Enabling the SmartGrid through Cloud Computing

April 2012

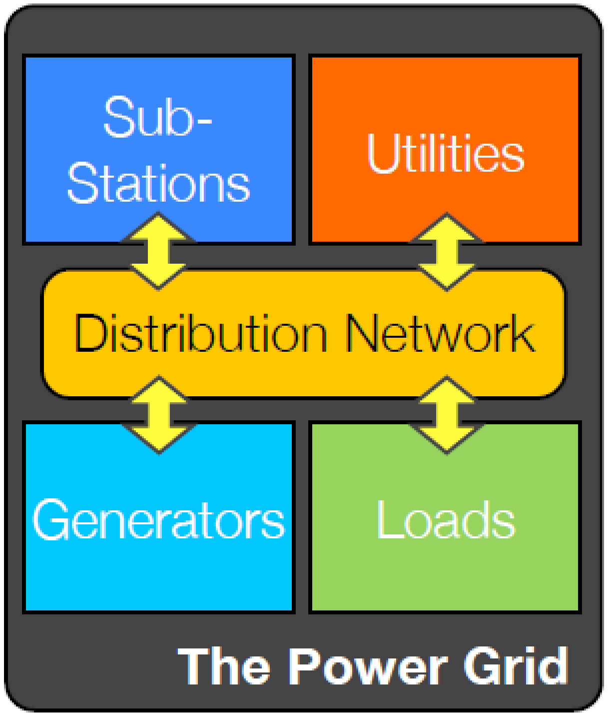
Creating Value, Delivering Results

Overall Objective

To deliver electricity from suppliers to consumers using digital technology to save energy, reduce cost and increase reliability and transparency.

Today's Power Grids

- Power Grids are formed mainly from generators, networks and loads
- Utilities will often control the power grid, and sub-stations will also be built to step voltages and ensure transmission



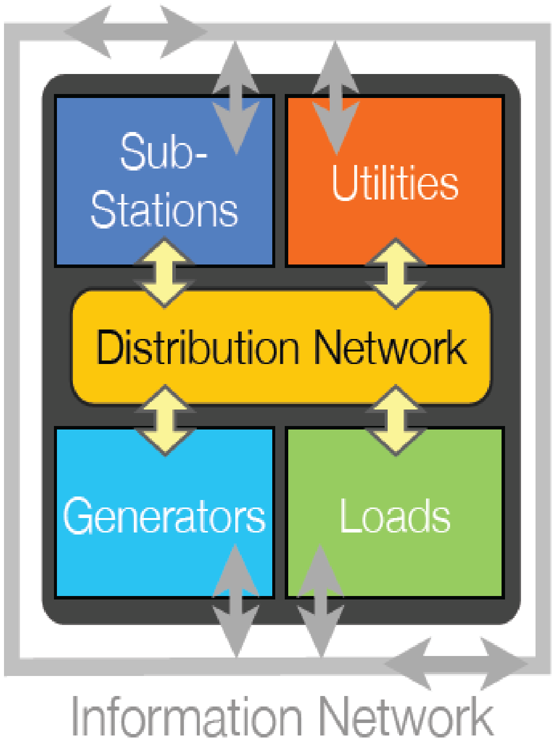
Today vs. Tomorrow

- **Today**
  - Power Grids rely upon excess standby generation capacity for reliable power delivery. Blackouts occur when there is no excess generation

- **Tomorrow**
  - In addition to standby capacity, the Smart Grid will rely upon distributed generation, future energy storage, advanced forecasting, and the ability to moderate consumption through dynamic pricing and demand response load reduction signaling based upon market and grid conditions.

