VITRIA

Advanced Analytics and IoT for Energy Utilities:

The Path to a Profitable Future

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The applications for advanced analytics in the utilities industry have the potential for adding significant business value in a number of ways – revenue enhancement, operational efficiency, and reduced costs. Achieving the best possible outcomes depends on understanding the use cases across all the operations of the business. The scale of the utility industry offers many opportunities and use cases where IoT analytics can add significant business value to their operations. The Vitria IoT Analytics Platform is one of the significant tools available to help utilities take advantage of advanced analytics and IoT.

I. TODAY'S UTILITY INFRASTRUCTURE vs. FUTURE – USE CASES

As shown in Figure 1 below, there are a number of scenarios and use cases in the industry where advanced analytics can add significant new business value. The examples range from improvements in basic operations to innovation in new products and services that drive new revenue for the utility.

USE CASES	TODAY'S INFRASTRUCTURE	FUTURE INFRASTRUCTURE WITH ADVANCED ANALYTICS
Active Consumer Participation	Uninformed customers consume passively	Informed consumers act in real-time to manage their power usage
Storage & Generation Options	Centralized only options limit efficiencies inherent in distributed generation	New forms of power generation and storage – often based on renewables - such as solar and wind
New Products & Services	Lack of tight integration limits consumer opportunities and wholesale markets	Products and services enabled by new and diagnostic information provided by advanced analytics
Power Quality & Loss Prevention	Focus on outages only	Characterized by a range of options and rapid resolution of issues vs. outages only; also detects and sets up smarter actions to avoid power loss along the grid
Optimize Assets & Operations	Process silos and limited data sharing restrict efficiency potential	Expanded data available increases options for optimized processes and active management of demand/supply
Self-Healing Systems	Reactive "after-the-fact" actions – protecting assets following fault	Detects and acts in real-time to prevent problems
Secure & Resilient Power Grid	Lack of real-time intelligence limits defensive options against malicious acts of terror & natural disasters	Detects and prevents stealing of power in various ways. The result is a secured grid with resiliency against attacks & natural disasters

Figure 1: Use Case Comparison: Today's Infrastructure vs. Future Infrastructure*

** The Smart Grid – An Introduction, prepared for the U.S. Department of Energy by Litos Strategic Communication under contract No. DE-AC26-04NT41817, Subtask 560.01.04*

II. MARKET & PLATFORM REQUIREMENTS

Successful implementation of this range of use cases as outlined in Figure 1 means that a new level of systems requirements must be met. These requirements can be summarized into the following categories:

- Bandwidth & Sampling Rate – communications required for real-time ingestion of data for a variety of IoT use cases
- Data Integration – fundamental requirement to interoperate with cloud platforms used by utilities as well as on premise systems that control various operational systems
- Streaming Analytics & Real-Time Response – the "always-on" requirement for utilities means that analytics and the actions associated with analysis must be done in real-time to have a meaningful impact on operations and business performance

Utilities have robust requirements relative to other industries in each of these key areas. The large volume of data that flows in real-time as well as the need to constantly monitor conditions in far flung operations creates a unique set of demands that traditional data and analytical architectures cannot support. New approaches are needed for utilities to meet their business goals in the environment of the future.

III. COMPLEMENTING UTILITY IT ARCHITECTURES WITH THE VITRIA PLATFORM FOR FASTER OUTCOMES

Implementing new technology for these use cases while maintaining normal ongoing operations is a major challenge. Dramatic changes to utilities architectures are rarely possible, and innovation must be done via an evolutionary and overlay approach for basic computing infrastructure.

The computing and communications infrastructure of a typical utility is usually some variation of the overview depicted on the left side of Figure 2 on page 3. The core architecture is often considered the "single version of the truth." These architectures usually include real-time services such as feeder automation and substation automation as well as enterprise services. Typical enterprise services include SCADA (Supervisory Control & Data Acquisition System), OMS (Outage Management System), ERP (Enterprise Resource Planning), GIS (Geographic Information System), and CRM (Customer Relationship Management). This information is typically less time-sensitive than core grid operations. Both of these sets of information are then passed to the business applications that consume this data. This traditional architecture works reasonable well, but was not designed with the demands of a modern utility.

