Introduction

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Personal Profile

- Former electrical engineer, bits-and-bytes designer/programmer
- Former Power Generation Energy Efficiency Product Manager
- Seven US patents: Internet connectivity, Asset Management, Power Plant electrical systems
- Now a self-styled “prognosticator” & “big picture” guy - examples:
  - Coal to Gas power paradigm shift (2009 - present)
  - Atmospheric CO2 growth models (begun in 2007)
  - AdvancedProjections.com (2013 - present)

The Big Picture in Power

- The situation today is very much market driven
- “Traditional” power generators are psychologically and fiscally risk averse from an operational view, as technology failures leading to trips and outages may cost million$$$
- ISOs/RTO’s & Generators view reliability as a “10” and energy efficiency as a “2” on 1-10 scale
- In regulated markets, PUC restrictions and the new tax laws are actually reducing available cash for upgrades and improvements

Big Data 1

- It’s there, in plant data historians: days, weeks, months, perhaps years of operating data
- You don’t have to undergo huge and complex analysis to uncover issues of financial importance to O&M
- Restricting scope for individual topics saves from being “overwhelmed” at first by Big Data

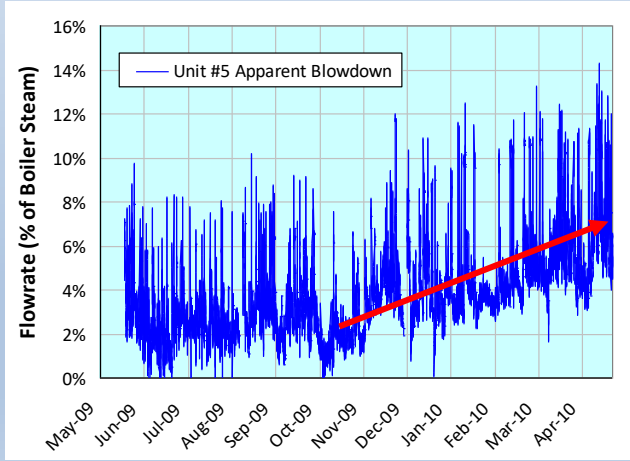
Big Data 2

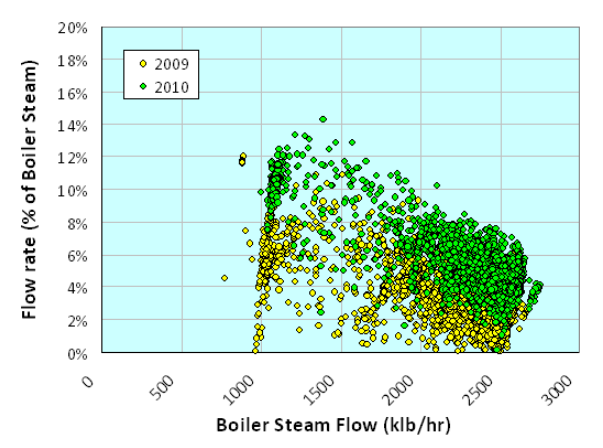
- Basic “Quick KPI” analysis to begin
- Focuses:
  - Revenue sources/sinks
  - High probability events identified in NERC GADS*
  - HILP events: High Impact Low Probability
- Examples:
  - Ancillary services: Load & Frequency responses
  - Plant Efficiency & Performance
  - Water consumption
  - Machine condition
  - Loop performance and tuning

*Tube Leaks!

High Return Examples

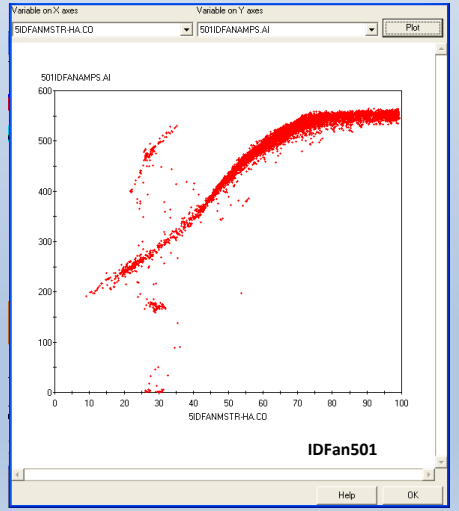
- Case: Calculated water use moves from 3% to 7% in 6m
  - Cost of makeup water + energy losses
  - At the time of discovery, loss rate **$2M/yr** and climbing