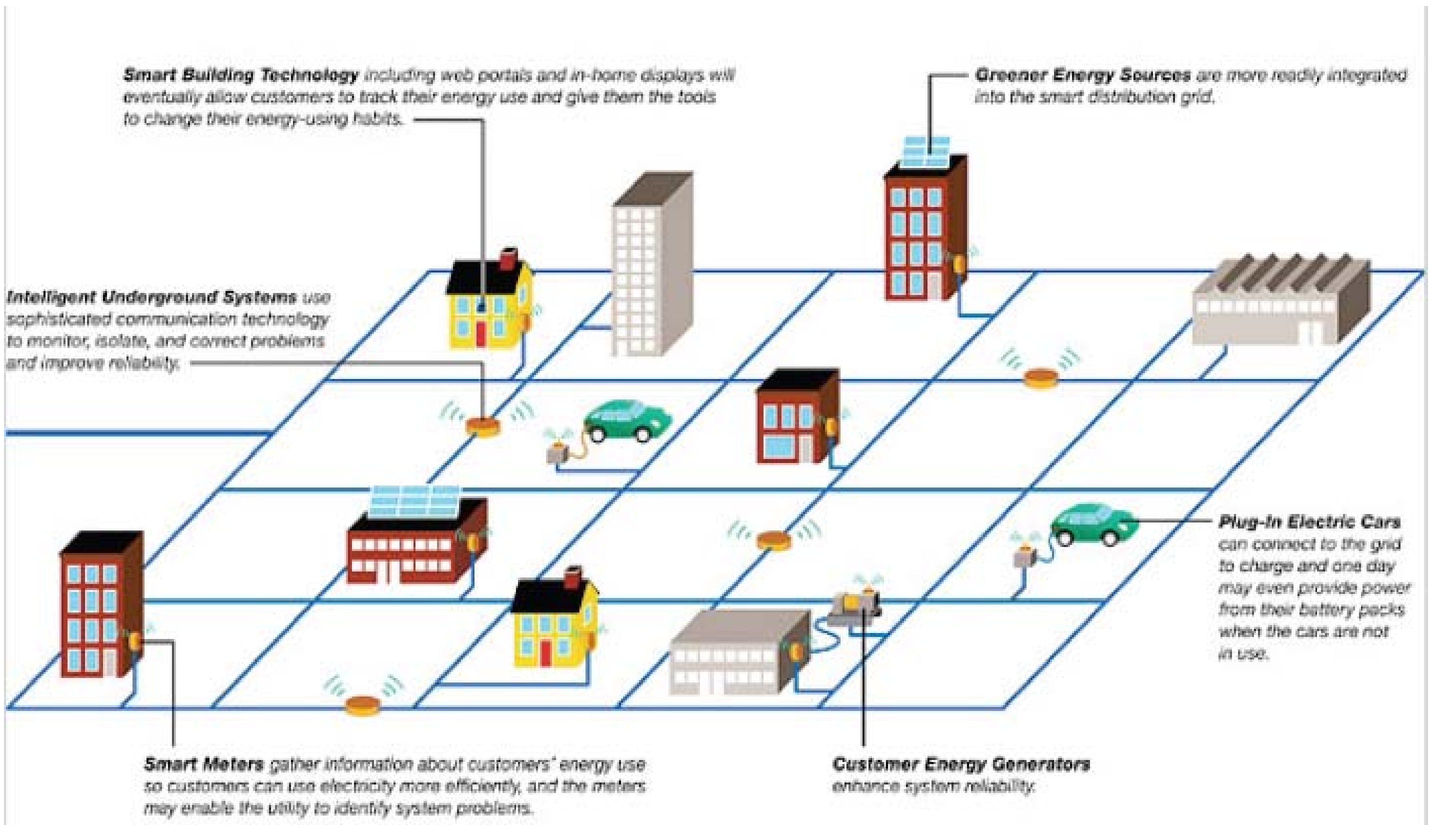
The Smart Grid

- A focus on data flow and information management central to the power grid, with the following goals:
  - Optimize asset utilization and operating efficiency.
  - Accommodate all generation and storage options.
  - Provide power quality for the range of needs in a digital economy.
  - Anticipate and respond to system disturbances in a self-healing manner.
  - Operate resiliently against physical and cyber attacks and natural disasters.
  - Enable active participation by consumers.
  - Enable new products, services, and markets.



