



TESCO METERING

# METERING ANALYTICS AND AI IN METER SHOP OPERATIONS

Prepared for the Metering Systems Working Group

EEI, Fall Meeting

10:00 AM Session, September 30, 2024

*Presented by Tom Lawton  
TESCO Metering*



# METER ANALYTICS AND AI IN METER SHOP OPERATIONS

---

Artificial Intelligence is quickly moving from being a novelty item to becoming a part of many business processes. This presentation discusses how AI is starting to be used in metering applications and some of the potential that exists for coupling AI with ever improving Meter Analytics as we take greater advantage of our massive quantities of AMI data and as we begin into move into AMI 2.0.

This presentation will introduce the attendees to

- what AI is
- the various platforms that exist
- how AI is intended to be used
- And what AI is not.

Once defined the presentation will discuss how AI can be used to help filter the massive amount of data that AMI systems collect to provide utility personnel with actionable information or a far more concise data set that can be delved into deeper to see if there are actions that should be taken. Then we will look at a few examples and save some time for Questions and Answers.

The introduction in 2007 of mass deployed Advanced Meter Infrastructure (AMI) systems promised more effective and more efficient Meter Service Operations.

This was to be accomplished in a variety of ways starting with:

- No need to read meters (if AMR had not previously been deployed)
- No need to roll a truck to perform a disconnect or a reconnect
- Better ability to detect and respond to outages
- Better ability to detect theft
- Better ability to detect (and eventually capture) unbilled energy
- Better understand customer usage and make better energy buying decisions



And with all of this came a promise of “Additional Capabilities and additional Operating data.”



# WHERE WE ARE NOW

---

We are over 85% deployed in the US and Canada and Electric Utilities now collect hundreds of millions of events and readings every day from sources such as the following:

- Meters (status, manufacturer, purchase date, events such as reprogramming notifications and tamper alerts)
- Transformers (ID, circuit section, circuit ID)
- Service points
- Customer accounts (type, status, billing cycle)

Utilities and meter manufacturers have been developing, using and improving a variety of alarms, notifications and reporting on this data and have been reaping operational benefits.

AMI 2.0 is being rolled out. The basic concept is to move more of the data filtering/analysis to the meter so that the amount of information being sent from the meter is less and more importantly is more worthwhile.

Better Analytics are being developed by Utilities, Meter Manufacturers and a variety of third parties both inside and outside of the metering space.

Artificial Intelligence is starting to become a viable business tool to assist in taking these analytic capabilities to the next level.



# Artificial Intelligence (AI)

The Field of Computer Science that seeks to create intelligent machines that can replicate or exceed human intelligence

How Old is AI and how has AI evolved over this time?

## Brief history of AI

Artificial Intelligence

Machine Learning

Deep Learning

Generative AI



1956

### Artificial Intelligence

The field of computer science that seeks to create intelligent machines that can replicate or exceed human intelligence.



1997

### Machine Learning

Subset of AI that enables machines to learn from existing data and improve upon that data to make decisions or predictions.



2017

### Deep Learning

A machine learning technique in which layers of neural networks are used to process data and make decisions.



2021

### Generative AI

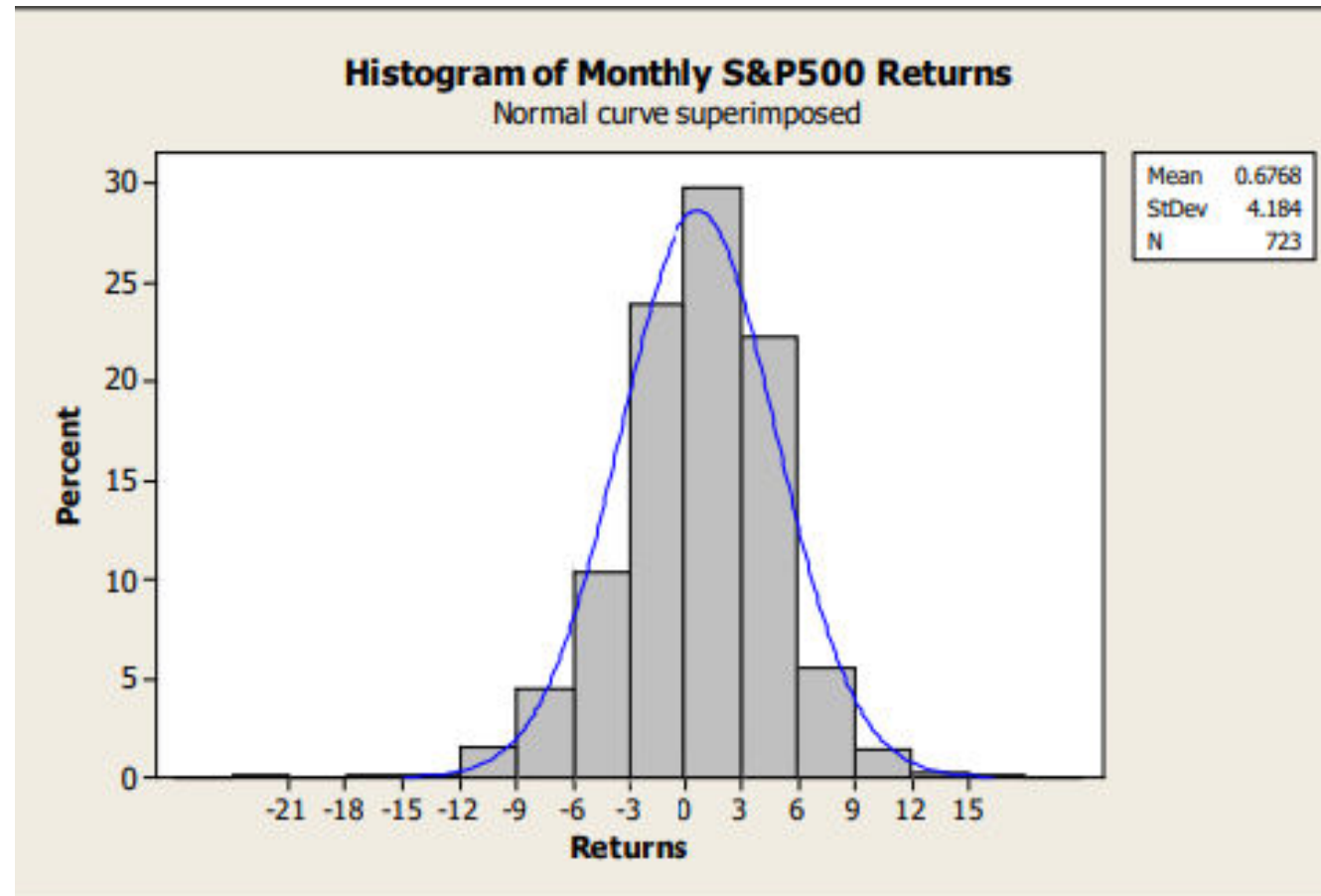
Create new written, visual, and auditory content given prompts or existing data.

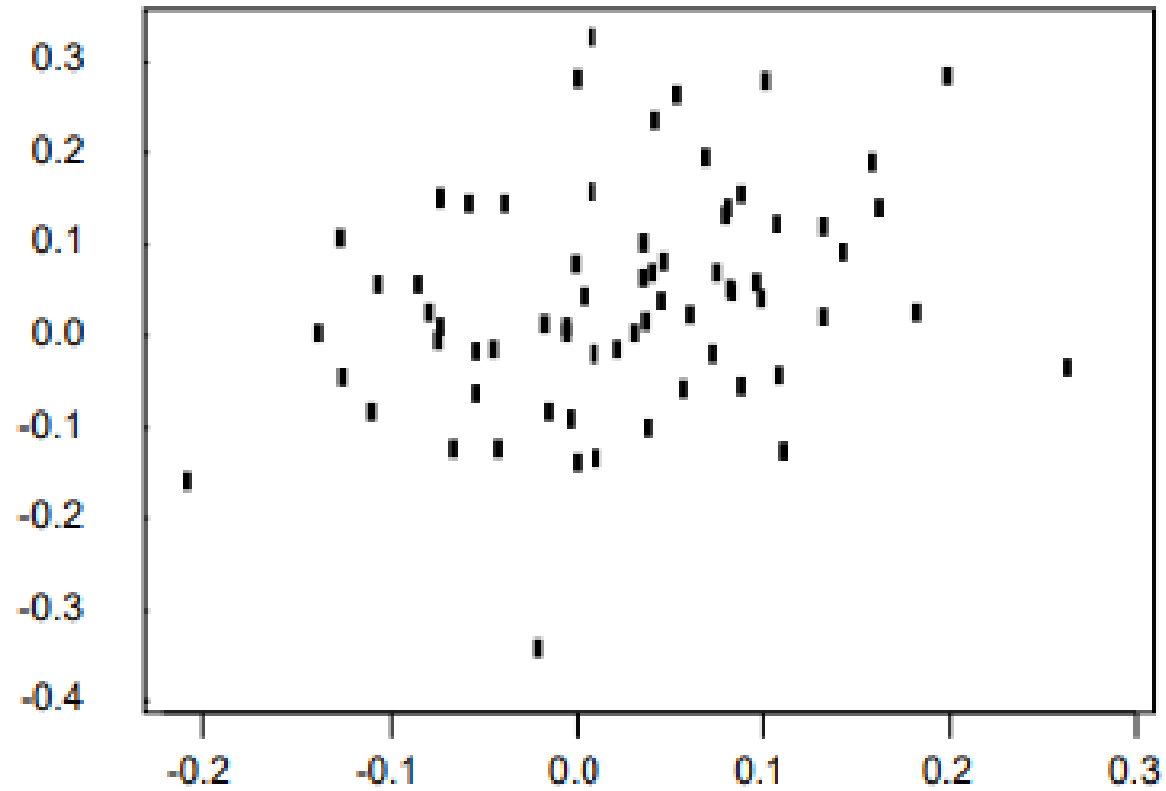
1. Average, mean, mode, median
2. Do this a lot = long run frequency