Leveraging existing systems and assets while implementing advanced applications rapidly is a complex balancing act. The focus of the Vitria IoT Analytics Platform is to be a complementary overlay to the utility management architecture to enable faster business outcomes as outlined in Figure 1 on page 1.

The right side of Figure 2 below shows Vitria's Architecture with a high level mapping of the real-time and enterprise services busses to the Streaming Ingestion and Date Warehouse/ Data Lake components of the platform.

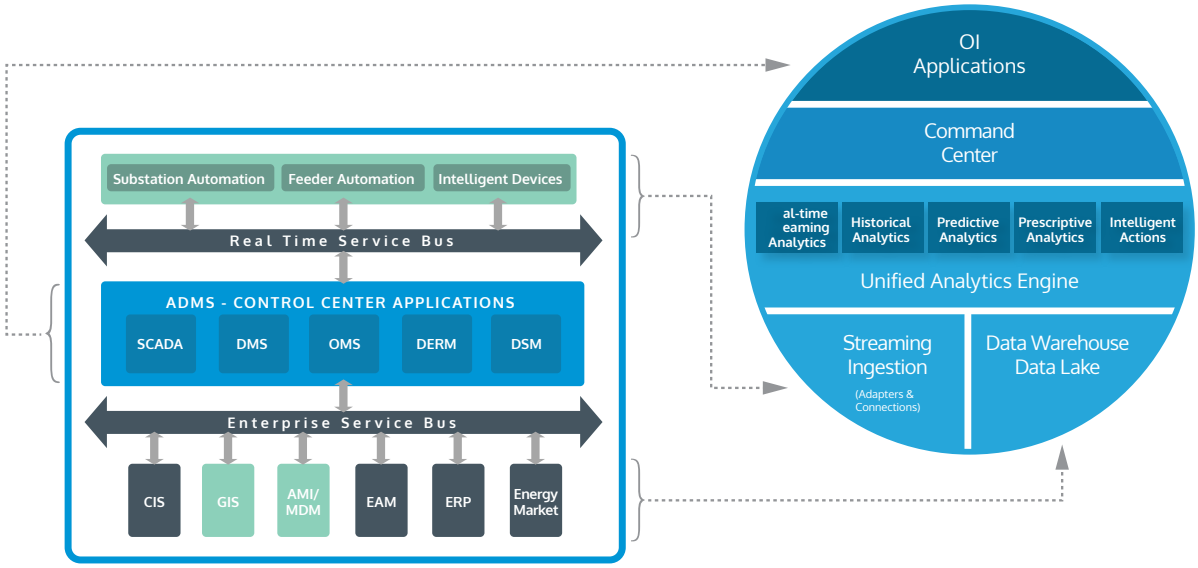


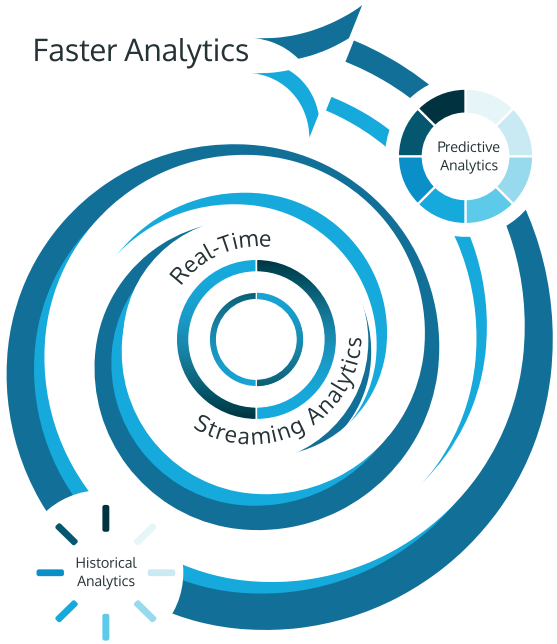
Figure 2: Mapping Utilities IT Architecture to the Vitria Platform*

The Streaming Ingestion & Data Warehouse layers of the Vitria platform support the real-time and enterprise services in a traditional utilities infrastructure. These Vitria services ingest data and deliver it to the Unified Analytics Engine that is the heart of the platform.

a) Unified Analytics Engine

The Unified Analytics Engine in the Vitria Platform provides real-time execution of the analytics value chain across streaming, historical, predictive, and prescriptive analytics and provides the analytical foundation for many of the use cases.