Smart Grid Concept

Smart Grid puts information and communication technology into electricity generation, delivery, and consumption.



Key Elements

- **The following elements are critical to achieving this vision:**

1. **Sensing and measurement technologies**: To support faster and more accurate response such as remote monitoring, time-of-use pricing and demand-side management.
2. **Advanced components**: To apply the latest research in superconductivity, storage, power electronics and diagnostics.
3. **Advanced control methods**: To monitor essential components, enabling rapid diagnosis and precise solutions appropriate to any event.
4. **Improved interfaces and decision support**: To amplify human decision-making, transforming grid operators and managers quite literally into visionaries when it come to seeing into their systems.

Key Element: Infrastructure

- **The following infrastructure elements are critical to enabling Smart Grid:**

1. **Security & Encryption:** The Smart Grid community must publish detailed specifications for different levels of security and encryption standards. Smart Grid security needs to be thoroughly investigated to enable a multi-tiered security model for the grid.
2. **Open Application Programming Interfaces (APIs):** Ensures integration of the Grid with different endpoints (i.e. smart meters, advanced metering infrastructure, programmable logic controllers (PLC), wireless mesh networks and portal gateways).
3. **Secure Grid Layer:** For centralized, classified administration, monitoring and controlling of grid resources and functions.
4. **IT Infrastructure Disaster Recovery:** A fault-tolerant channel to ensure that all resources are set up for collaboration to deliver an automated, self-healing recovery operations process. Should not disrupt any other basic channels of communications or utility services.

Key Element: Integrated Communications

Integrated Communications: **Connecting components to open architecture for real-time information and control, allowing every part of the grid to both ‘talk’ and ‘listen’.**

- The Smart Grid will need to be supported by an integrated communications network and well-defined communications protocols. (For example, the Internet Protocol Suite (TCP/IP) enabled a common inter-network protocol for web-based communications.

- Communications will most likely make use of two different types of networks:
  - Access networks: Typically used by remote devices for communication at the edge of the network. (i.e. WiFi)

  - Backhaul networks: High capacity, low latency broadband networks that extend the enterprise network to remote areas, bringing the data from the access networks back to the enterprise. Includes both wired and wireless point-to-point and point-to-multipoint broadband systems, fiber and microwave systems. These backhaul networks will form the backbone for all Smart Grid access networks.

Other Application Needs

- ✓ The need to use standard data models and communication encoding technologies.
- ✓ The need to be compatible with as many relevant standards as practical.
- ✓ The need to be compatible with the existing Internet and broadband infrastructure.
- ✓ The need to scale quickly and economically.
- ✓ The need to provide access and cyber security that is compatible with existing firewalls.
- ✓ The need to provide low-latency communications.
- ✓ The need to provide highly available communications.
- ✓ The need to provide rapid time-to-market along with acceptable costs.

Cloud Computing

What is Cloud Computing

Cloud computing (according to NIST) is defined as:

