

# Time Series AI for Naval Power Systems

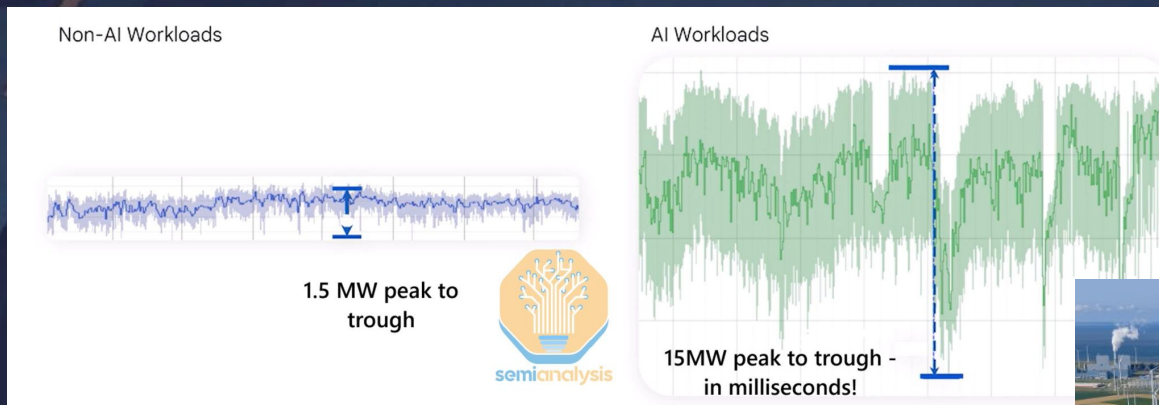
Advancing Readiness and Resilience Through AI-Driven  
Analytics



falconry | The AI Bridge Between Design and Operations.

# Power demand increase necessitates major changes to Infrastructure, including to the USN

pytorch\_no\_powerplant\_blowup=1



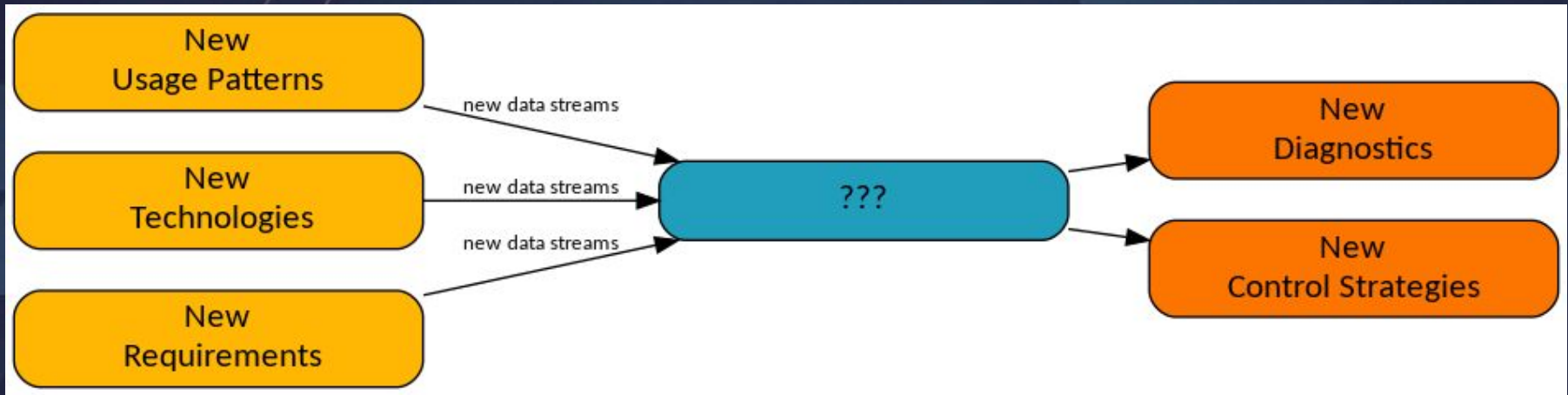
Source: Google at OCP EMEA Summit 2025, via SemiAnalysis