Most of the cases rely on the ability to react quickly in real-time to take actions that will address business value immediately. The Unified Analytics Engine's ability to process incoming data, and give it context against a



** Typical Utility Architecture as defined by Schneider Electric in "How the Convergence of IT and OT Enables Smart Grid Development" page 4.*

broader set of data is a common requirement in the utilities environment. Whether it is operational efficiency, capacity utilization, new product & services, or real-time pricing – the utilities network and infrastructure of the future requires a nimble and unified platform with analytics in real-time.

The Unified Analytics Engine combined with Intelligent Actions enables a unique level of real-time analytics and is complemented by a set of self-service and model driven tools that accelerate application development.

b) Analytics Value Chain in the Unified Engine

To address the challenges described above, there is a need to execute analytics in real-time across the analytics value chain (streaming, historical, predictive, and prescriptive) with relevant contextual and situational data that addresses the critical last step for timely outcomes. The Unified Analytics Engine drives this process in the Vitria platform. As shown in Figure 3 below, this is then combined with the ability to take the next best action in any particular scenario that creates the greatest value. The increasing value chain shows how each step in the process refines the data and adds more value and context.

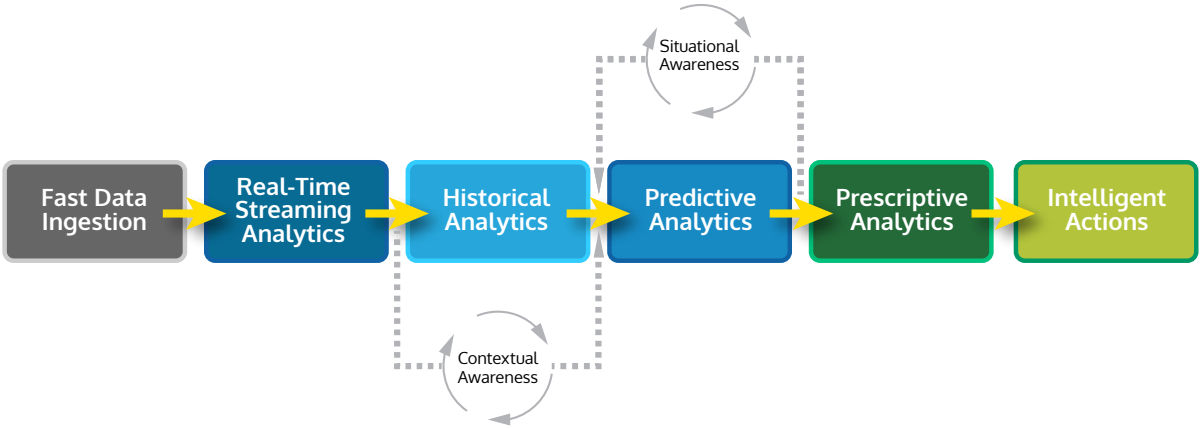


Figure 3: IoT Analytics Value Chain

- Ingesting data at speed and volume sets the stage for additional processing
- Real-time Streaming Analytics processes incoming streams of data from grid sensors and devices
- This refined data is then correlated with contextual and historical data to provide a baseline for advanced analytics. Contextual data can include information like GIS (geographic information systems) data relating to an application
- The next step is to predict failures, anomalies, or patterns using predictive analytics that are based on machine learning over historical and situational data such as external events like weather

- The final step in the analytics value chain is to apply prescriptive analytics to determine the next best action to take. This next best action could be a wide variety of actions associated with lowering risks, addressing an outage, or spinning up a new generator

The important point is that specific actions based on a rich understanding of history and context must be taken NOW in order to capture that value. New tools are needed to achieve this ambitious goal.

c) Vitria Command Center

The Command Center in the platform offers real-time dashboards and visibility into the processes and network to enable faster decision-making. Innovation in utilities infrastructure and services depends on having real-time access to network and device status, and the Command Center provides this capability.

IV. SUPPLY/DEMAND RESPONSE USE CASE - A CASE IN POINT

In IoT we deal with an enormous amount of data that has a high degree of variance over speeds, feeds and data cycles.