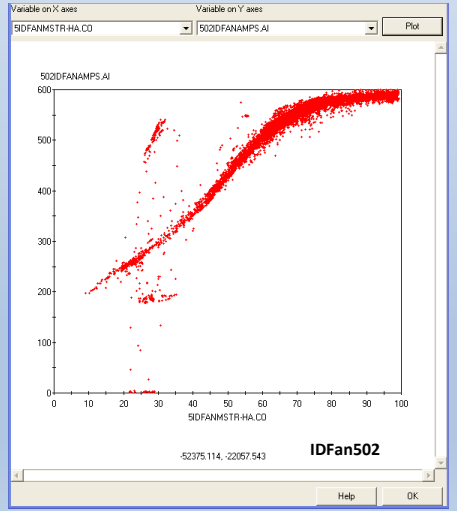




High Return Examples

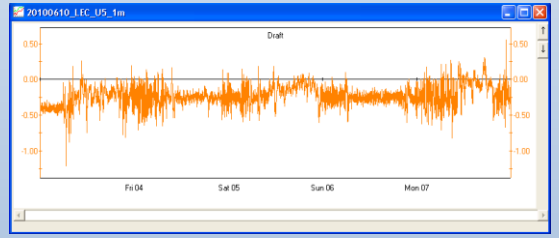
- Case: ID Fan Efficiency Loss
  - Cost of top end of load, aux power consumption
  - At the time of discovery, loss rate was **~$350k/yr**



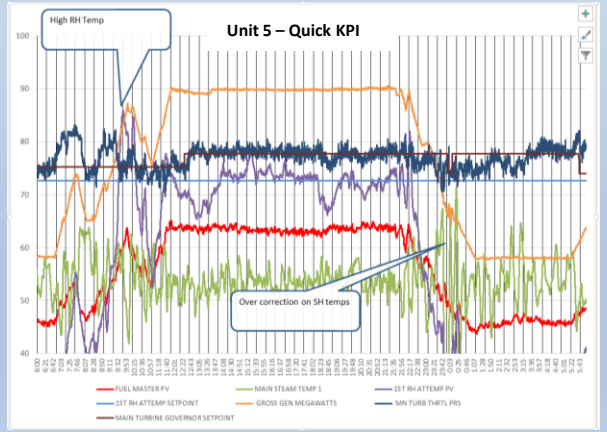


High Return Examples

- Case: Control Loop Performance & Tuning
  - Cost of performance loss, operational “dances” to compensate, inability to ramp at 3%/min, or to make rated load
  - At the time of discovery, loss rate exceeded **$500k/yr**



Furnace Pressure Excursions



Boiler Tuning Required

Automation Speeds of Response

- Safety & process protection — Automated “reflexive actions”
  - Milliseconds to seconds — 0.001 to 100 sec
- Process/equipment O&M — Auto & Manual “Tactics”
  - Seconds to hours — 100 to 100,000 sec
- Enterprise/Fleet management — Automation of “strategies”
  - Hours to Months — 10,000 to 100,000,000 sec

When automation is better

- Instances where reaction time is faster than people can respond.
- Ongoing control with highly simultaneous and repetitive characteristics (plant controls)
- Data mining, deep pattern recognition where information is collected over widespread populations and long periods of time