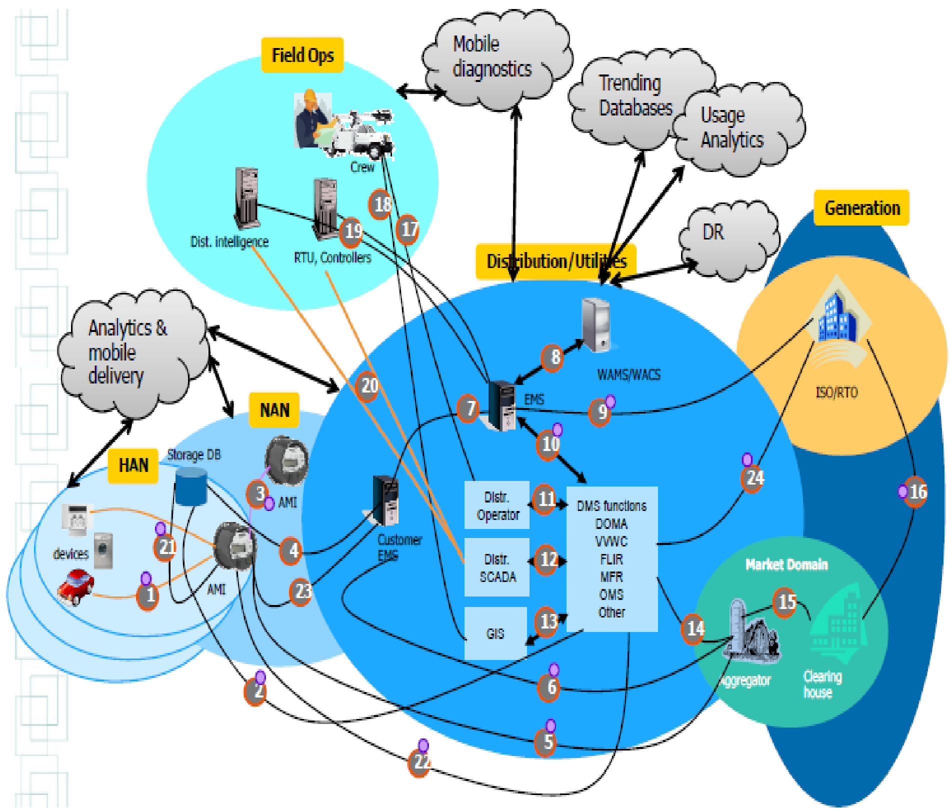
- *"a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."*
- **The characteristics of cloud computing include:**
  - On Demand Service
  - Ubiquitous Network Access
  - Location Independent Resource Pooling
  - Rapid Elasticity
  - Measured Service

***In order to achieve a "scalable, demand-based Smart Grid IT Infrastructure", cloud computing solutions and services must be incorporated*.**