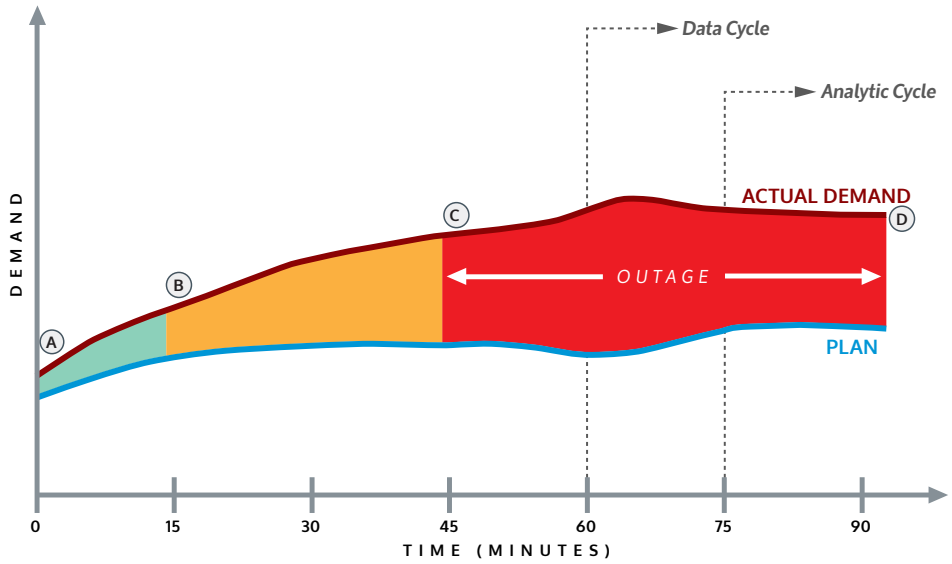


Figure 4: Supply-Demand Forecast with Traditional Analytics over Slow Data

In the case of the utilities industry, let's focus specifically on a meter readings use case. Consider a smart grid with 30 million smart meters with each meter reporting its energy consumption once an hour. It takes 60 minutes to complete a data cycle and additional 15 minutes to compute the analytics with traditional methods resulting in 75 minutes for a full data-to-analytics cycle. Such long cycle times are slow to react to sudden or unexpected changes in weather. Imagine a midsummer day where the

temperature is unexpectedly hot and humid. The supply plan would follow the bottom blue "plan" line as show in Figure 4 above, however the actual demand due to sudden surge in temperature will follow A to B to C to D in Figure 4 and eventually exceed the high-end of the capacity threshold. With traditional analytics you will not be able to foresee the problem until 75 minutes into the cycle where the actual demand is way above the supply plan. In addition, it would take another 30 minutes to spin up a new generator online to meet the demand. At that point it will have been more than one and a half hour during which the SLAs will not be met.

As a matter of fact, we will be receiving 500,000 updates every minute in this 30 million smart grid network. Statistically this is a significant population that we can leverage to predict trends.

a) Analytics Value Chain

To address the specific challenge described above and meet the future infrastructure vision of utilities, the Vitria Platform executes analytics in real-time across the analytics value chain. All use cases require the ability to create and build value across the value chain and take action to capture the value in a timely fashion. The updated value chain shown in Figure 5 below shows the process for key use cases and applications in the utility industry. The standard value chain is given situational awareness by events like weather and smart meter status.

FASTER ANALYTICS FOR UTILITIES ACROSS THE VALUE CHAIN

Achieving results requires a methodology to move along the analytics value chain and take the timely actions needed to capture value.