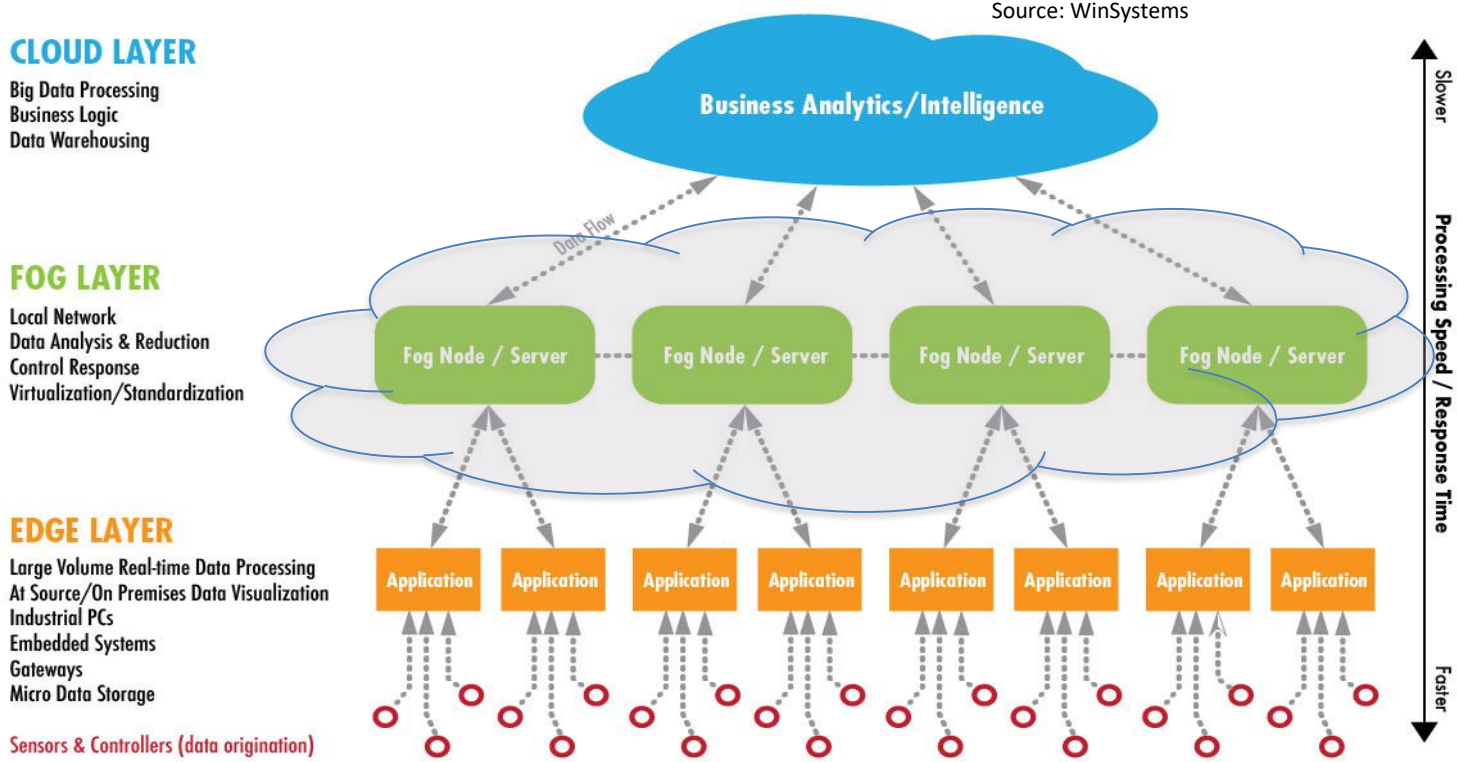
- People are slow compared to timescales required for accurate process controls and equipment safety.
- People have limited bandwidth and quickly experience situational fatigue, but can supervise operations with help

- Limited bandwidth & capacity
- “Algorithms” are subjective/intuitive
- Attention span is limited due to “watching paint dry” syndrome