Beyond the Utility

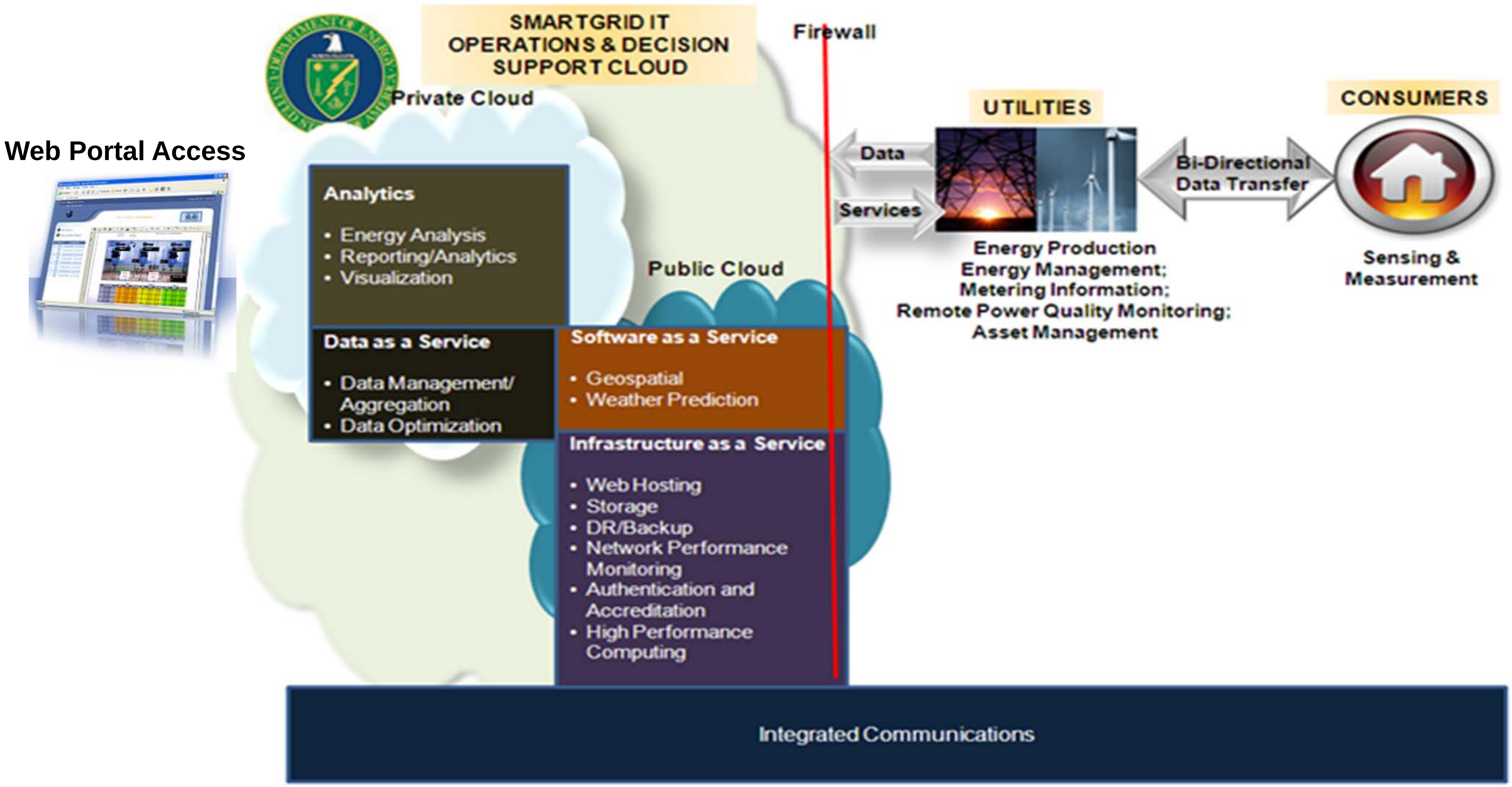
A cloud architecture at the utility level is important, but how will:

- Energy usage be monitored across the country?
- Energy be redirected between utilities and regions?
- Energy health and reliability be monitored on a nation-wide level?
- Data and technology standards be developed?
- Data interoperability be accommodated?
- Common services be reused?
- Knowledge/information be shared?



Concept of Operations

A DOE-focused Hybrid Cloud Concept of Operations



Integrated Hybrid Cloud Concept

This "Ecosystem" is based on an integrated hybrid Smart Grid Cloud consisting of the following:

DOE Smart Grid Private Cloud: Developed and owned by the Department of Energy (DOE) and to be used primarily for energy data management, reporting, and analytics. Services will be based on standardized data collected from utilities nationwide and maintained in a secure environment due to sensitivity.

- Services can be provided to stakeholders (such as State Governments, Local Governments, and Utilities) through a web-based environment so that energy reporting and analytics can be performed in a standardized, approved, and reliable manner

- Data and service access will be restricted by DOE through well-defined security access controls and end-user authentication.

Integrated Hybrid Cloud Concept (continued)

- By offering aggregated, centralized data management services, the Department will have comprehensive energy data visibility and transparency reflecting real-time conditions across the United States.

    - "Data as a Service" model will enable DOE to continuously monitor the health and performance of the Smart Grid and to support energy management decisions quickly and accurately. DOE will also be able to use this aggregate, real time data to perform trend analyses, forecasting, demand planning, infrastructure planning, and to immediately detect outages, shortages, and performance issues.