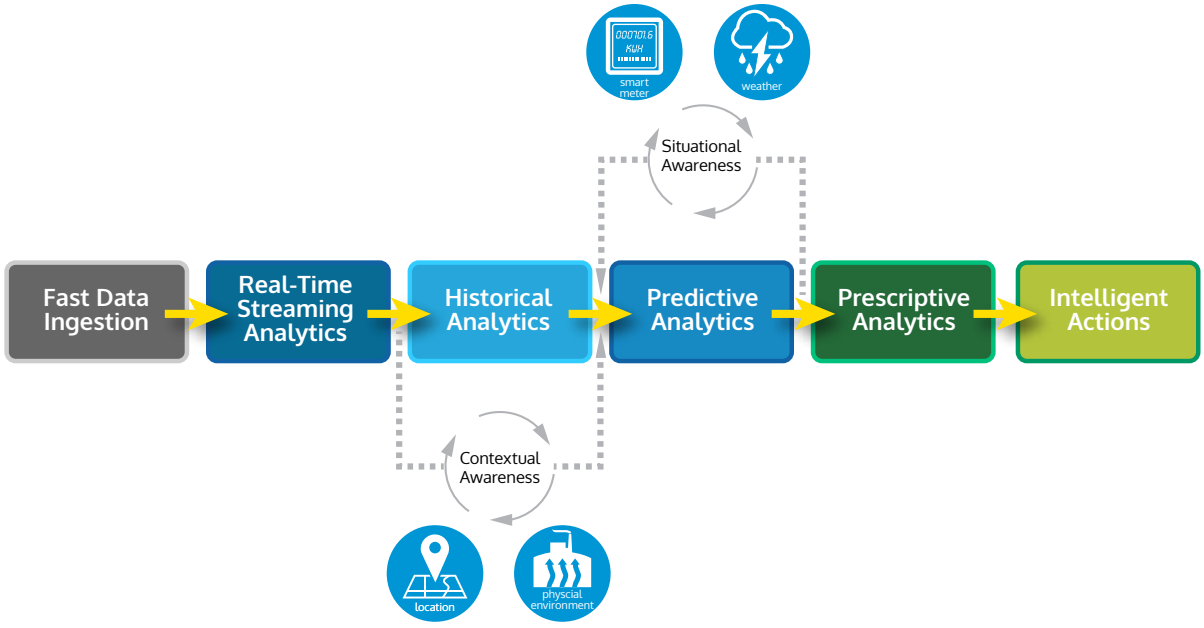


Figure 5: Analytics Value Chain for Future Infrastructure

Contextual awareness would be provided by the physical environment or location of a particular grid element or transmission site. The addition of these two types of context provides the ability to increase value for the Supply/Demand use case.

b) Faster Analytics with the Value Chain for the Supply/Demand Use Case

By applying the faster analytics of the Vitria Platform together with the analytics value chain, as shown Figure 5 on page 6, we can achieve the following:

- Within 5 minutes into the data cycle we can detect a variance from actual demand based on 2.5 million new readings, A in Figure 6 below
- Within 10 minutes into the data cycle we can predict a shortage of capacity based on 5 million new readings, B in Figure 6
- Within 15 minutes into the data cycle, we can predict an energy shortfall with over 99% confidence level based on 7.5 million new readings. At this point we can start to spin up a generator, C in Figure 6
- Within 45 minutes into the data cycle, we can bring a new gas turbine online, just-in-time to avoid the red state (new plan in Figure 6, D)