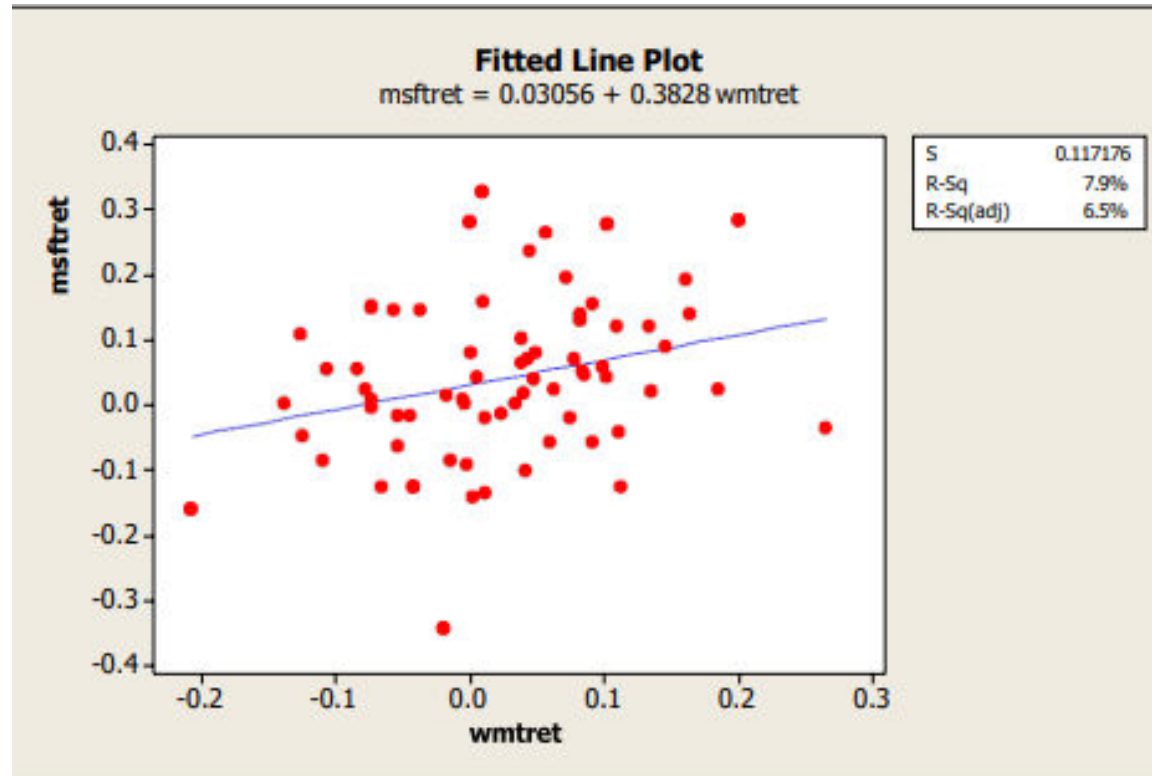
$$P(A) = \frac{\# \text{ outcomes in event } A}{\text{total } \# \text{ of outcomes}}$$

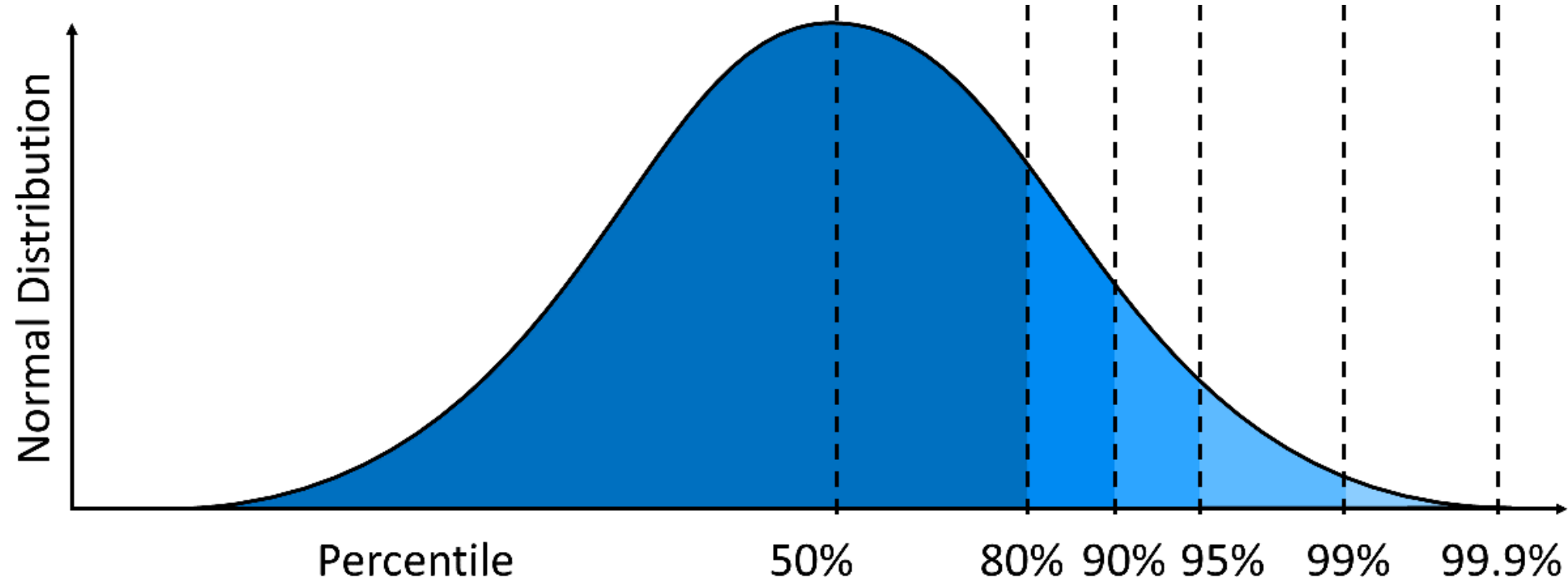
1. Normal distribution
2. Kurtosis





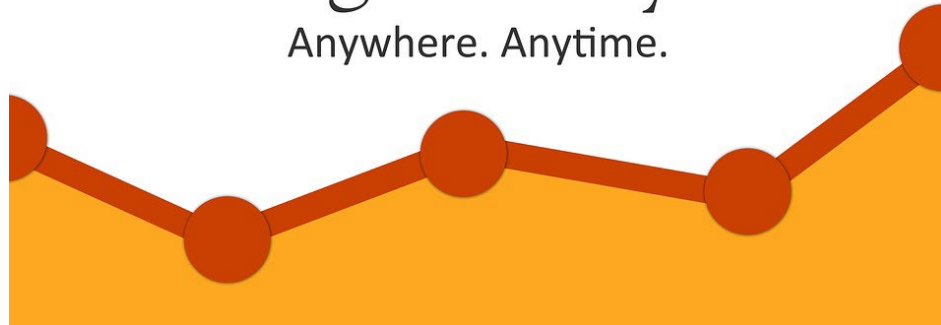
Regressions  
Best fit  
Copulas





Discovery, interpretation, and communication of meaningful patterns in data

Google Analytics  
Anywhere. Anytime.



- Machine Learning is a subset of AI that enables machines to learn from existing data and improve upon this data to make decisions or predictions

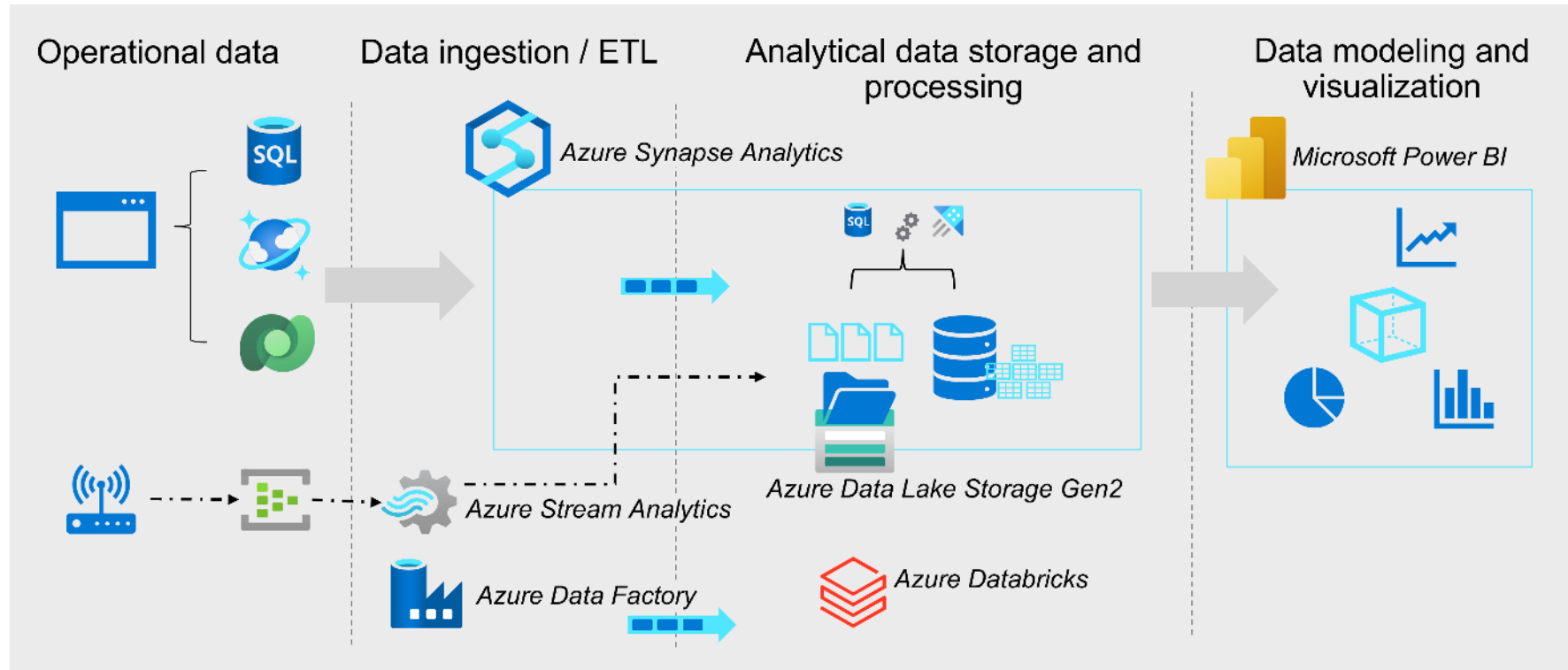


- Cloud and Compute
  - CPU, GPU, Quantum



- Data Engineering
  - Structure, semi-structure, unstructured data
  - Integration, consolidation, cleansing, transformation
  - Operational and analytical data, streaming data, live data
  - Data pipelines, data lakes, data warehouses