## Sample Domains

- Substations → Cyber/CIP
- DER & BESS
- Data Centers → AI



# Adaptation workflow is heavily reliant on data



1. Generate a lot of data
2. Figure out the data pipeline
  - a. Move it to a place where you can use it
  - b. Apply analytics to the data
  - c. Evaluate the analytics results
3. **Iteratively refine**

# Typical data pipeline design challenges

## Sensor Capabilities & Restrictions

- Missing Ids, unmapped locations, time syncing and corrupt pipelines at source
- Legacy software and data formats dependencies
- Calculation and stream limitations

## Disconnected & Air Gapped Sites

- Centralized platforms are unreachable
- Edge-based model development and deployment is difficult

## Data Visualization

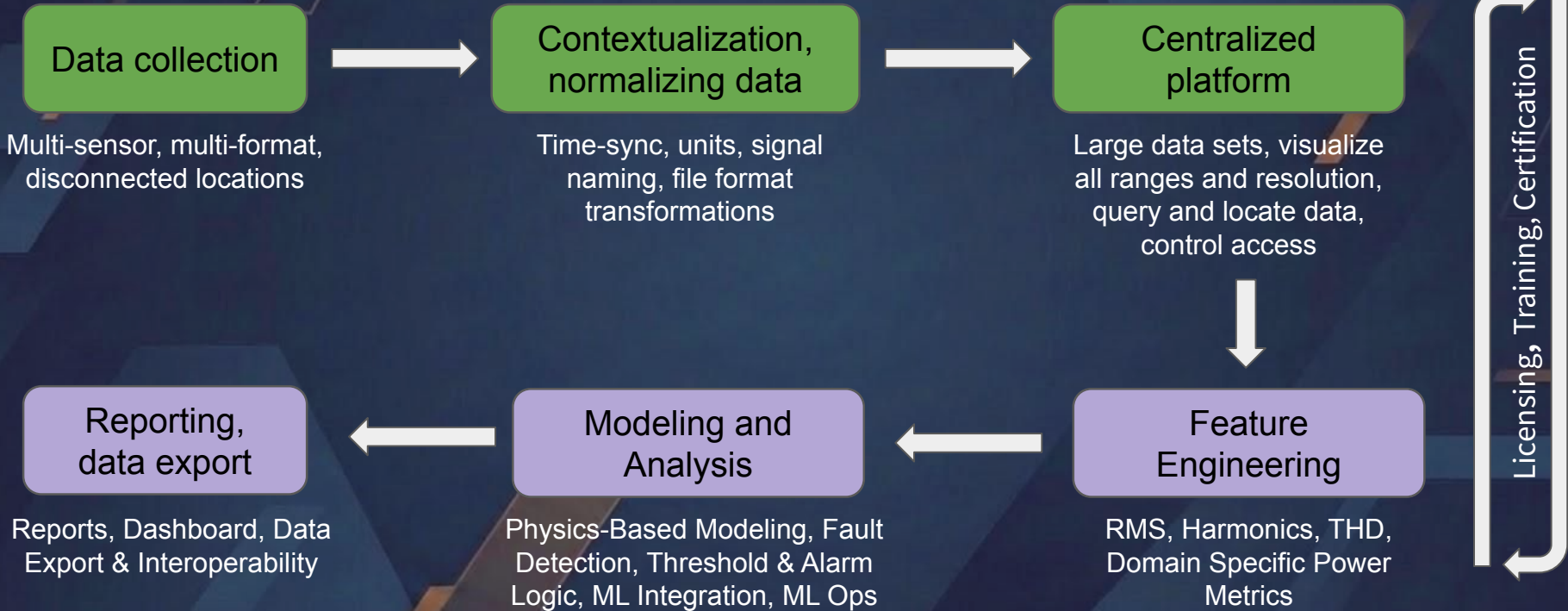
- Visualizing high frequency signals over long time ranges makes pinpointing significant events extremely difficult