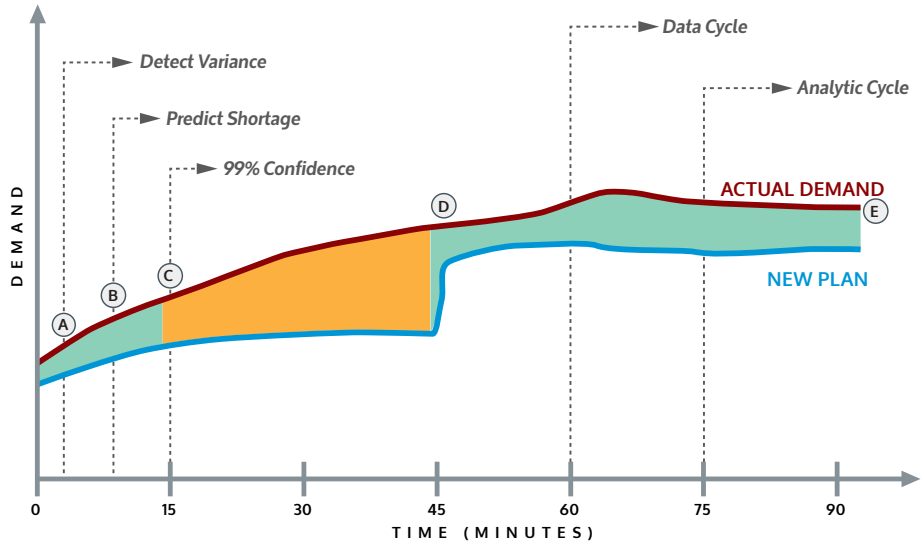


Figure 6: Supply-Demand Forecast with Fast Analytics over Slow Data

This scenario is highly relevant and extensible across all scenarios, where the use cases often involve dealing with millions of sensors, meters or devices providing continuous feeds at a given time. Applying fast analytics over sub-populations of slow reporting devices, with new data inflowing every second, improves business outcomes for utilities. In addition, faster and unified analytics enable rapid movement across the value chain to achieve maximum business value as shown in Figure 7 below.

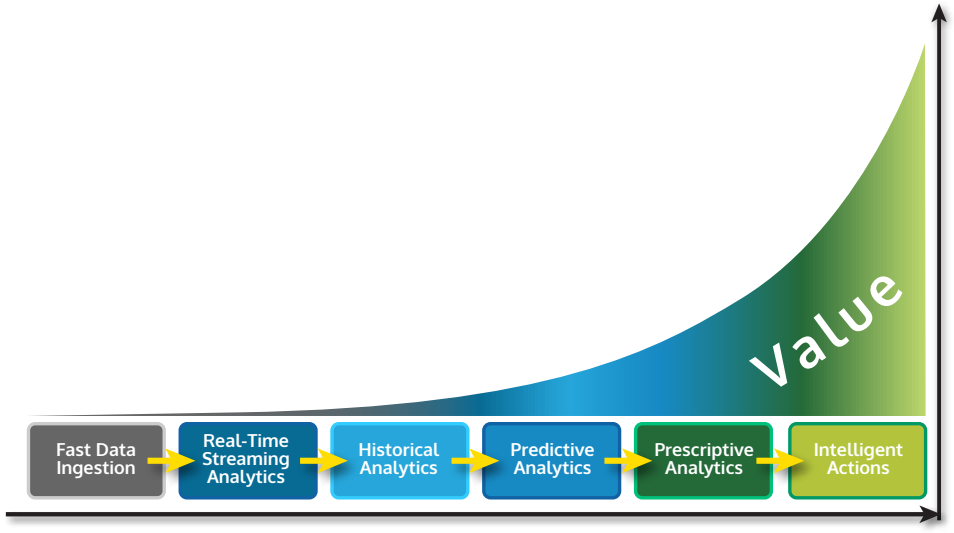


Figure 7: The Completed Analytics Value Chain

V. VALUE GENERATION BY UTILITY INFRASTRUCTURE MATURITY MODELS

Utility use cases and applications vary in their potential to add business value. The cases outlined in this paper can be generally divided into 3 maturity models that represent increasing levels of value (see Figure 8 on page 9).

a) **Maturity Level I – Basic Operations and Infrastructure:** Better reactive improvements to basic infrastructure and operations in areas such as power security (preventing theft of power), quality of power, and enablement of consumer management of their usage.

b) **Maturity Level II – Operational Efficiency and Cost Savings:** Proactive implementation of advanced use cases that drive efficiencies across the full value chain of the business provide greater value. Examples of this scenario include:

- Increasing the range of power generation & storage options – this includes new renewable generation options like solar and wind, as well as new technology to store and forward power to where it is needed most at any particular point in time.

- Asset Optimization & Operations Efficiencies – major capital assets require careful management to maximize ROI. Their scale means that small improvements can yield significant financial returns. Intelligent management of these assets drives significant value.

c) **Maturity Level III - Transformative Services:** The value generated goes far beyond basic operations or efficiency and drives major changes to the business value for the utility. These transformations typically take two forms:

- New Products & Services – new infrastructure enables the utility to offer new services at both the wholesale and consumer level by providing deeper insights on capacity demand, issue identification, pricing options, and more. These new products and services represent value that was simply unavailable in a traditional utility environment.
- Self-Healing (Autonomic) Systems – another major source of value is the ability for new information and systems to identify – in real-time – problems in the core infrastructure and automatically address or "heal" them. This advanced level requires new technology that can identify patterns and information that are reliable indicators of issues. In addition the automation tools trigger related systems to make adjustments to eliminate or mitigate the problem.