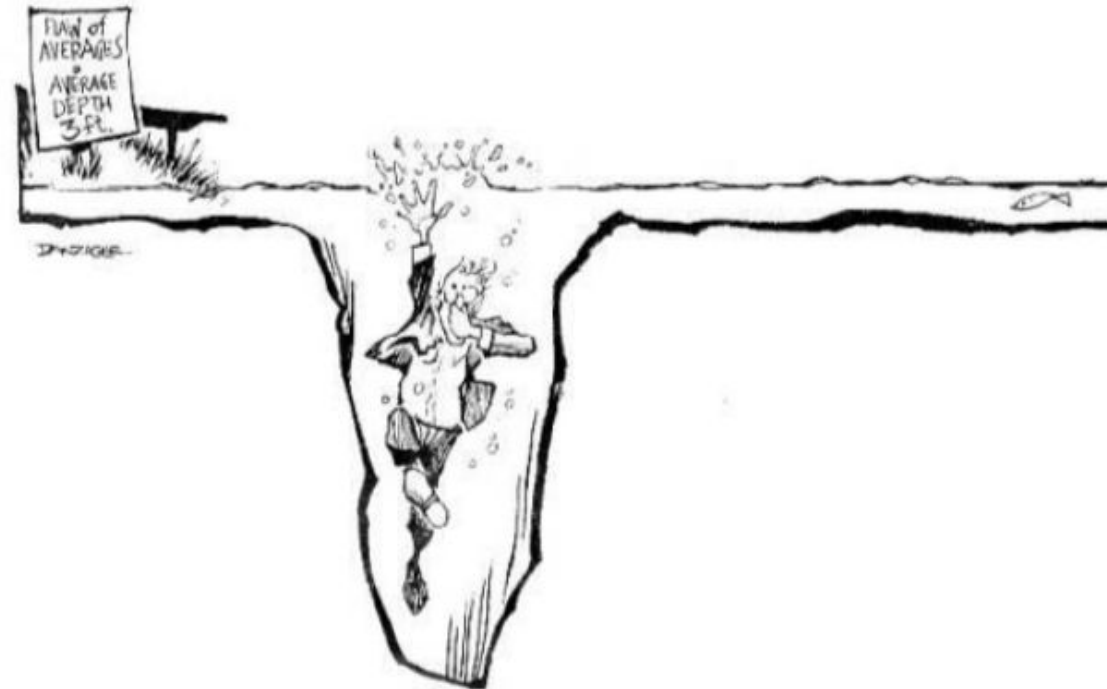






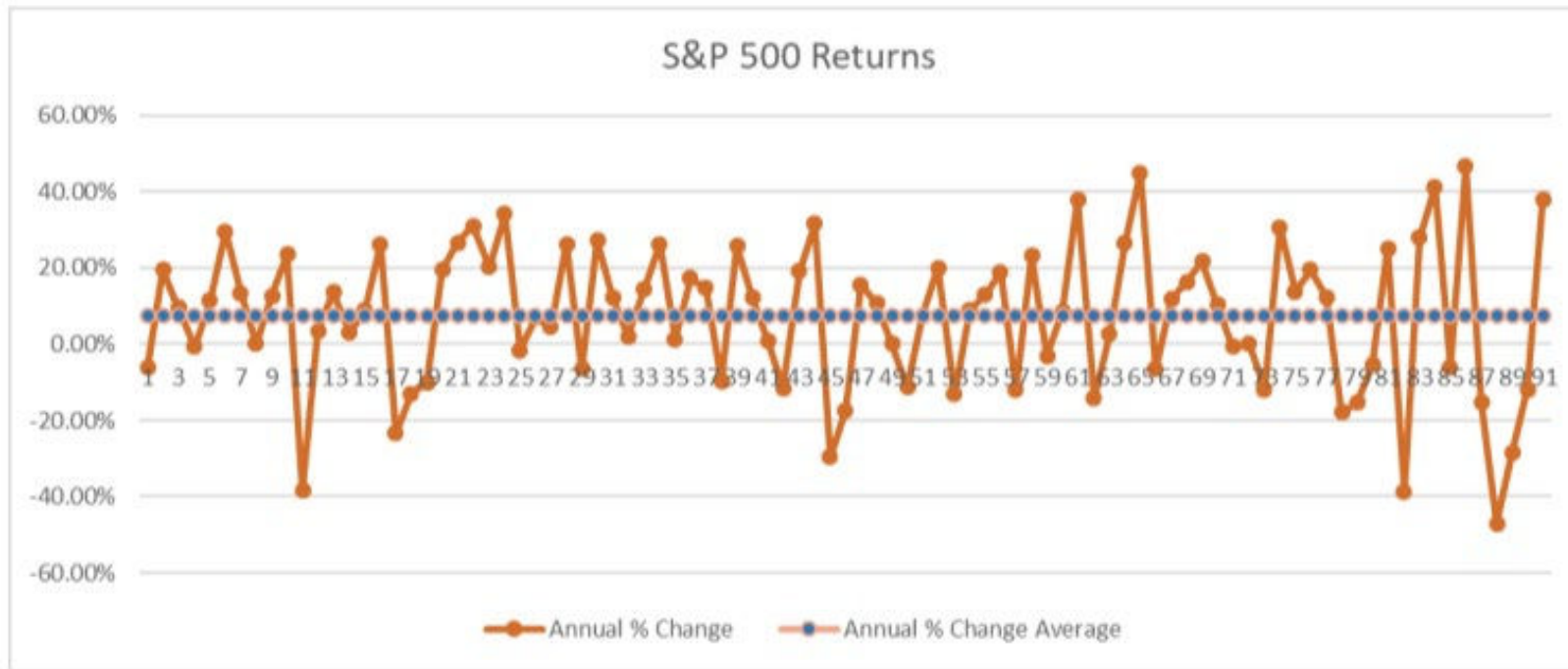
## Flaw of Averages

“Never try to walk across a river just because it has an average depth of four feet.” —Milton Friedman

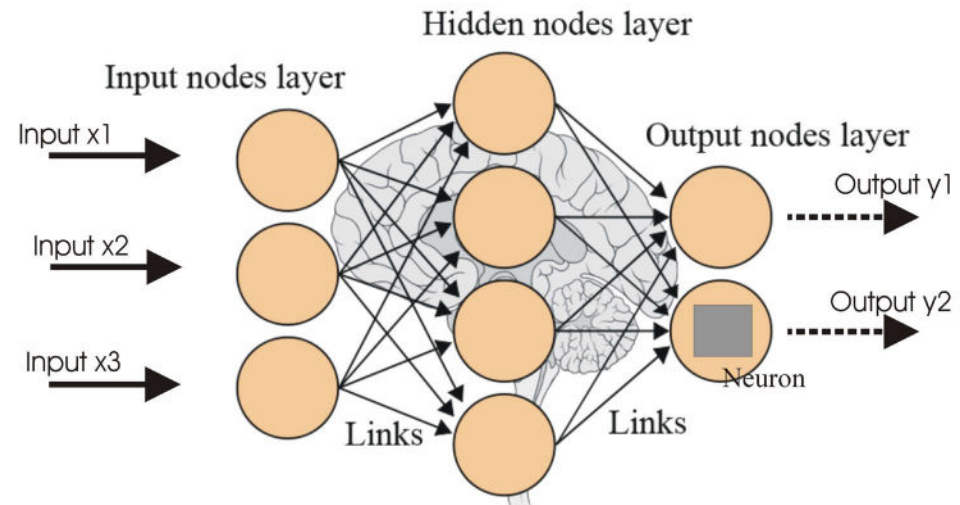
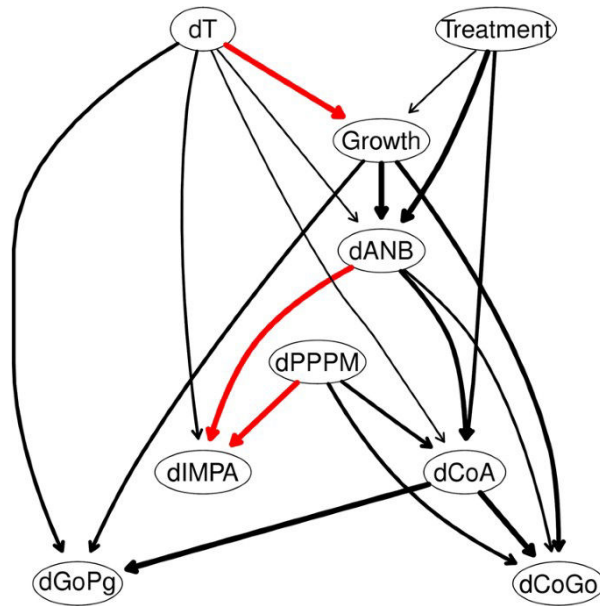


<https://web.stanford.edu/~savage/faculty/savage/FOA%20Index.htm>









# ARTIFICIAL INTELLIGENCE – REPLACING HUMANS?

AI and Robots  
Will Take All  
Our Jobs!



THE FISCAL TIMES  
Free Newsletter | Budget | Taxes | Health Care | Social

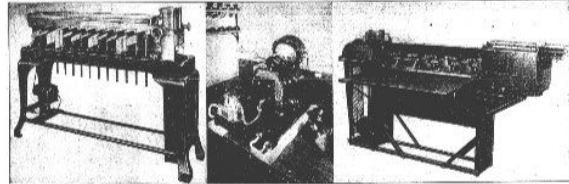
POLICY + POLITICS  
**Millennials vs. Robots—Who Will Win the Jobs?**



# MISCONCEPTIONS ABOUT TECHNOLOGY & AI OVER TIME

1935...

Robot-Brains Outdo Man's Mind in Speed and Accuracy of Results



## 'Thinking Machines' Replace the Thinker

They Predict Tides, Pick Criminals' Fingerprints,  
Calculate Mathematical Problems,  
and Perform Amazing Tasks.

Washington Post, January 1935

1960...

## Robots' Rise

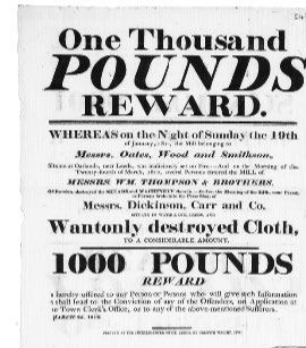
They Bid for Big Jobs  
Both in Outer Space  
And in U.S. Factories

A.M.F. Designs Robot to Send  
To Moon; G.E. Works on  
One to Paint New Autos

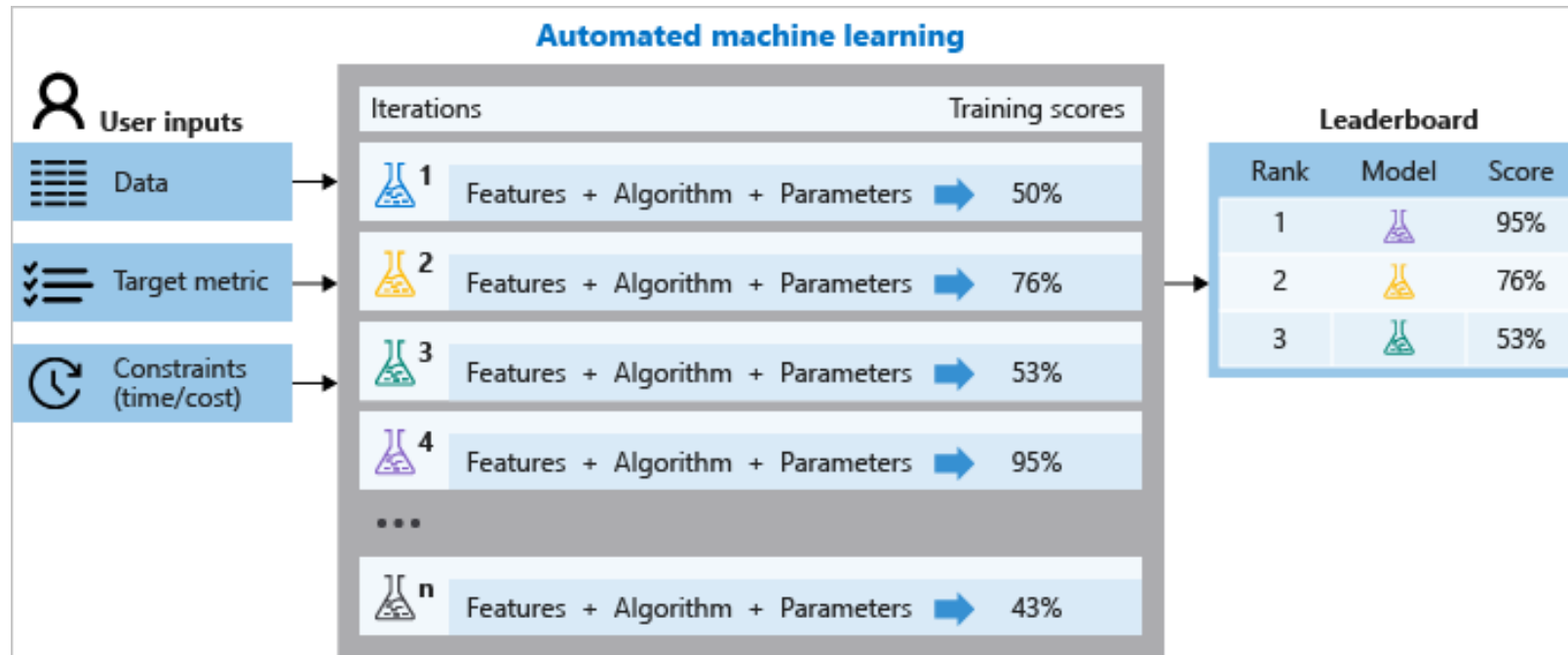
*"But these machines, nevertheless, are true robots—automatic devices that perform human functions or operate with seemingly human intelligence."*