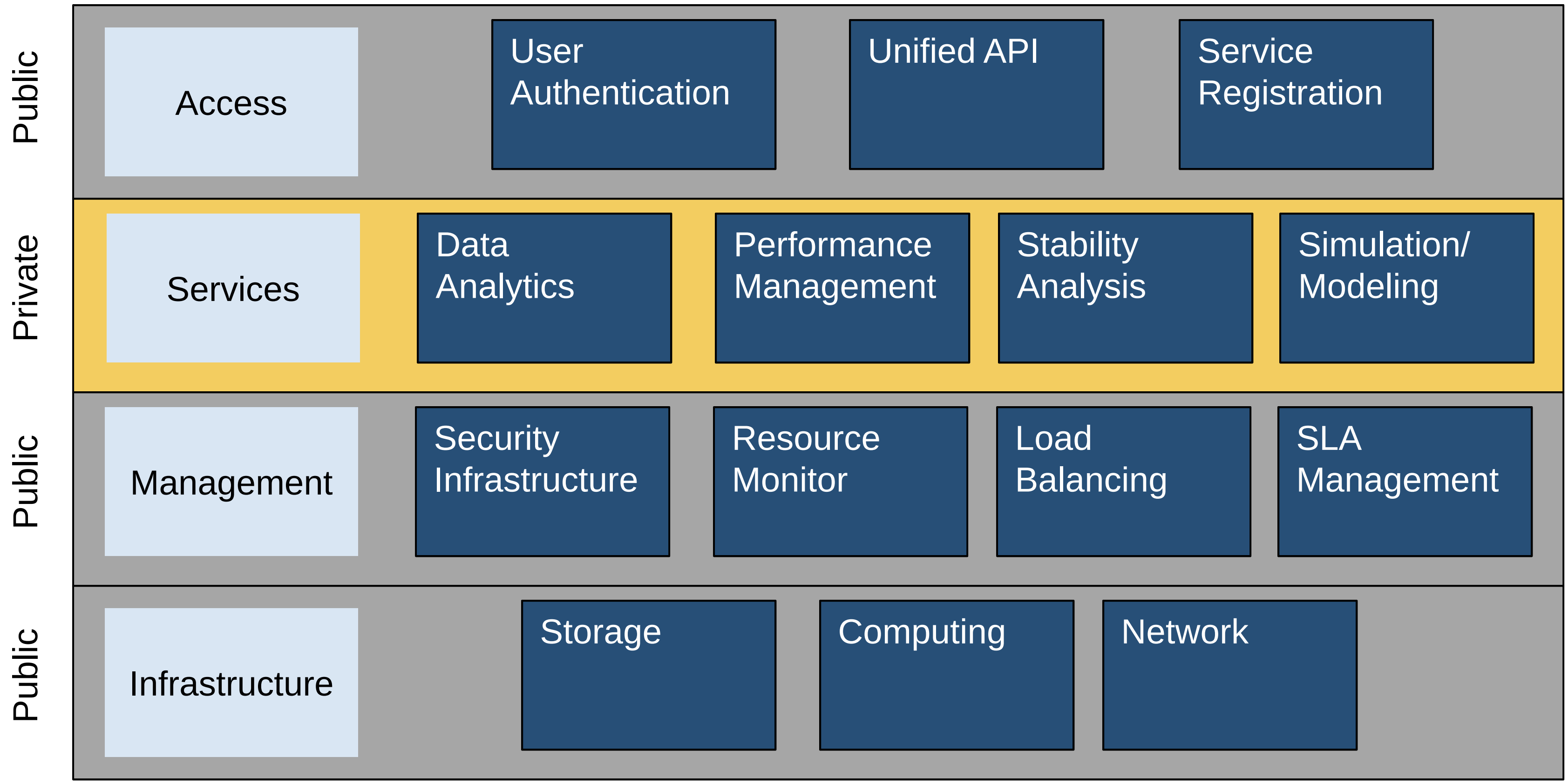
- Command and control functionally will reside with DOE – enabling centralized administration of services and the supporting IT infrastructure.