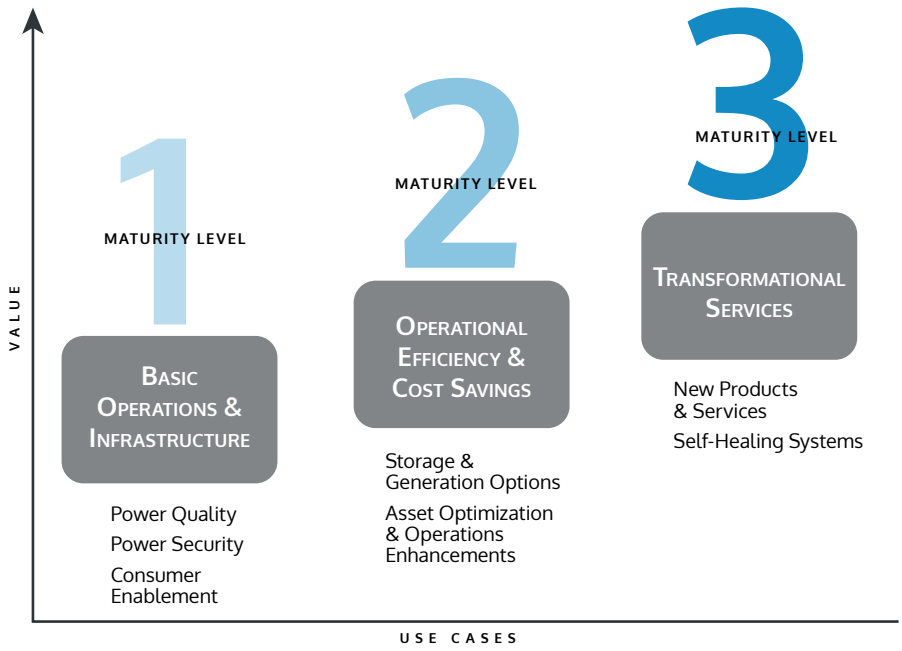


Figure 8: Business Value for Use Cases

VI. VITRIA VALUE & SUMMARY

Utilities deliver massive scaled services to consumers that require huge capital investments that must be used over long periods of time. The scale of these investments mean that they must be managed carefully from both a technical and financial perspective. At the same time, the technology for both generating and supporting these services are undergoing major changes.

- Power generation options and demands are accelerating rapidly in recent years as a result of technological innovation and the demands of providing power in a greener way. Renewables are finally reaching critical mass and are becoming competitive economically with traditional generation options.
- The reliability and quality expected for a modern utility cannot be met with the information systems and tools in place today.
- The information and communications technology that monitors, supports, and maintains these systems is in a period rapid change. Cloud Computing, Big Data, and new forms of Analytics Technology are providing opportunities for utilities to transform their businesses in many ways.

This combination of changes is driving the use cases outlined at the beginning of this paper. The operating models of the future require new ways of thinking and technology to meet the combination of business and technological challenges. Vitria's IoT Analytics Platform provides the framework to rapidly enable successful business outcomes. Figure 9 below summarizes how these pieces deliver value for energy utilities.