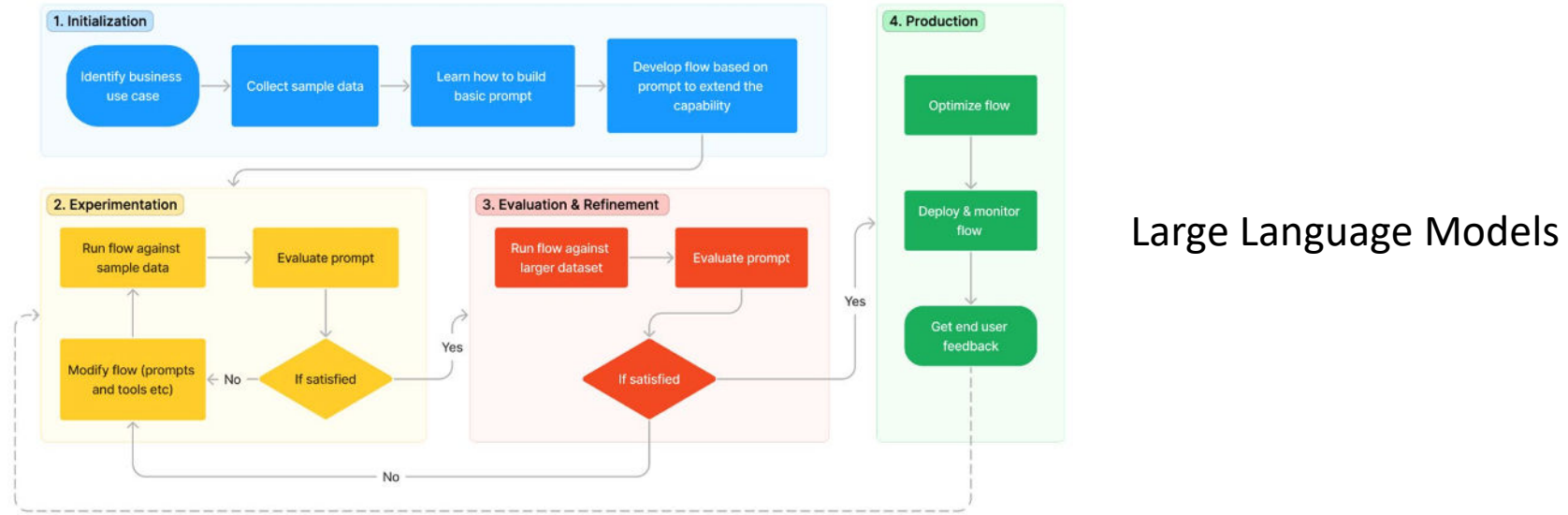
Wall Street Journal, July 1960

...1812...



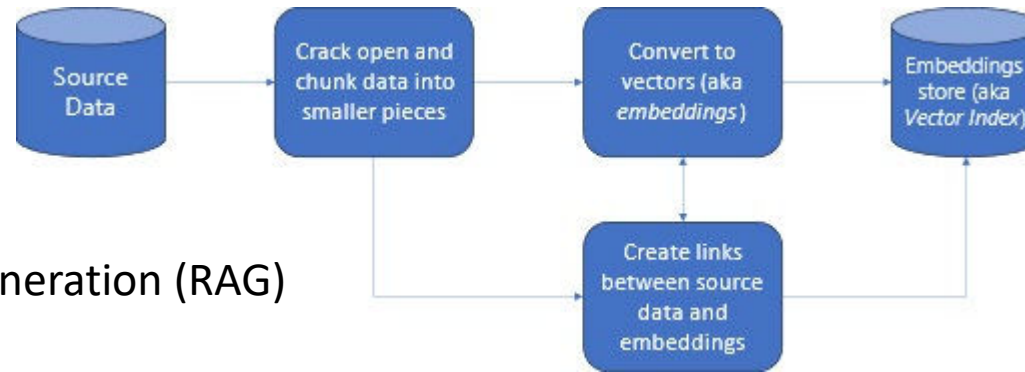
Reward Poster for Luddite Attacks Near Leeds, March 1812



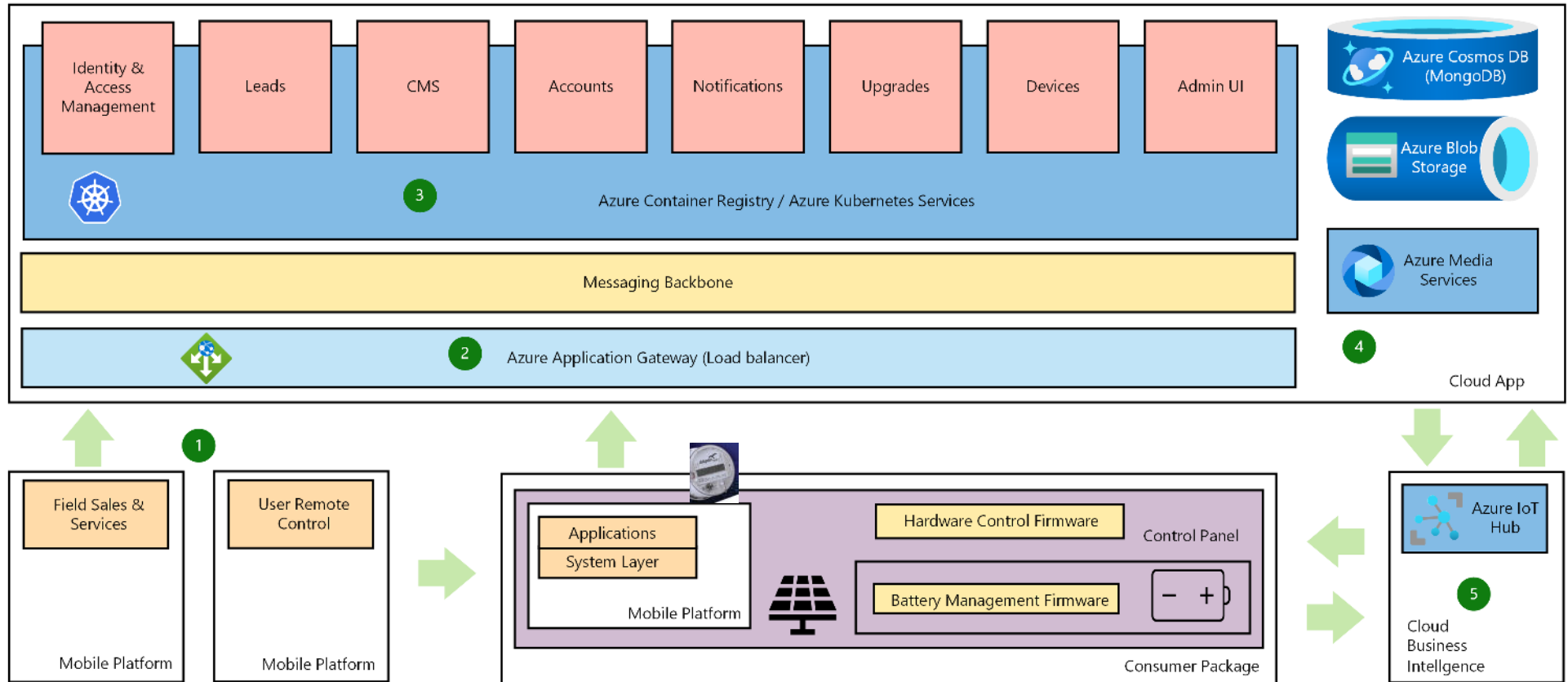


Large Language Models

Retrieval Augmented Generation (RAG)