Integrated Hybrid Cloud Concept (continued)

Public Cloud: The DOE Smart Grid private cloud will be supported by common and fully integrated IT infrastructure services procured from public vendors.

- **Rationale:**
  - Cost Savings: Decreased need to spend large sums of money into developing and managing an IT infrastructure
  - Pay Per Use: Ability to pay more when there is a spike in demand and a need for increased capacity – and will pay less when there is decreased demand.
  - Carbon Footprint Reduction: No need to build redundant data centers and server farms.
  - Leverage Existing Technologies: Use of commercially available solutions for Geospatial imaging, mapping, and weather forecasting solutions – which can be combined (or "mashed up") with energy data collected by DOE to enhance analytics and visualization capabilities.

Cloud Model Summary View



Using Data to Make Decisions

Data and the Smart Grid

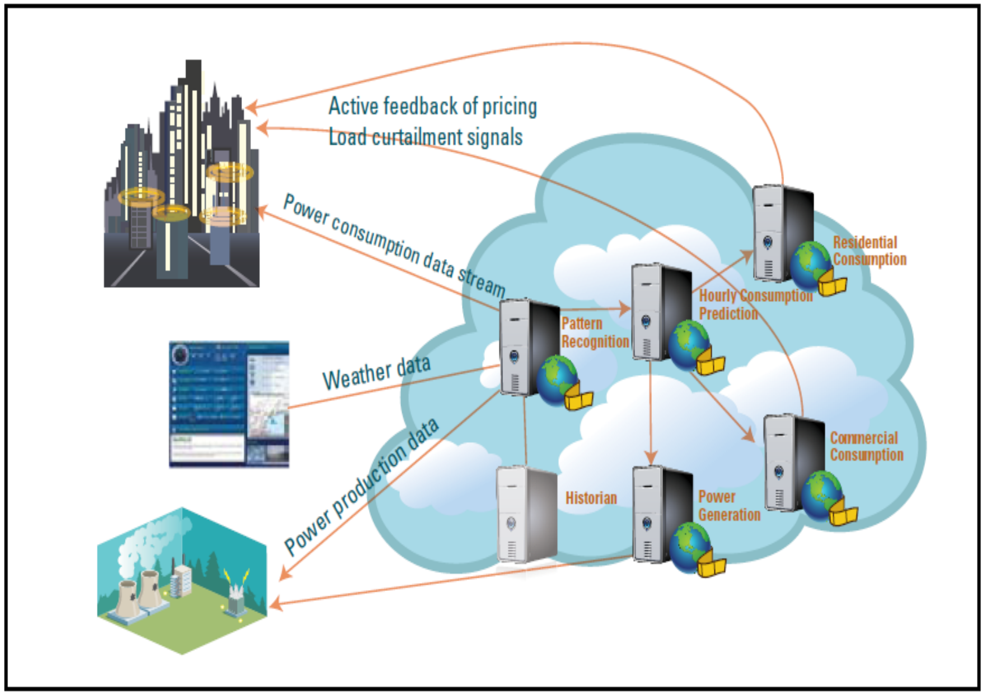
A major component of the Smart Grid initiative is accurate and timely information that can be analyzed in order to make rapid decisions. The gathering and analysis data will raise consumer, state, and national "situational awareness" of energy needs to allow all stakeholders to make better decisions.

- Smart Grid connects consumers by means of the right price signals and smart appliances. By enabling consumers to automatically reduce demand for brief periods through new technologies, and motivating mechanisms like real-time pricing, the grid remains reliable – and consumers are compensated for their help.
- Consumer participation provides tangible results for utilities which are experiencing difficulty in siting new transmission lines and power plants.