## Tool Chain Failures at Scale

- New assets multiply software and training complexity
- Metadata void (missing IDs, locations, types)
- Data collection errors go unseen until analytics pipelines are already made

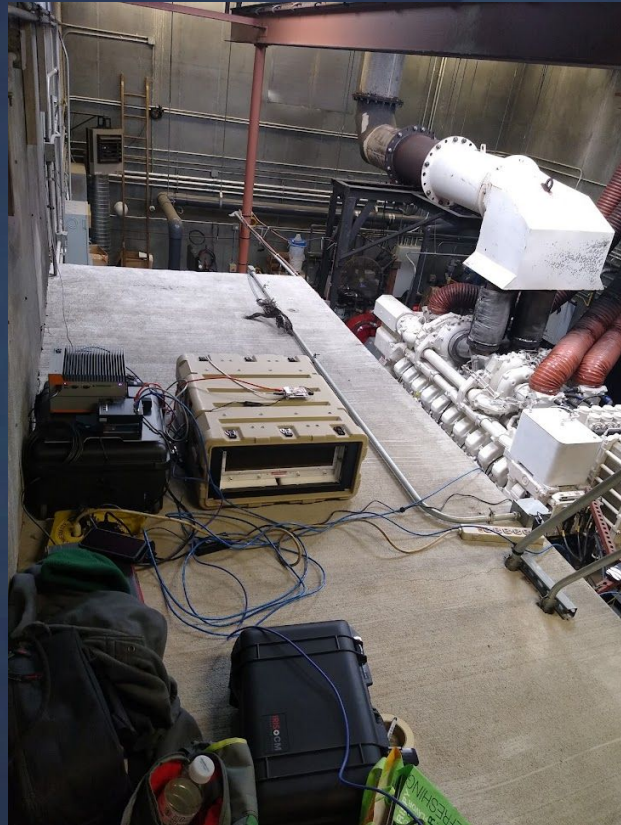
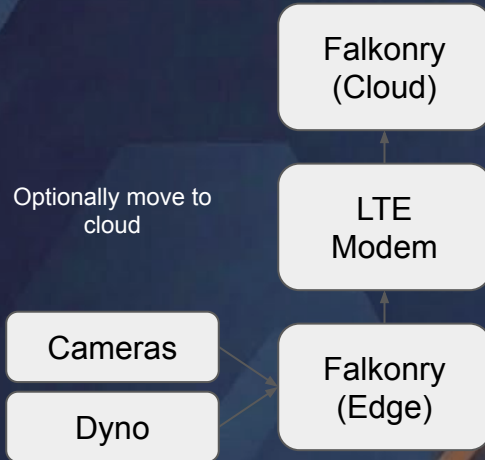
# Power Systems Engineers are now Data Pipeline Engineers

Making data available: Efficiency and consistency

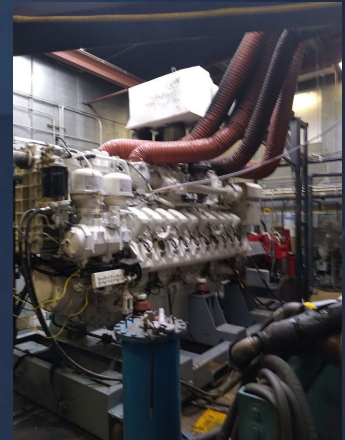


# LUSV Power Systems Analysis (AMTS '24)

- Oracle roving edge device
  - 40 core, 400GB, 40TB, GPU
  - Charged per day
  - Integrates with Oracle Cloud
- RDI IPC and cameras for vibration
- Raspberry Pi as glue