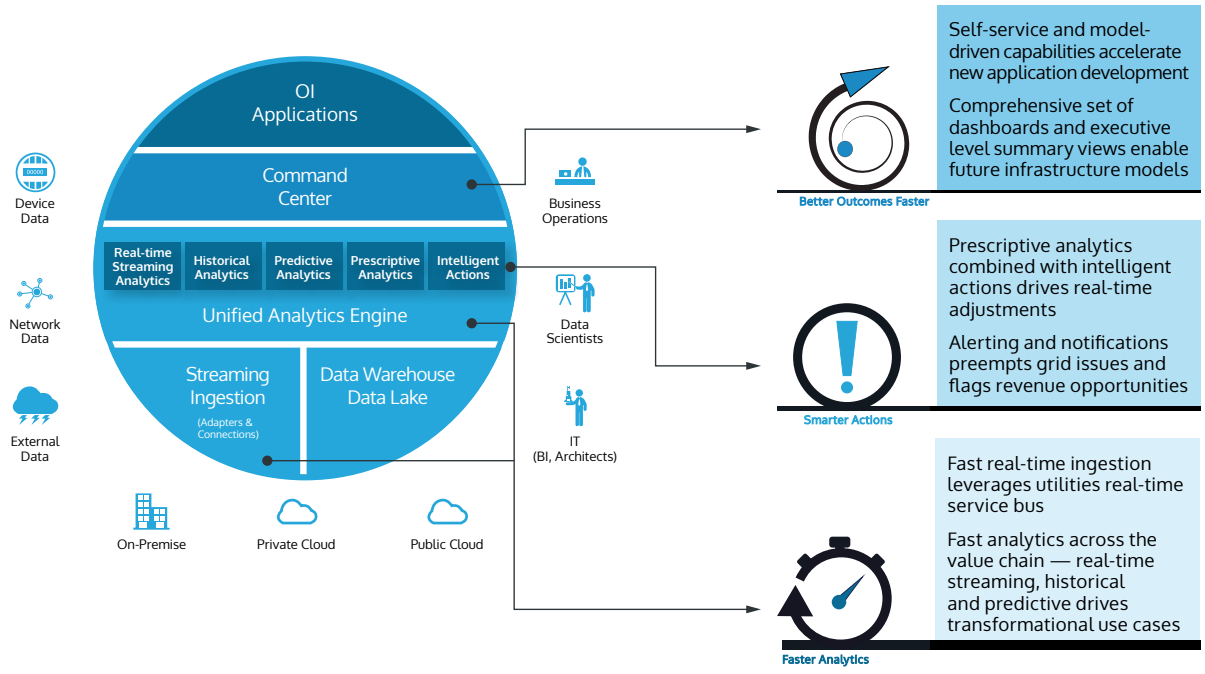


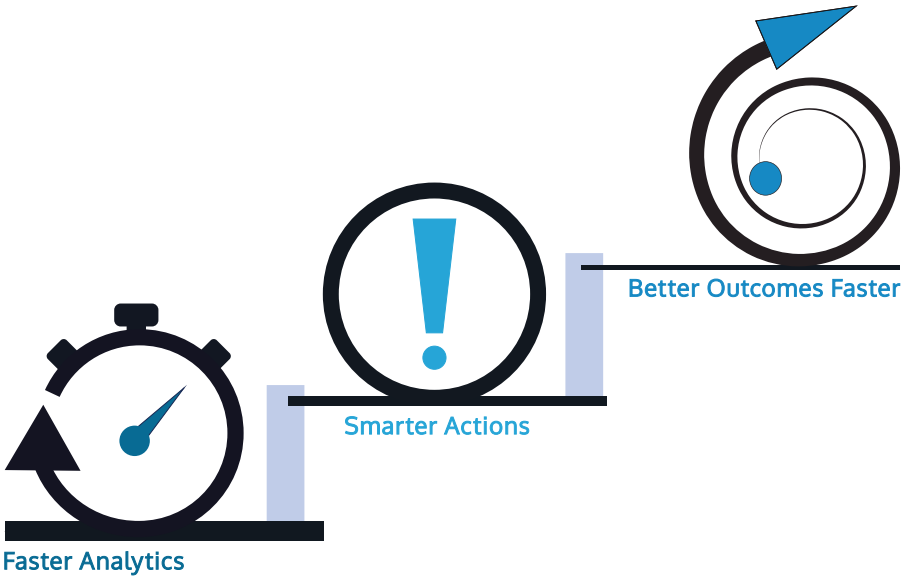
Figure 9: Utility Future Infrastructure Value with the Vitria Platform

ABOUT VITRIA

Vitria's advanced analytics solutions empower enterprises and industrial customers to achieve better outcomes faster in their business operations.

The company was founded in 1994 and has a long history of success in streaming analytics, business process management, enterprise application integration, and operational intelligence. Vitria is also a leading player in the rapidly growing IoT (Internet of Things) analytics market. Customers include Fortune 500 companies and enterprises across a wide range of industries, including finance, manufacturing, telecommunications, utilities, retail and more. For more information, visit www.vitria.com

Contact us to learn more about how our platform can help you achieve better outcomes faster



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