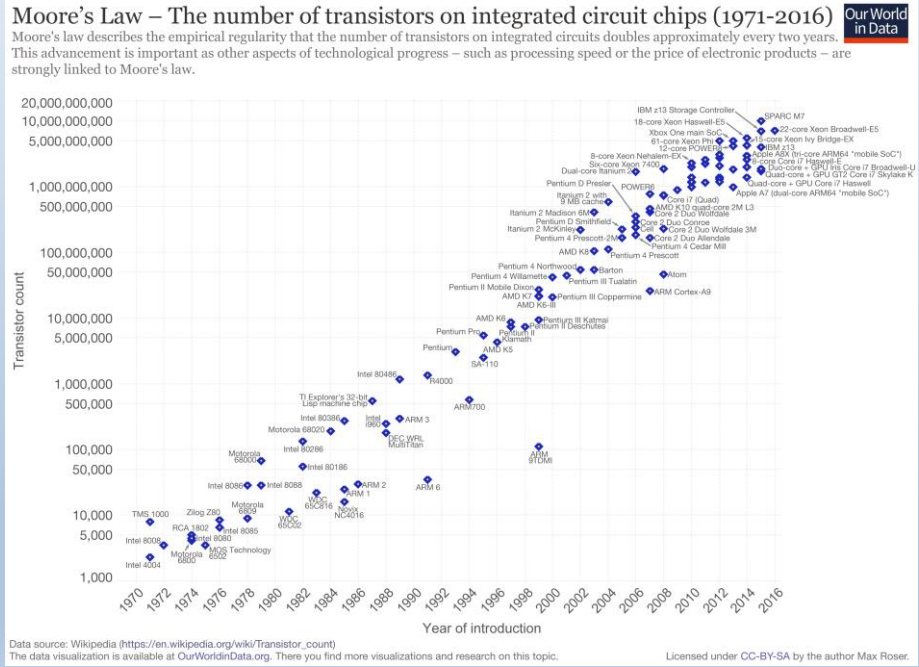
This “fog” layer is where we work and live!

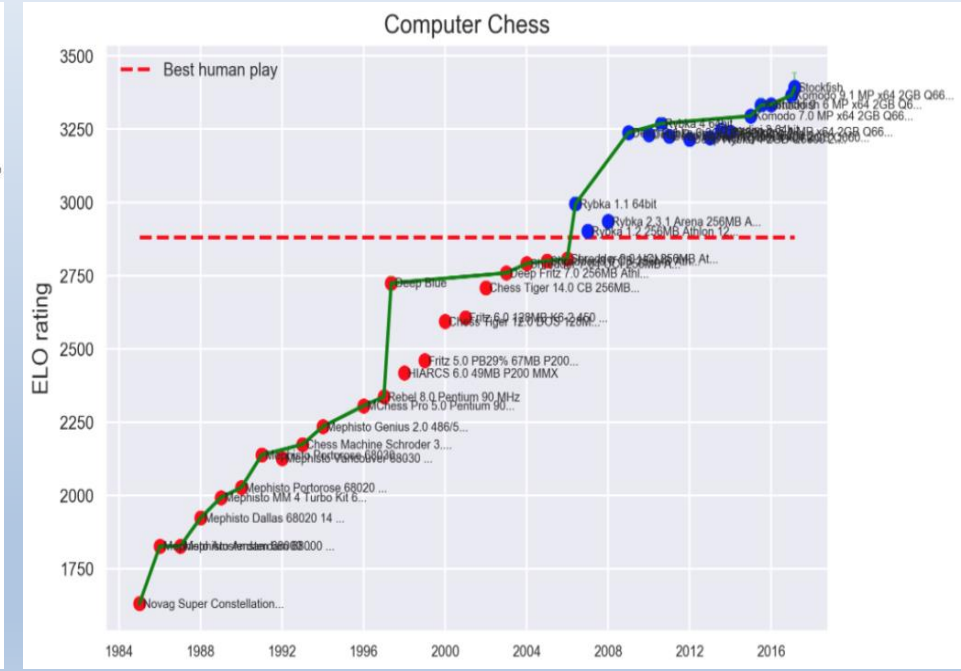
INDUSTRIAL IoT DATA PROCESSING LAYER STACK

Source: WinSystems



Evolution of Computing Power





Big Data Analysis isn't free, but it pays for itself!

- Manual data harvesting and investigation of unit history
  - $50k to $100k
  - Untargeted "studies" often prohibited by state regulations

- Setup for remote monitoring of current data and trends has about the same cost as above. Add to this the annual cost of data monitoring and mining through collaborative operations.

- Luminent Power of Texas claims $500M in savings over a decade through internal 24/7 collaborative operations center (Dallas), with costs of a small fraction of that, yet plants are still being closed.
  - No capacity market in ERCOT, unwilling to pay for non-spinning reserves
  - May 2018: some day ahead prices exceeded $500/MWhr
  - May 2018: some real time energy exceeded $3100/MWhr