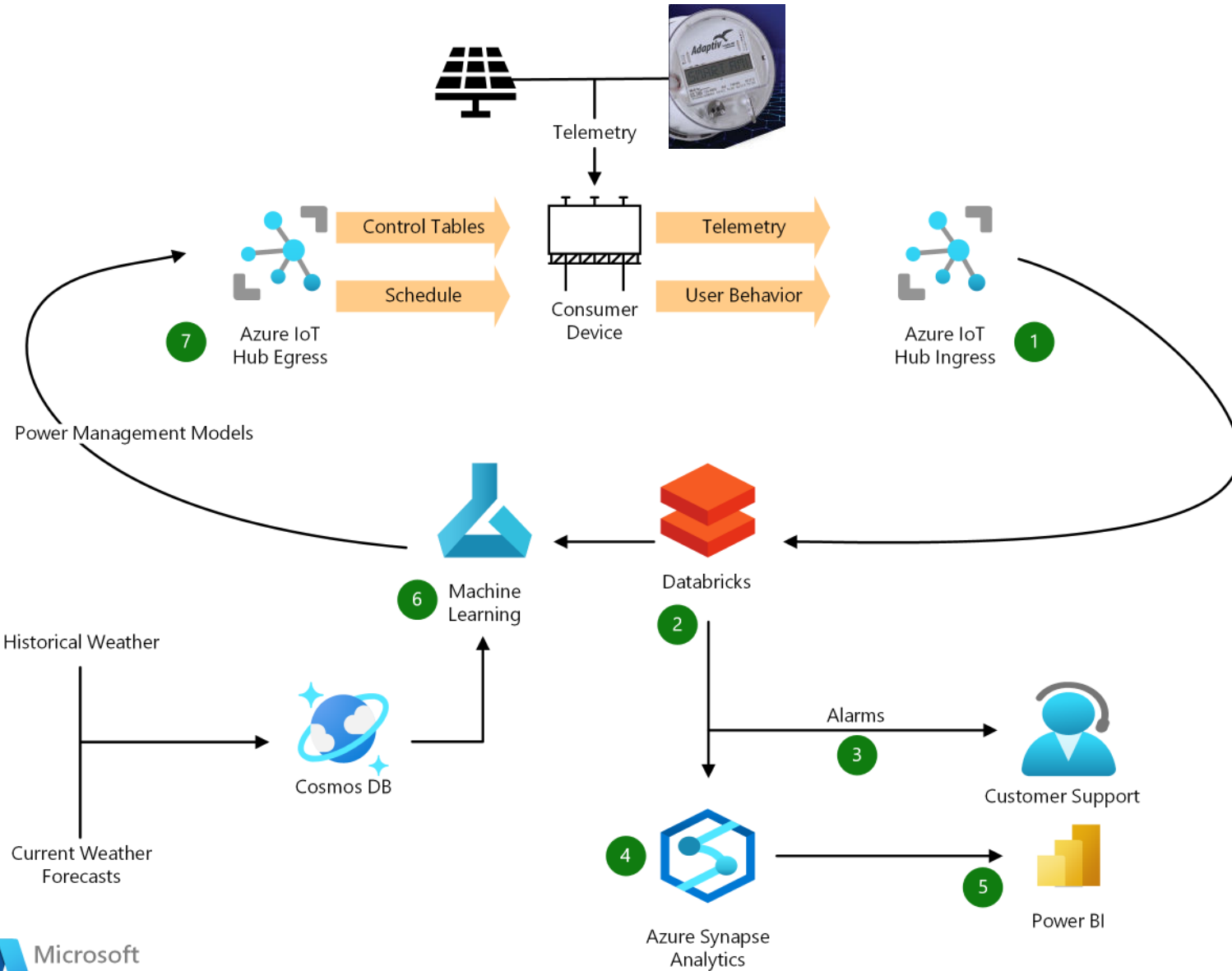




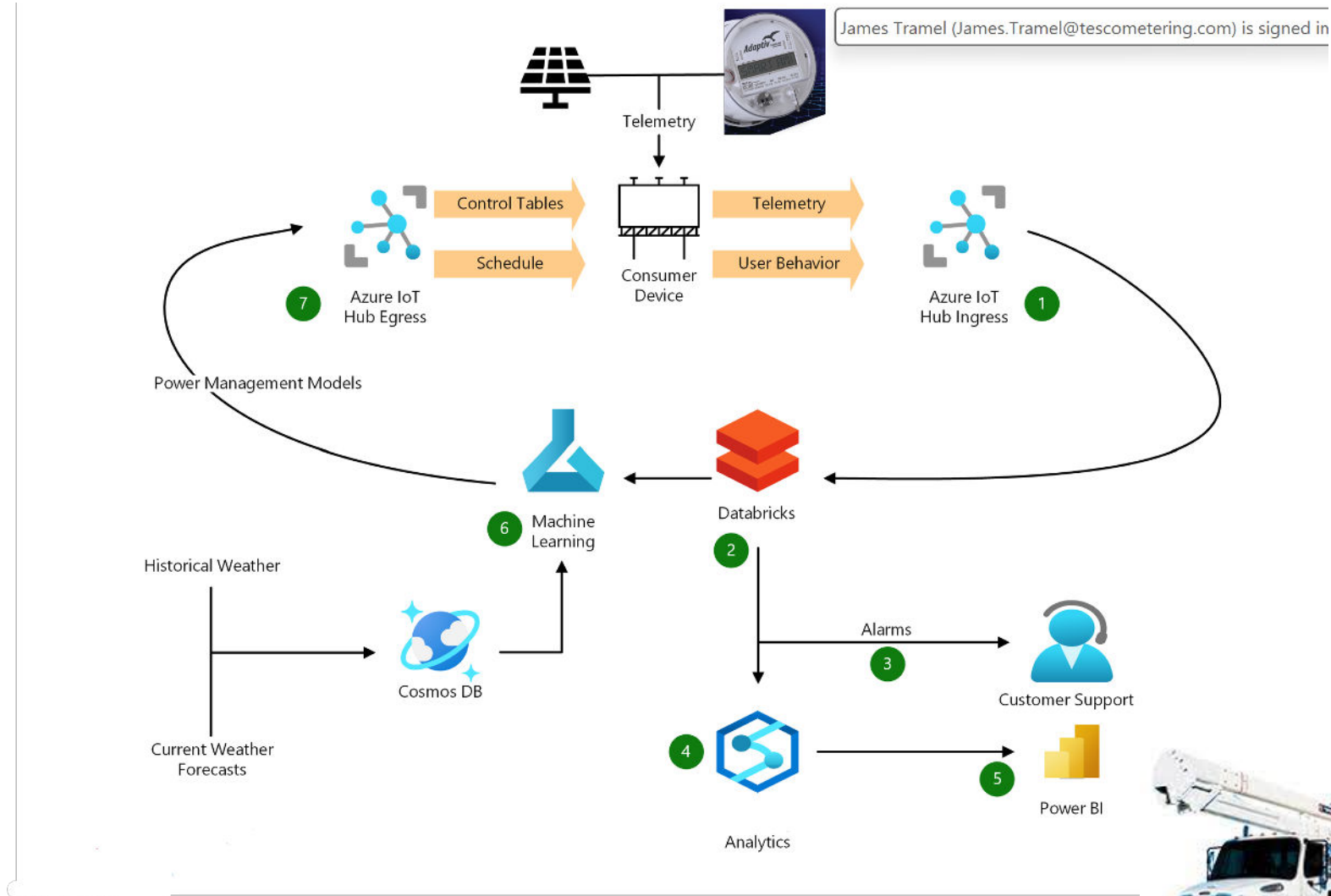


TESCO METERING

# PREDICTIVE MAINTENANCE



# AI & AUTOMATION EXAMPLE - PREDICTIVE MAINTENANCE



## Oversized Transformer Reporting

### Platforms used:

Meter Manager – has all physical assets at every location including the instrument transformers

Consumption information from the head end – in this case a Silver Spring/Open Way head end

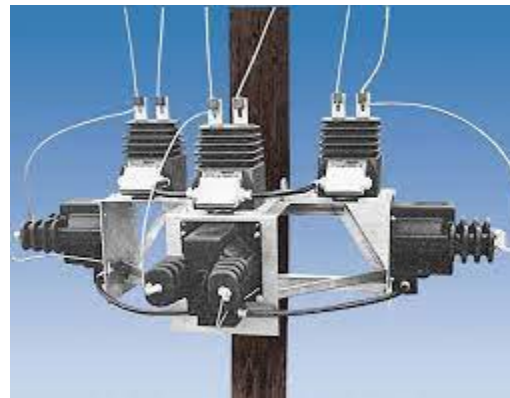
## Oversized Transformer Reporting

### Output:

A monthly report of the most egregiously over-sized transformer installations with usage going back over the past two years to demonstrate and estimate lost revenue

### Use:

Field services receives monthly work orders to replace the instrument transformers with appropriately sized transformers. Extended range transformers further improve the effectiveness of the monthly billing



## Oversized Transformer Reporting

### Results:

A steady increase in monthly revenue gains on every Commercial/Industrial account addressed. Payback for the work is under three months in every case as there are so many oversized accounts.



## Oversized transformer reporting

### Results:

Safety hazards found in the field were initially anticipated to be only failed socket jaw (hot socket) events, but this proved to be only a fraction of what was found. Some of the various safety related issues discovered in the field include;

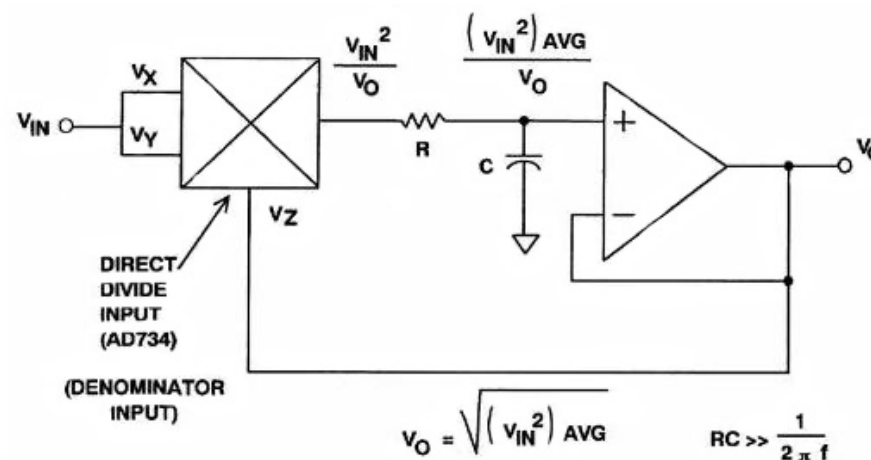
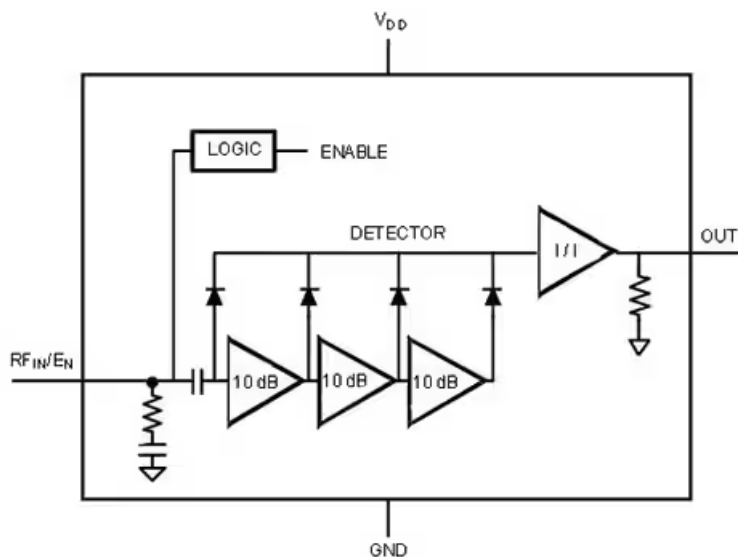
- Failed meter socket jaw
- Frayed and breaking weather head connections
- Arcing on a customer circuit on the customer side of the service panel in the home
- Arcing at the connection to the Distribution transformers closest to the house
- Arcing in the manual disconnect mechanism of the meter box
- Frayed and failing wires between the socket and the service panel in the home

## RF Detection Alarms

### Platforms used:

Itron Open Way head-end and L+G Gridstream head-end – receive alarm data on the RF signature of electrical arcs in or around the service

TESCO Analytic software – over-arching customized analysis software to work across a variety of platforms



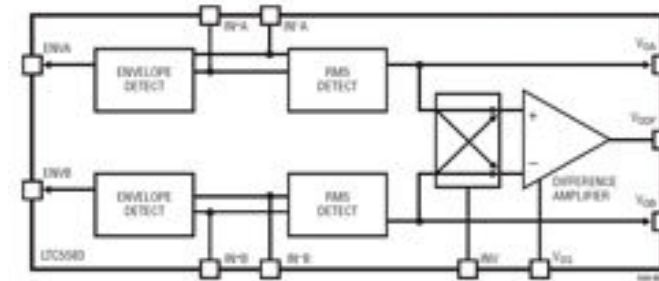
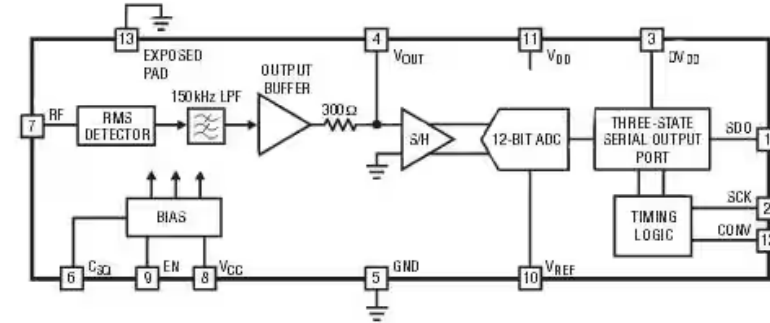
## RF Detection Alarms

### Output:

A weekly report identifying sites with RF detect (micro arc) alarms that fit an identified pattern

### Use:

Field services receives a weekly report of sites to check for safety related issues. Inspection involves a visual detection as well as the use of RF detection equipment to pinpoint the source of the problem.



