and accessed individually (such as a license of an application) individually without needing to provide a full desktop interaction. This is often less of virtualized desktops, but reducing the display of a traditional client-server application to the application presentation window over a VDI solution such as Citrix as an "advertised application".

Mobile - In a more archaic format, mobile technology was described as simply providing cellular communications to mobile phones, to where now it encompasses all facets of computing known to the consumer and enterprise today. As technology has advanced, become more compact, and the layer above it, the operating systems, have become more sophisticated, much of what people traditionally did while tied to desktops or restricted to laptops are now available on smartphones and tablet-formatted devices. With that, the demand for high-bandwidth wireless data systems and networks have driven the need for reliable service providers and management infrastructure. Complicating the environment is the switch from developing enterprise-focused technology to adapting consumer-oriented technology to the enterprise, including managing application and device configurations (including provisioning, and user management). Mobile technology is expected to evolve into "smart things" that break down what is typically provided on these devices into something more distributed via embedded sensors and instruments in everyday things, as well as wearable technology.

BYOD / Variant - *Bring Your Own Device*, and variants on the theme (as this could be mobile, desktops, entertainment and gaming devices, or something yet to be

developed) will change how enterprises currently view the "perimeter", and to that, how data is accessed, handled, transferred and stored. This involved new ways about thinking about tagging and classifying data, developing and supporting strong authentication and authorization schemes, and ensuring that data is shared and stored securely. As the consumerization of technology far outpaces enterprise-specific development, the mentality of "just for business use" will have to be abandoned and new paradigms will come into place that leverage the efficiencies and economies of the consumer, with the policies and management of the enterprise.

Social Nets - This is essentially *social networking* as viewed today, but also in the expected transformation of "social computing", where, like the evolution of "smart things" into "intelligent computing" - of which each will eventually intersect to allow for knowledge transfer and optimization of support. If you have an appointment scheduled with friends, and need to get gas in your "connected" vehicle, the calendar on your smart watch/pad will automatically build in time for a scheduled alarm, route you to where you need to go and let your friends know you may be late if traffic is bad. This helps computing cross the human boundary, by developing information pathways organized by social graphs that the user develops or interacts with.

"Smart Things" - As explained by technologists, this circles around the concept of "an Internet of things", devices connected over a network that work in consort to gather data from the environment and themselves to enhance the user experience and efficiently provide information. This can include sensor networks, smart devices (appliances, entertainment, transportation, etc.), wearable computing (i.e., Google Glass, Apple iWatch, etc.) and other technology. These devices will constantly communicate and update one another about the state of the device itself as well as the environment and adjust how they perform their tasks based on that data. With the alteration in size and increase in number, the ubiquity of having all this data will allow for richer sources of data to better perform decision analysis.

Intelligent Computing - Intelligent computing takes the "smart" technology further by adding a level of autonomy to the mix, such as self-assembling and modifying technology, swarm computing, and predictive AI-level systems. The technology is "fire and forget", such as once deployed, the technology will continue on task without interaction from a user and leverage data gathered from it's sensors of the environment as well as other data feeds to adjust it's own computing and work. In some cases, this technology will seek out resources it needs to complete tasks and provide data back to the requestor to solve problems, dynamically requesting, provisioning, and utilizing what it can find in it's environment or via it's own social network. In essence, this provides the "intelligence" by adapting it's own "thinking" about how to best solve a problem with available resources like a human would traditionally be required to perform.

Extremely good resource about trends. (This was not where the data was pulled from, but coincides with what is being discussed.)
http://www.connectedtech.org/uploads/docs/InterLink-IT-Trends-Report.pdf