Data and the Smart Grid

Cloud platforms are intrinsic to creating a software architecture to drive effective use of Smart Grid applications. Cloud data centers:

- Can accommodate large scale data interactions that take place on Smart Grids
- Are better architected than centralized systems to process huge, persistent streams of data generated across the utility value chain.
  - On-going data streams from multiple sources need to be continuously monitored, verified, and processed given changing conditions, with near-zero latency (Complex Event Processing)
  - Assessment needs to be real-time



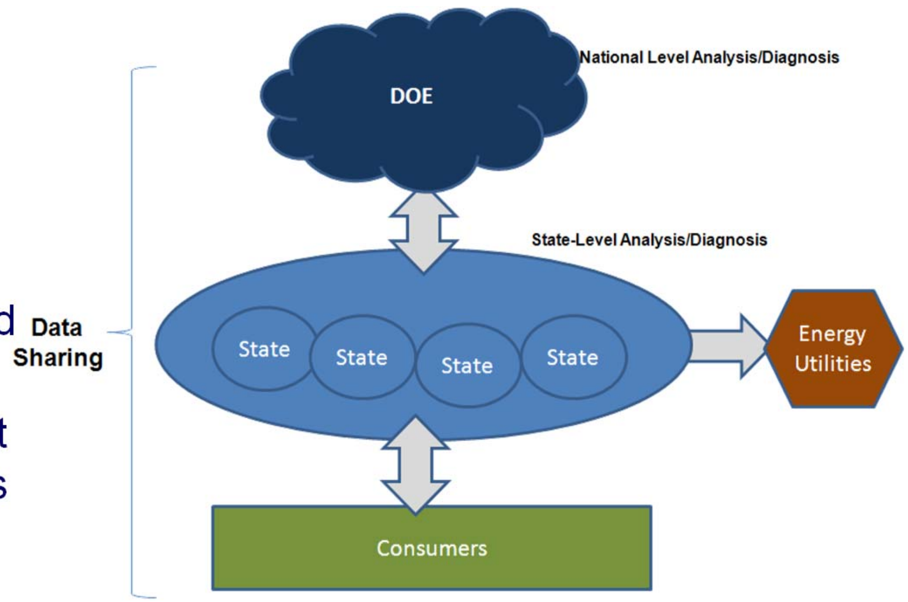
Other Considerations

- **Data needs to be assessed against several factors, such as geographic location, in order to make effective decisions. For example, VERDE (Visualizing Energy Resources Dynamically on Earth), in development for DOE at the Oak Ridge National Laboratory, will provide wide-area grid awareness, integrating real-time sensor data, weather information and grid modeling with geographical information.**

  - Will enable exploration of the state of the grid at the national level and switch within seconds explore specific details at the street level. It will provide rapid information about blackouts and power quality as well as insights into system operation for utilities.
  - With a platform built on Google Earth, it can also take advantage of content generated by Google Earth's user community.

The Benefit of Cloud Computing

- **A Cloud Computing approach will allow DOE to:**
  - Provide tools such as Verde via the Web to all applicable stakeholders;
  - Provide services as such a Google Earth to state, local entities to assess their data via a common, standardized format;
  - Provide other analytical/measurement services to all applicable stakeholders (enabling standardization and interoperability);
  - Enable an integrated data sharing environment that will allow state and national level analysis using the same information on demand.



The Challenge

1. **Determine an efficient way of processing queries incrementally and applying the results to emerging/dynamic business process models**
2. **Managing and accessing data efficiently**

Potential solutions do exist:

- **OSIsoft's PI System: Operation data management infrastructure for Smart Grid components**
- **IBM's Infosphere Streams: Stream processing system that continuously analyzes massive volumes of streaming data**
- **mySAP ERP: Adapts in-memory processing algorithms that delivers event-drive insight to understand the impact of operational events in real-time.**

eGlobalTech Contract Vehicles & Contact Information

Contract Vehicles:

- GSA 8a STARS II
- GSA Schedule 70
- GSA MOBIS Schedule
- 8(a), SDB Sole Source
- IDIQ Contracts

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