### RADAR ENGINEERS



MODEL M331  
MINI RFI LOCATOR

**Consumption Analysis:** Combine data from Tesco Meter Manager and Nighthawk AMI to analyze consumption patterns of utility services such as water, gas, or electricity. Utilities can identify high consumption areas, detect anomalies, and offer energy-saving recommendations to customers.

**Demand Forecasting:** Use historical consumption data from Nighthawk AMI and Tesco Meter Manager to predict future demand patterns. Accurate demand forecasting helps utilities plan their resources more efficiently, avoiding overcapacity or shortages.

**Leak Detection:** By analyzing data from both systems, utilities can detect water or gas leaks in the distribution network. Early detection of leaks allows utilities to reduce water waste, prevent potential accidents, and minimize repair costs.

**Asset Performance Management:** Combine asset data from Tesco Meter Manager with usage data from Nighthawk AMI to assess the health and performance of utility assets. This analysis can aid in predictive maintenance, reducing downtime, and extending the lifespan of infrastructure.

**Customer Segmentation:** Analyze customer data from Tesco Meter Manager and usage patterns from Nighthawk AMI to segment customers based on consumption behavior. Utilities can tailor their services and marketing strategies to specific customer segments.

**Load Profiling:** Create load profiles by analyzing data from Nighthawk AMI and Tesco Meter Manager. Load profiling helps utilities understand peak demand periods, plan capacity, and optimize energy distribution.

**Revenue Assurance:** Integrate billing data from Tesco Meter Manager and usage data from Nighthawk AMI to identify discrepancies and reduce revenue losses due to metering errors or inaccurate billing.

**Operational Efficiency Analysis:** Analyze data from both systems to evaluate the efficiency of utility operations. Identify areas where processes can be streamlined, resources optimized, and costs reduced.

**Outage Management:** By combining data from Tesco Meter Manager and Nighthawk AMI, utilities can improve outage detection and management. They can quickly identify affected areas, estimate restoration times, and communicate more effectively with customers during outages.

**Environmental Impact Assessment:** Analyze consumption data from Nighthawk AMI and Tesco Meter Manager to assess the environmental impact of utility services. Utilities can monitor their carbon footprint, set sustainability goals, and implement initiatives to reduce environmental impact.

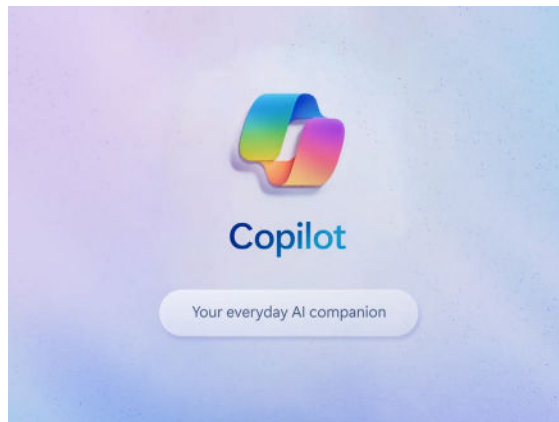
- Transformer Overload Identification
- Behind The Meter Identification
- Weather Sensitivity
- Wholesale Settlements
- Mark-to-Market
- Suitability for DER
- Profitability
- Grid Loading
- Demand Forecast
- Generation Forecast
- ISO Forecast
- Net Open Position
- Scenario Analysis
- Coincidence Peaks
- Load Optionality
- Grid Constraints Load Scheduling
- Demand Response
- Risk Management
- Decarbonisation
- Cost Reduction
- Customer Engagement
- Billing
- Grid Dispatch & Planning

# Gemini

[This Photo](#) by Unknown Author is licensed under [CC BY-SA](#)



[This Photo](#) by Unknown Author is licensed under [CC BY-NC-ND](#)



## Nighthawk platform:

1. Doubled productivity of both the software development teams (Meter Manager, TDM, Nighthawk) and the Nighthawk support teams
2. Doubled the number of users in one year for Nighthawk and added close to ten million metering asses for Meter Manager
3. Rewrote large sections of the Nighthawk platform, wrote Meter Manager 3.0, and released new revisions for TDM in a series of monthly sprints. This ability to move so much fasster with the assistance of AI significantly reduced system errors and User errors for all three platforms - aka – making the applications bulletproof

**Better and Faster, with the same budget**

## Benefits



### Reduced costs

- Reduction in truck rolls for false alarms and unexpected failures
- Data strategy & requirements
- Energy theft reduction
- Reduce peak demand charges



### Increased reliability & safety

- Showcase momentary outages; detect anomalies in usage.
- Predictive analytics on equipment failure
- Better grid management with intermittent Distributed Energy Resources



### Better visibility and planning

- Real-time visibility on consumption
- Future demand forecast
- Improved investment decisions in AMI

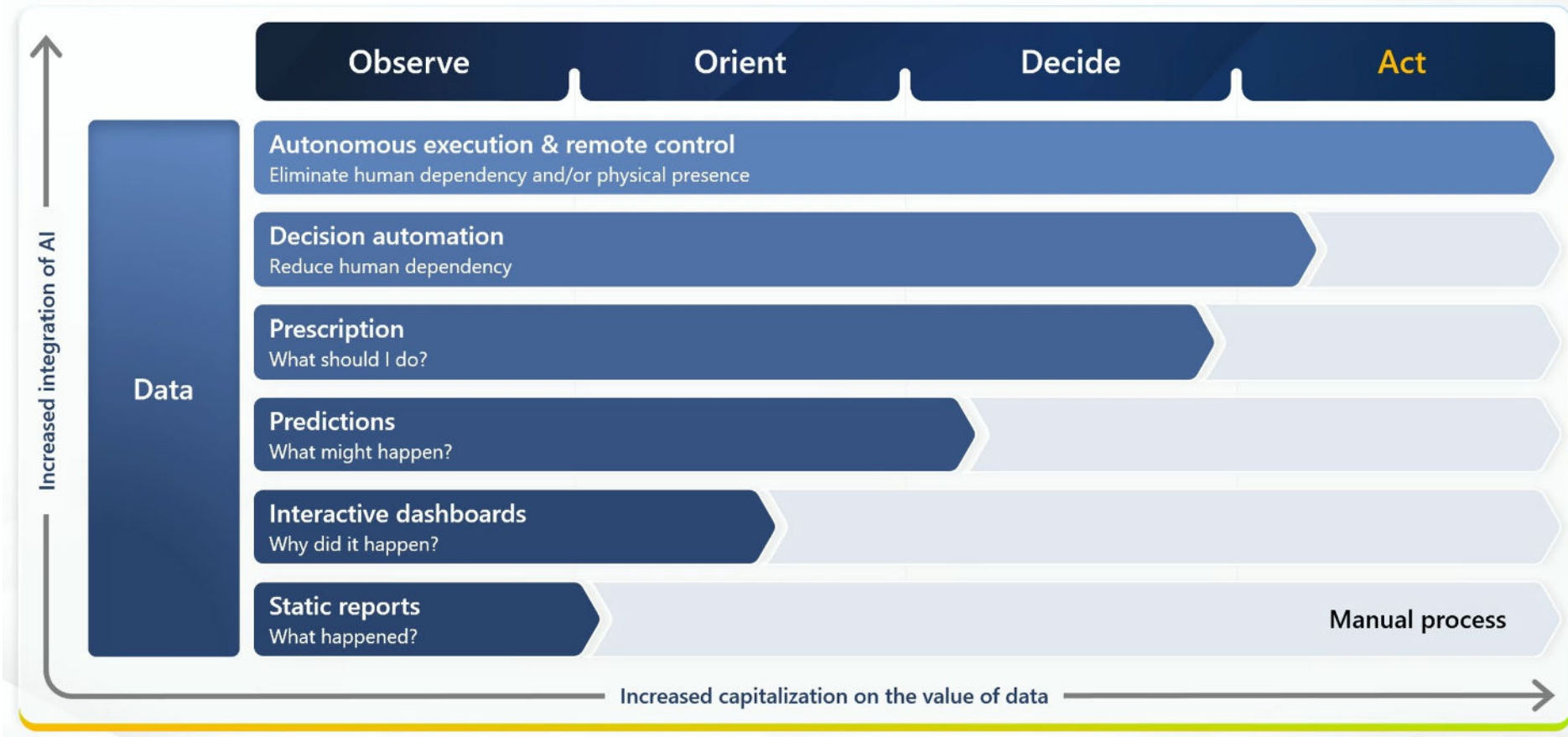
## Traditional Meter Data

- Daily meter read which does not support most near real-time operations.
- Usage data for billing retained and interval data and non-usage data removed to save on storage.
- Meter data processed in batches aligned to billing groups providing customers visibility every 24 hours.
- No ability to source data from anything except meters.