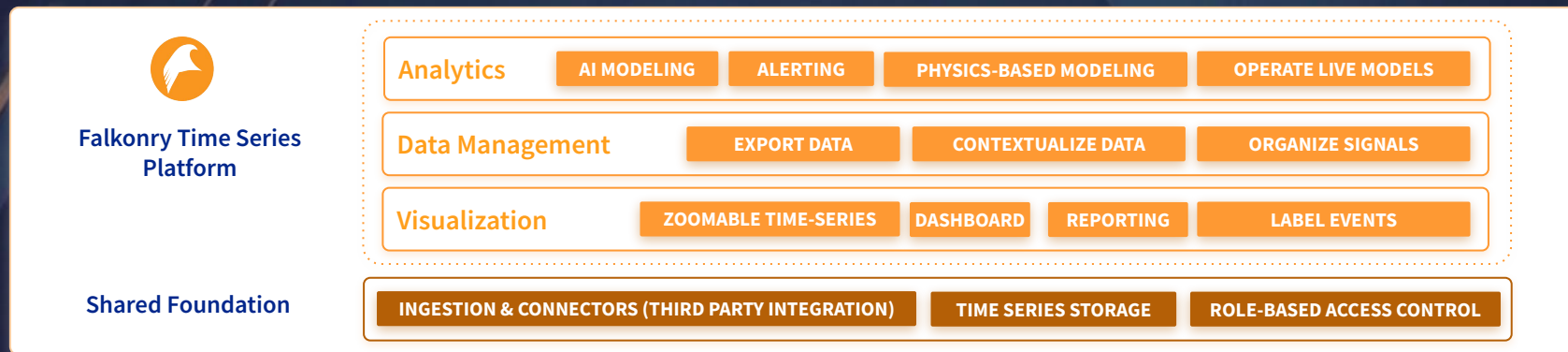


Equipment in exposed space

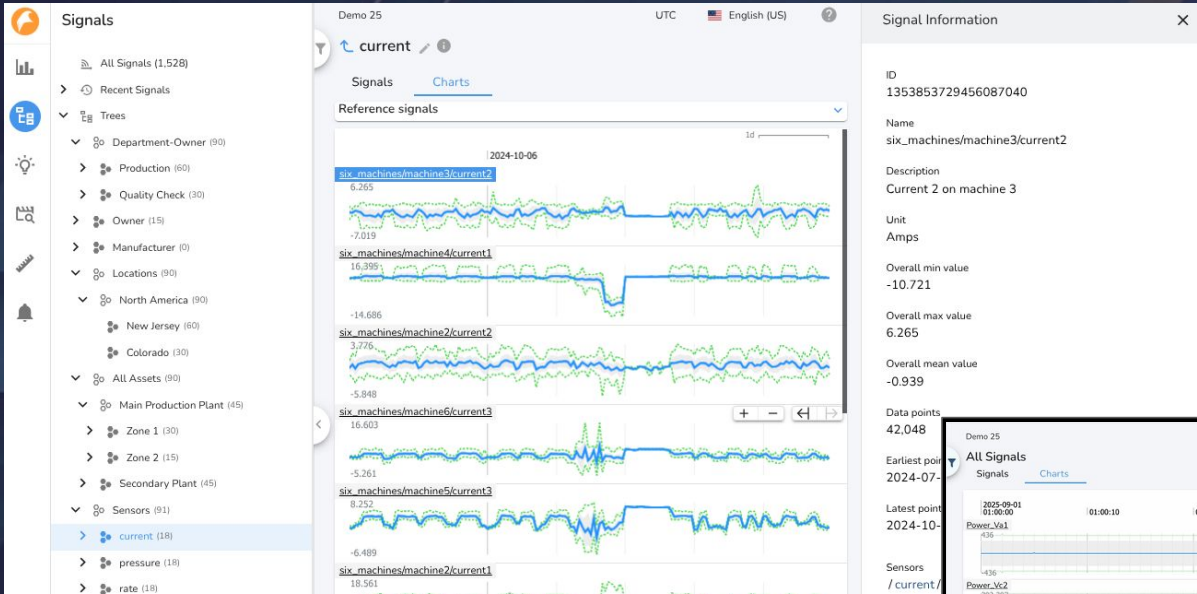


View from vibration camera

# Time Series Platform for standardized pipelines



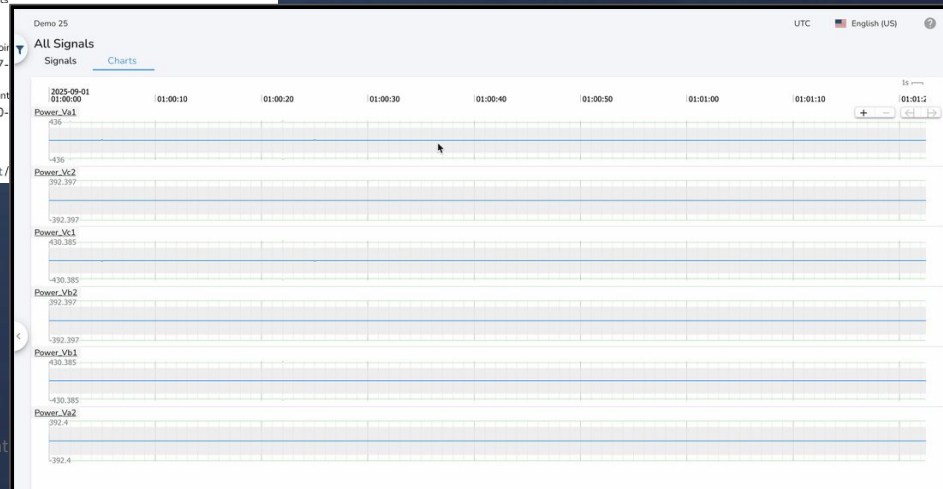
# Contextualization, Visualization, and Analysis



**Contextual Overlays:** Integrated descriptive metadata, limits, timestamp alignment, etc.

**Zoomable Time-series:** Google-maps like interface for time series data

**Signal Organization:** Structured asset trees map physical locations, sensor types, responsible parties, etc.



# Power Data: Many Analytics Opportunities

Source of Issue	Power Quality Issues	Detection Metrics
Operational	<ul style="list-style-type: none"><li>- Equipment malfunctions or unscheduled outages</li></ul>	Breaker statuses, Fault currents, Relay event logs, smart PSU
Load-side Issues (System-wide)	<ul style="list-style-type: none"><li>- Excessive demand</li><li>- Peak load events, frequency instability</li></ul>	Real/reactive power, frequency deviation, load measures, etc.
Load-side Issues (Localized)	<ul style="list-style-type: none"><li>- Voltage sags/swells from motor start</li><li>- Harmonic distortion from nonlinear loads</li></ul>	Voltage RMS, Total Harmonic Distortion (THD), etc.
Grid-side Issues	<ul style="list-style-type: none"><li>- Transmission line faults (short circuits, ground faults)</li><li>- Unbalanced phases / poor power factor</li></ul>	Voltage/current phasors, power factor, frequency stability indices, line impedance
Data Capture Issues	<ul style="list-style-type: none"><li>- Missing or corrupted sensor data</li><li>- Time synchronization errors (e.g., GPS clock drift in PMUs)</li><li>- Bandwidth/latency issues in communication networks</li></ul>	Data latency, packet loss rate, timestamp alignment accuracy