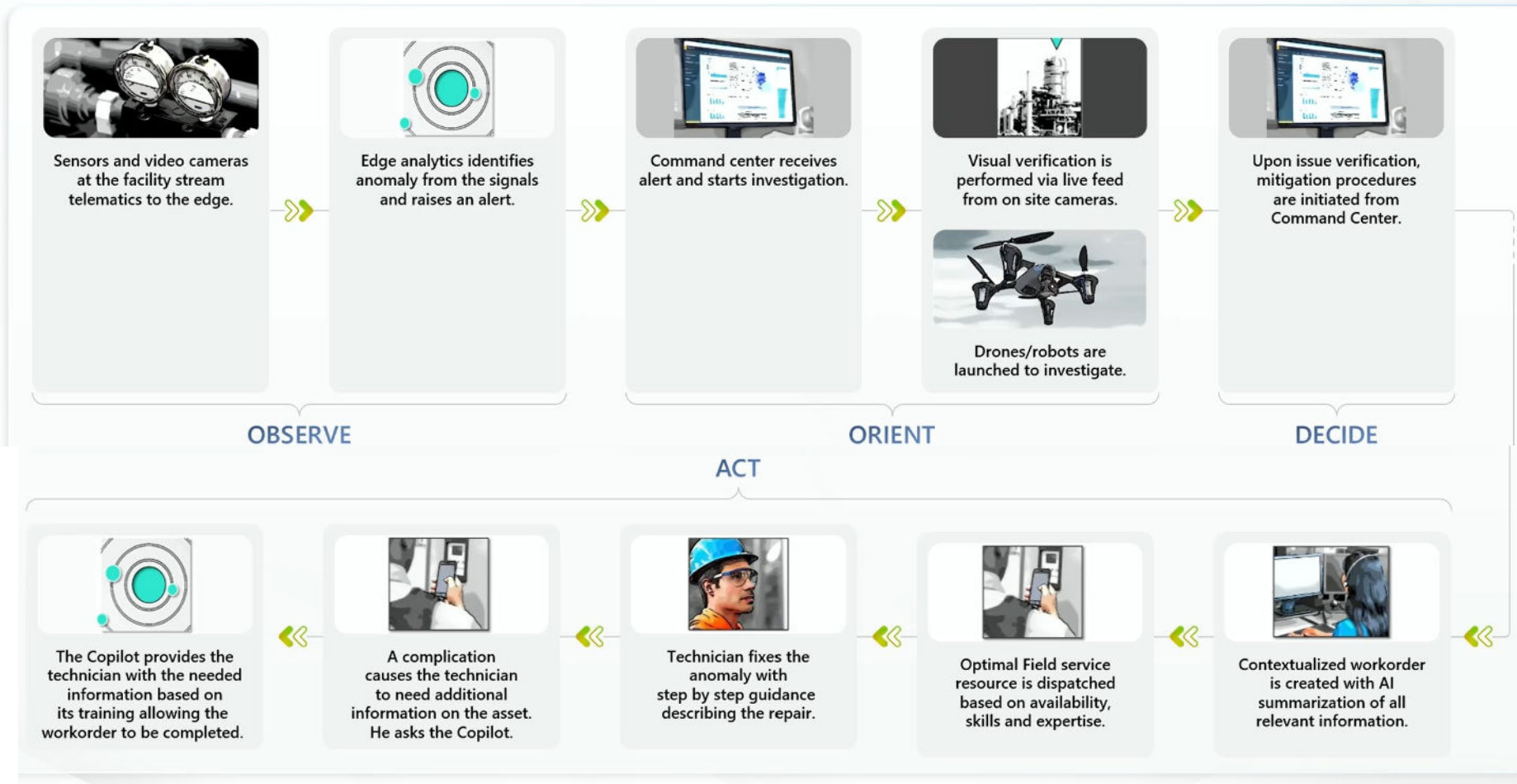
## AWS Meter Data Analytics Solution

- Meter data collected at sub-hour intervals to support near real-time operational benefits cost effectively.
- Data retained at full resolution enabling prediction of outages, estimation of changing load patterns, and detection of usage anomaly with Machine Learning.
- Meter data processed as received for customer and utility visibility which is key in implementing behavior-based demand response or Volt/VAR Optimization programs.
- Object storage data lake that can absorb nearly any kind of data.

# From data to insight, control and reduced risk



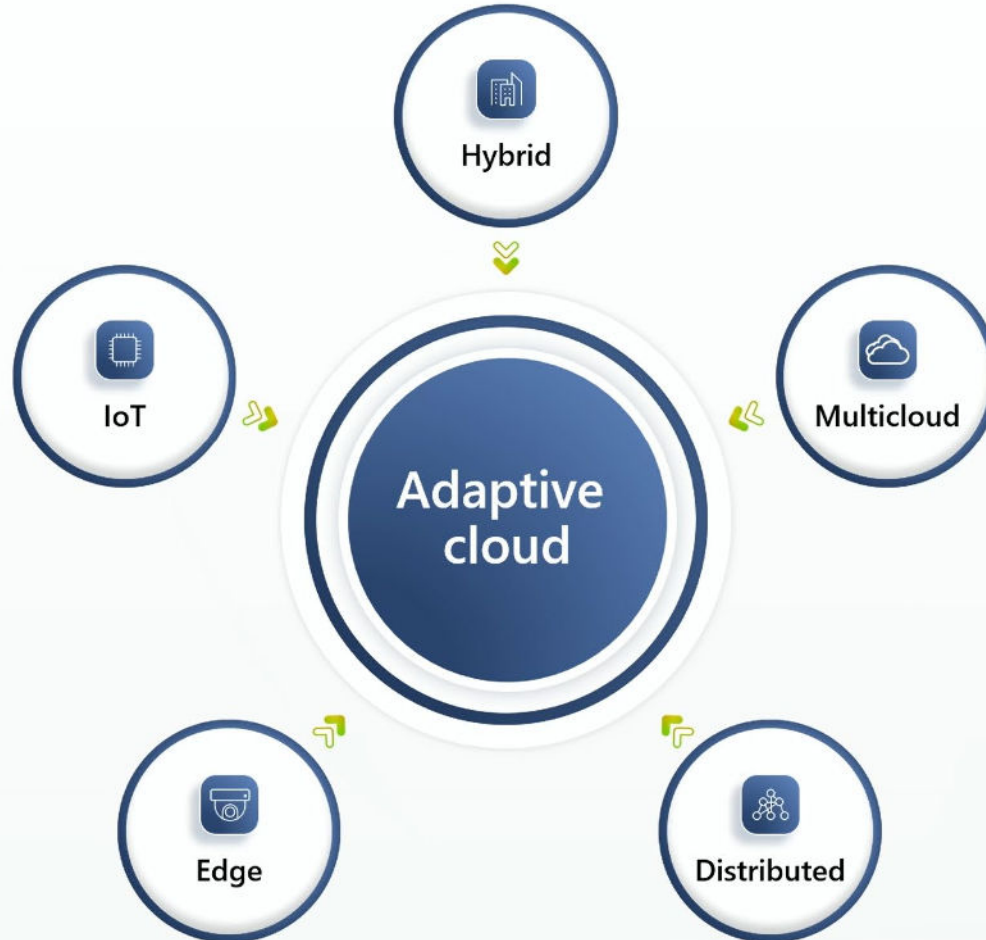
## Future state operations



# Adaptive cloud

Unify siloed teams, distributed sites, and sprawling systems into a single operations, security, application, and data model.

Leverage cloud-native technology and AI to work across hybrid, multicloud, edge, distributed computing and IoT.





TESCO METERING

# Drive flawless execution in your operations



Right Person



Right Place



Right Time



Right Skills



Right equipment

Increase

Productivity

Service Quality

Accuracy

Resource Utilization

Organization Visibility

Lower Service Cost

Optimize Scheduling and Planning

Online/Offline Mobile

Democratize Knowledge & Competency

Reduce Time to Invoice

AI COPILOT ENABLED



TESCO METERING

# Drive flawless execution in your operations



Right Person



Right Place



Right Time



Right Skills



Right equipment

Increase

Productivity

Service Quality

Accuracy

Resource Utilization

Organization Visibility

Lower Service Cost

Optimize Scheduling and Planning

Online/Offline Mobile

Democratize Knowledge & Competency

Reduce Time to Invoice

AI COPILOT ENABLED

# Azure OpenAI enables customers and partners to build their own Copilots

Call center



Personalization



Doc processing



Trend analysis



Refactoring



Research



Ideation



# Azure OpenAI

## Top Capabilities and Use Cases



### Content generation

**Call center analytics:**  
Automatically generate responses to customer inquiries.

Generate personalized UI for your website.



### Summarization

**Call center analytics:**  
Summary of customer support conversation logs.

**Subject matter expert document:**  
Summarization (e.g. Financial reporting, analyst articles)

Social media trends summarization.



### Code generation

Convert natural language to SQL (or vice versa) for telemetry data.

Convert natural language to query proprietary data models.

Code documentation.



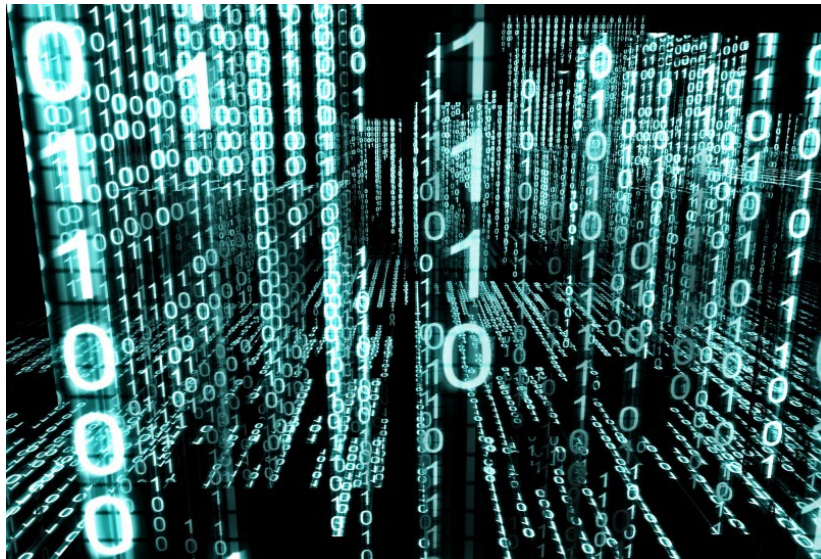
### Semantic search

Search reviews for a specific product/service.

Information discovery and knowledge mining.

# WHAT DATA ARE WE GETTING & HOW ARE WE USING IT?

- **Meter quality assurance:** Focusing on meter reading performance enables utilities to ensure AMI reliability. For instance, when meter readings are expected but not delivered, the system takes note, and calculates overall performance statistics for the AMI system. Utilities are made privy to problems they never would have been able to identify in the past.



**Good Start**

- **Outage event analysis and prevention:** Integration enables real-time, accurate, and complete outage event analysis that helps identify nested outages and optimize field crew dispatch – all to support efficient response and restoration.
  - We can often determine the exact piece of equipment causing a problem, along with the customers directly impacted by it.
  - We can use outage information that is delivered along with meter readings to identify and track outages.
  - These outage event reports help us to understand the overall impact of outages, then drill down to find the problem areas in the distribution network.
  - We can then isolate areas of high impact and work to understand how to address them.



- We can filter planned outages and momentary from this data for reporting purposes and provide meaningful customer satisfaction and performance measures and trends

- Average interruption durations
- Number of interruptions
- Number of customers impacted
- These system performance indexes and information can be shared with management, regulators, customers, media, and other stakeholders.



- Gain a better understanding of events, as well as what they mean. For instance, we can correlate power outage events or voltage alarms with the transformers involved to identify faulty or aging infrastructure. And we can roll trucks between 8 AM and 4 PM, Monday to Friday on non-storm days.
- Generate new customer insights
- Size distribution assets
- Implement preventive maintenance techniques
- Forecast and build predictive models for demand program planning
- Develop new rate plans and services for customers
- Gradually improve Line Loss



- Potentially bad metering
- Non metering of certain usage
- Failing equipment and bad connections
- Bad GIS integration and information. To make any of this work we need an up to date and integrated geographic information system (GIS) geodatabase. We need to be able to link our meters accurately to the rest of the system along with every other piece of equipment between the sub station and the meter. The initial investigative work will uncover not system errors but GIS errors and holes. Once corrected, this work then begins to uncover correctible losses.



- Load profiling – You have accurate and highly granular transformer load profiles, especially significant for effective distribution planning when electric vehicle (EV) charging and distributed generation are involved. What will the impact on your system be as isolated pockets of users influence each other and purchase electric vehicles; adopt home level energy storage and renewable energy solutions.
- Pricing analysis – Perform ‘what if’ rate and load shift analysis. Compare current tariffs with alternative pricing scenarios. Estimate energy costs for a new rate at different load levels.



# WHAT ARE SOME OF THE CHALLENGES IN ANALYZING THIS “FLOOD OF DATA?”

The first issue is that currently data required for complete meter data analytics solution does not reside in the same database. While there is tremendous real time data being collected the information required to complete many types of analysis may reside in other data bases (e.g. system mapping data).



Another challenge is that while the MDM is configured as a “Fast Write” data base, since it needs to quickly record large volumes of real-time meter information, a useful analytics tool needs to be normalized for “Fast Reads,” since it needs to provide fast access to data for users looking for real-time insights.

- **No impact on billing:** Making sure that you can analyze the data in the MDM system (the “system of truth”) without impacting basic billing operations in any way. As important as meter data analytics is, this capability cannot interrupt billing and other operational systems in terms of performance, data corruption or functionality. Bottom line: The analytics capability cannot threaten the utility’s ability to collect revenues.



- **Near real-time:** Lastly, in order to retain its value to executives, engineers and operational staff, data analytics need to be performed in as near real-time as possible.
- **The ultimate goal:** To establish a repeatable data analytics discipline and infrastructure to reduce the time, cost and complexity of each incremental capability, and with the lowest risk possible to the existing MDM functionality.



# HOW SHOULD AN “ANALYTICS” DATABASE BE SET-UP?

---

The analytics database should use a different design that classifies the attributes of an event into “facts,” which would include the data itself, and “dimensions” that can give the facts context such as meters, transformers, service points, customer accounts, register reads, billing values, interval readings, register readings, missed reads, data quality information and meter events.

Using a “Fast Read” design, the analytics database correlates measured data (“facts”) along many “dimensions” (e.g., location, by transformer, etc.) and stages them so that the data can be analyzed in many ways.

This enables users to gain more understanding of events, as well as what they mean. For instance, analysts can correlate power outage events or voltage alarms (“fact”) with the transformers (“dimension”) to identify faulty or aging infrastructure with a single simple calculation.

## Now what can we do with this information? Well....To start;

- Isolate and determine where we have voltage issues, correct them and bring an entire line to the same level. This not only works better for our customers but also allows the utility to pursue voltage reduction in a meaningful and controlled way.
- Determine what transformers should be used in any location
- Determine which transformers to store in which inventory yards
- Determine when new loads are present and which transformers are in jeopardy
- Locate Bad connections
- Locate Undersized lines
- For Transformer Rated Services determine which ones are operating for a substantial amount of time below 10% of the rated current
- Find and remediate theft
- Find and remediate remote outages before the user knows they exist
- Find and address Power factor issues



- Utilities also need new skill sets to be able to perform this analysis. To use this data we need
  - Data base experts
  - Metering and operations experts
  - Business analysts
- In a perfect world all of these characteristics are rolled up into one. In a less perfect world into two. And in an even less perfect world – three individual groups or people. But too many utilities are missing one or more of these groups or people even after completing their AMI deployment.



- Advanced functional test boards
- Automated firmware and setting comparison tools
- Site Verification equipment, procedures and data
- .....and data
- .....and data
- .....and data



# AND NOW WE WANT MORE.....

---

More data

Greater frequency

Whatever bandwidth you thought you needed, now you need more.



Can we use our existing infrastructure?

Do we have to rip out and replace with a new infrastructure?

What about LTL back haul or a Private Network?

What about Power Line Carrier? Is there life there for my most remote service areas?



- Advanced visualization tools – Built-in tools provide an alternative to cumbersome data tables and provide enhanced visibility of your smart meters, AMI network, and distribution network
- AMI system health dashboards – A custom definable user interface enabling a visualization of real-time events and trending



On the distribution side customers will be encouraged to put in more and more renewable energy and they will also add more and more energy storage

Residential loads will move further and further away from power factors of one and put increasing pressure to move to either a Blondel solution for them, a VA/VAR solution for them, or a correction factor for them as AMI systems begin to report back customer power factor for all metering solutions

- 12S or 2S?
- kVA/kVAR or kWh w/ PF correction?
- DC metering?



On the distribution side customers will be encouraged to put in more and more renewable energy and they will also add more and more energy storage

- Larger customer based energy production and solutions will lead to expanded micro grids.
- Second Generation AMI and potentially new communication paradigms as LTL data becomes less and less expensive and reaches larger and larger areas.



Utility grade energy storage will replace new generation at an increasing pace as some of the largest capital investment projects for utilities.

- The great tunnel under Niagara Falls, Ontario \$1.6 Billion; 150 megawatts – part of an Ontario plan to shut all of their Coal generation Plants



New generation projects are increasingly becoming renewables coupled with energy storage

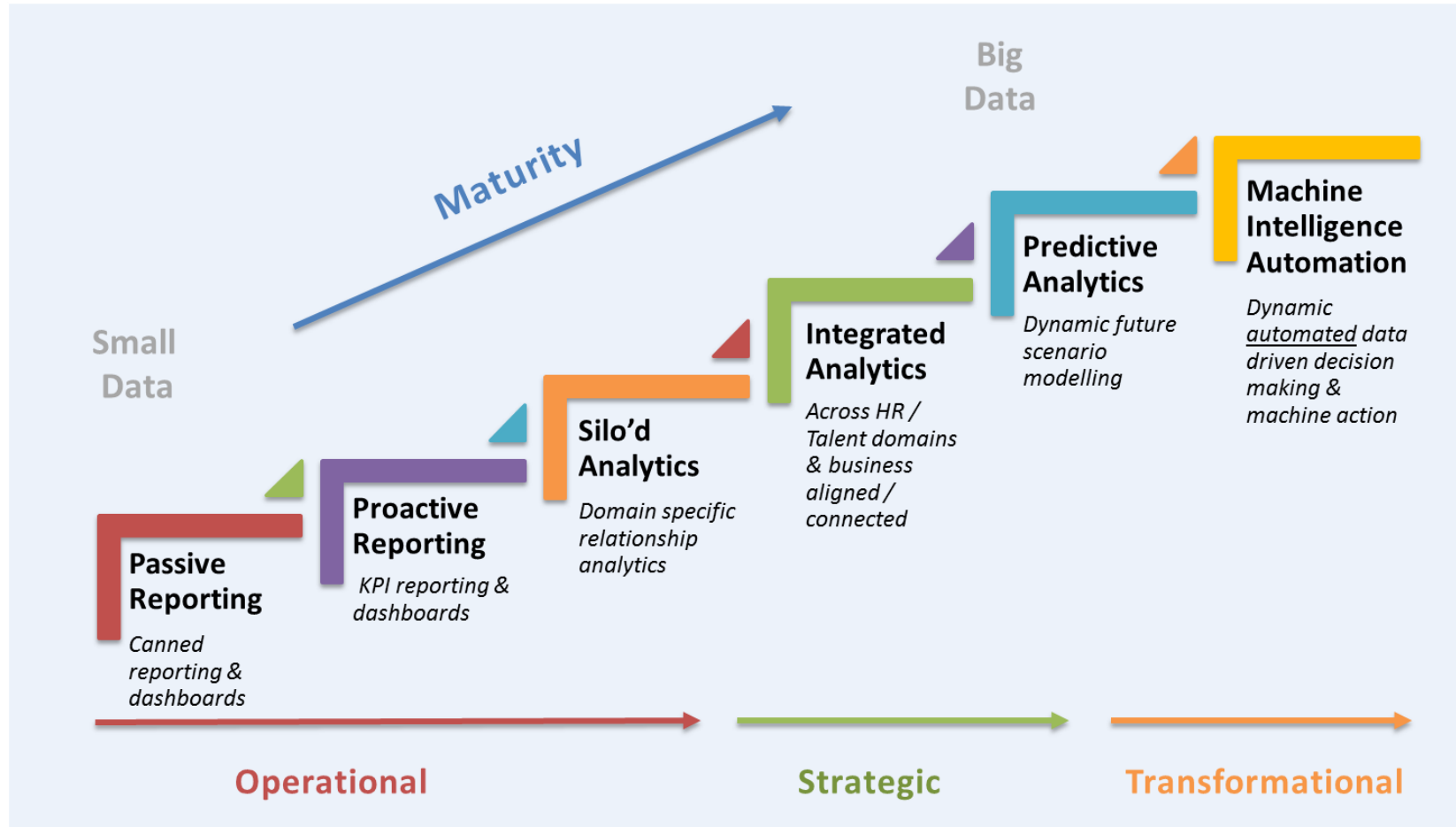
- Island communities are already showing us this on larger and larger scales – Ta'u American Samoa; 1.5 megawatts with battery storage for three days



- Second Generation AMI and potentially new communication paradigms as LTL data becomes less and less expensive and reaches larger and larger areas – without new infrastructure
- Research in Power Line Carrier Technology may provide expanded bandwidth to allow for greater data transfer more frequently without as much new infrastructure
- Mesh networks continue to improve and AMI 2.0 is anticipating leveraging the infrastructure installed in AMI 1.0



# ANALYTICS MATURITY CURVE



Tom Lawton

*President*

[tom.lawton@tescometering.com](mailto:tom.lawton@tescometering.com)



**TESCO – The Eastern Specialty Company**

*Bristol, PA*

**215.228.0500**

This presentation can also be found under Meter Conferences and Schools on the **TESCO** website: [tescometering.com](http://tescometering.com)



TESCO METERING

*This is your invitation to fun!*



*Rat Pack-O-Rama*  
*Courtesy of* **TESCO!**

Swing to the tunes of Frank Sinatra!  
Enjoy a Fabulous Dinner at the  
(in)famous *Indian Canyons Golf Resort*,  
host to a few Rat Pack hijinks.



**Date:**  
**Wednesday**  
**October 2, 2024\***  
**Time:**  
**6:00PM to 9:00PM**

*Please RSVP at the TESCO Booth*

*\*Transportation will be provided to and from the resort. Meet in the TESCO suite at 5:00.*