# Falconry TSI Models

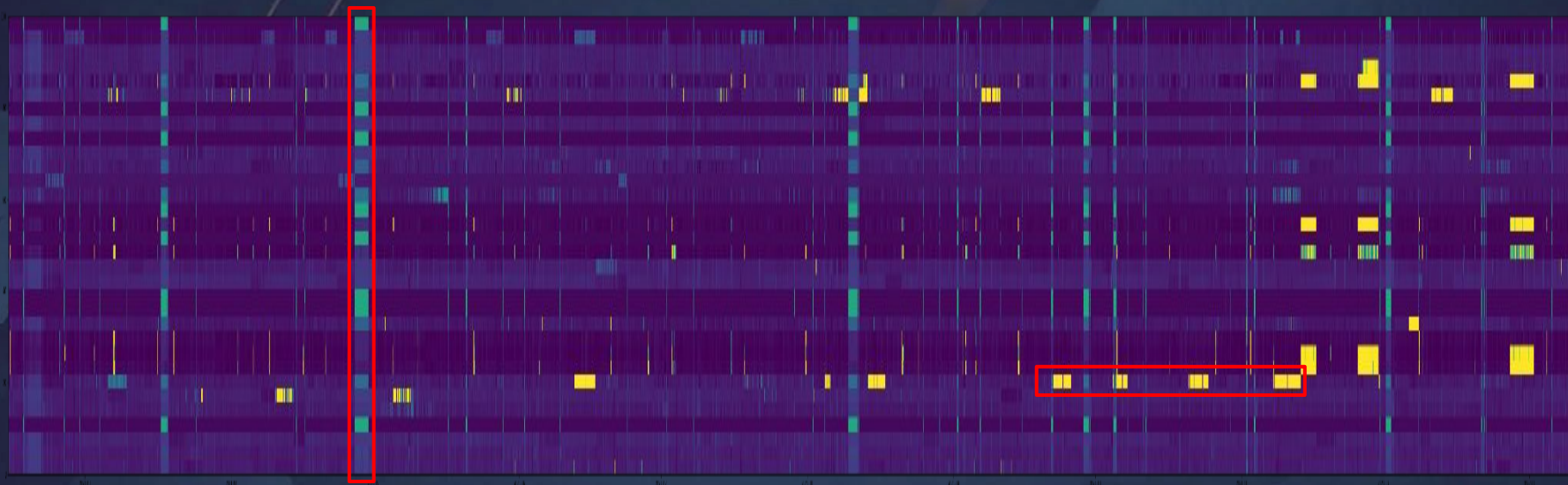
Models map data to inferences either based on domain expertise or empirically

- Calculations (bring your own)
- Rules
- Insights (AI for univariate anomalies)
- Patterns (AI for multivariate unsupervised clustering)
- Patterns (AI for multivariate semi-supervised classification)

Models can be linked into a processing graph which can be run on-demand, batched, or streaming.

*Coming soon: seamless path to develop in cloud then deploy to edge*

# AI works at system scale - unexpected correlation often implies causality



## Systemic event

- Seen by many sensors
- Sensor context informs RCA



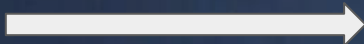
## Locally Persistent event

- Seen by at least 1 sensor
- Behavior over time key to RCA

# Data is available to be integrated with new tools

Raw data, threshold rules, AI evaluations, calculated signals

Export raw data, means, maxs, mins, downsampled, etc.



## Dashboarding Tools

Power BI, Tableau, Grafana, Looker

## Agentic AI & LLM Tools

Alert signals or model outputs are condensed conditions, so they can fit in context windows

## Notebooks & Data Science Tools

Just change dates, limit local download

## CMMS/EAM Systems

Trigger based on alert → automatic creation of work orders

## Custom Applications & Future Integrations

Simple API accessibility, anyone can build on top of it

# Recommendations

Generate a lot of data	Figure out how to use it	Iteratively refine
<p>Turn intuition into sensors</p> <ul style="list-style-type: none"><li>• Don't fear data volume</li><li>• Record provenance</li></ul>	<p>Start offline</p> <ul style="list-style-type: none"><li>• Contextualize</li><li>• Visual browsing</li></ul>	<p>Start early</p> <ul style="list-style-type: none"><li>• Automate processing</li><li>• Evaluate utility</li></ul>
<p>Analyze early</p> <ul style="list-style-type: none"><li>• Visualize your data</li><li>• Share data for analysis</li></ul>	<p>Analyze ad-hoc</p> <ul style="list-style-type: none"><li>• Add calcs, rules</li><li>• Create reports</li></ul>	<p>Refine collection</p> <ul style="list-style-type: none"><li>• Augment data sources</li><li>• Selectively prune data</li></ul>
<p>Manage change</p> <ul style="list-style-type: none"><li>• Update provenance</li><li>• Changes are data too</li></ul>	<p>Experiment with ML</p> <ul style="list-style-type: none"><li>• Pattern classification</li><li>• Anomaly detection</li></ul>	<p>Refine analysis</p> <ul style="list-style-type: none"><li>• Investigative</li><li>• Prescriptive</li></ul>



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**Thank You**

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