

The Impact of AI and Data Analytics in Nuclear

NAYGN Facilitator: Mark Llewellyn

The Impact of AI and Data Analytics in Nuclear

NAYGN Annual Meeting

Joan Knight – Innovation Director, Exelon

June 3, 2019



Exelon Generation®

Artificial Intelligence in Pop Culture

What comes to mind when you hear the term 'AI'?
Hollywood has an opinion...



Stanley Kubrick brought Arthur C. Clarke's HAL9000 supercomputer to life in the 1968 classic, 2001: A Space Odyssey. It didn't work out well for the humans...

More Recently, Tony Stark's digital assistant, JARVIS, played a prominent role in the 2012 Marvel Universe film, Avengers: Age of Ultron, eventually becoming a physical manifestation as the conflicted Vision character.



The reality of today's AI capabilities is far different, but exciting and valuable nonetheless.

AI and Data Analytics in Today's Nuclear Industry

AI in Nuclear can be broken into four general categories.

Computer Vision – identification of assets, people and anomalies through imaging

Machine Learning – use of algorithms and statistical models to perform a task *without specific instructions*



Chat Bots – simulation of human conversation either verbally or textually

Natural Language Processing – Computer processing of large amounts of data that exists only in natural language format

Data Analytics refers to the ability to draw insights and conclusions from raw data. It relates to AI in the sense that these insights can then be utilized to feed **Machine Learning** algorithms.

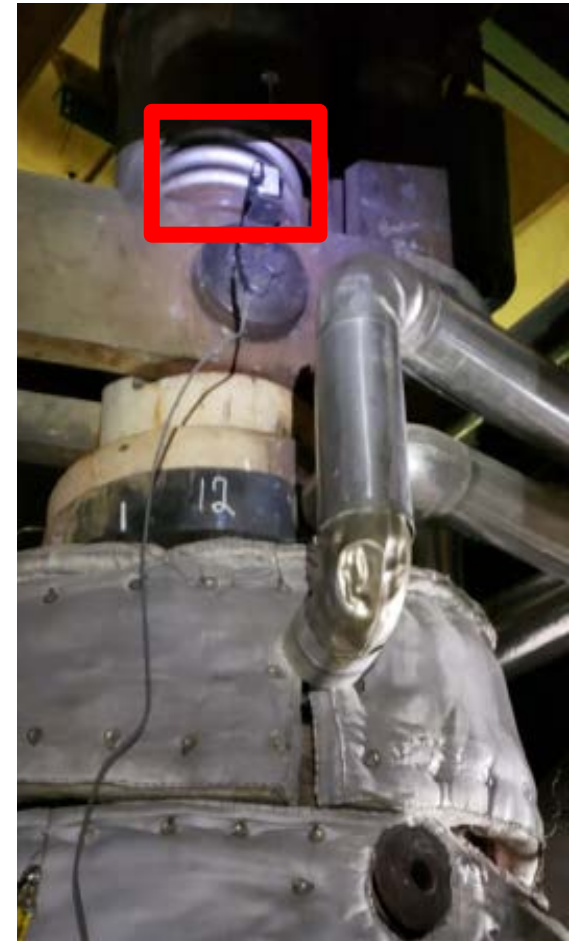
Computer Vision - Example

Question: How might we closely monitor the relative performance of a turbine steam control valve when...

the valve has no installed position indication and
the valve stem is covered by insulation and
the valve travel is only 2.5 inches and
the valve is in a high dose area?

Answer: We might...

install a camera with a view of the closing spring and
establish a boundary box around the spring
develop a custom algorithm to let us know when
the performance of this valve (based on minute
variations in spring position) differs from the norm.



Example – Machine Learning / Data Analytics

Question: How might we utilize Data Analytics to drive better decision-making by...

leveraging all data sources

moving from a reactive to a proactive stance

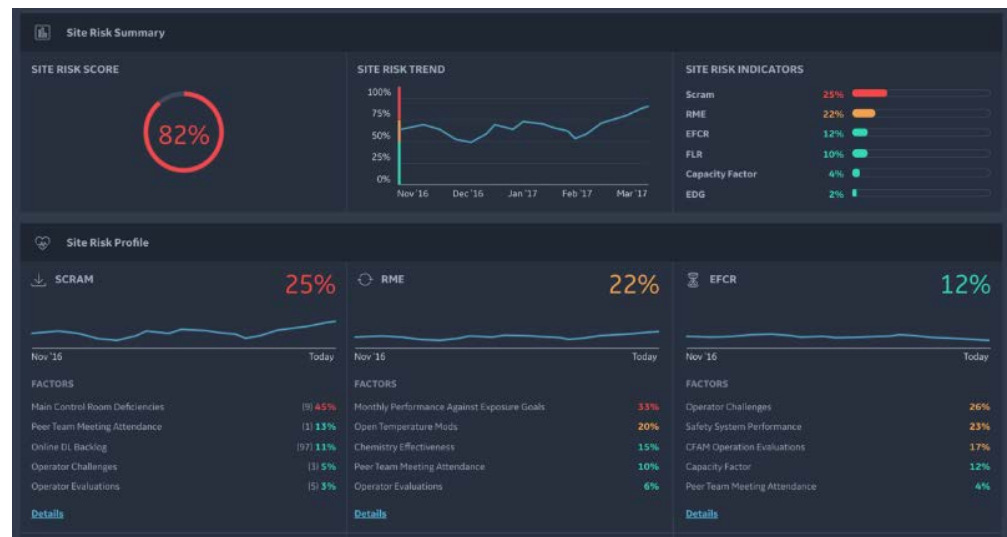
suggesting solutions to curb adverse trends

Answer: we might ...

identify symptomatic indicators & organizational behaviors correlated with early signs of performance decline

develop analytical models to predict performance challenges fleet-wide

Provide insights into mitigation strategies for identified risks



Current Applications in Nuclear

Analytics are currently being applied and are bringing REAL value to the business

- Proactive predictions of equipment performance via use of historical on-line monitoring data
- Optimization of equipment maintenance frequencies based on historical maintenance and performance data
- Extension of equipment maintenance frequencies based on expected plant life/de-commissioning
- Proactive predictions of maintenance resource challenges based on current and historical resource allocations
- Proactive predictions of potential outage schedule delays through use of historical outage schedule performance data

Value:

Reductions in:

- Maintenance resources
- Maintenance material costs
- Unexpected station trips and down-powers
- Unexpected outage and startup delays



AI and Data Analytics in Tomorrow's Nuclear Industry

We are just starting to scratch the surface. Imagine...



A wearable, **computer vision** system that can identify a component and provide real-time data to the wearer through an augmented reality interface.

A **chat bot** that can engage employees in real time and provide context-sensitive instruction and coaching.

A **machine learning** algorithm that can take process **data analytics** and provide suggestions for process optimizations.

A **natural language processing** AI that can review thousands of pages of corrective action program data and generate new trends and insights into equipment and human performance.

The possibilities are both numerous and exciting!

Connected Solutions

Predict Performance | Prolong Asset Life | Optimize Total Cost of Operations

XENIA MASTROPETROU, ECOLAB INC.

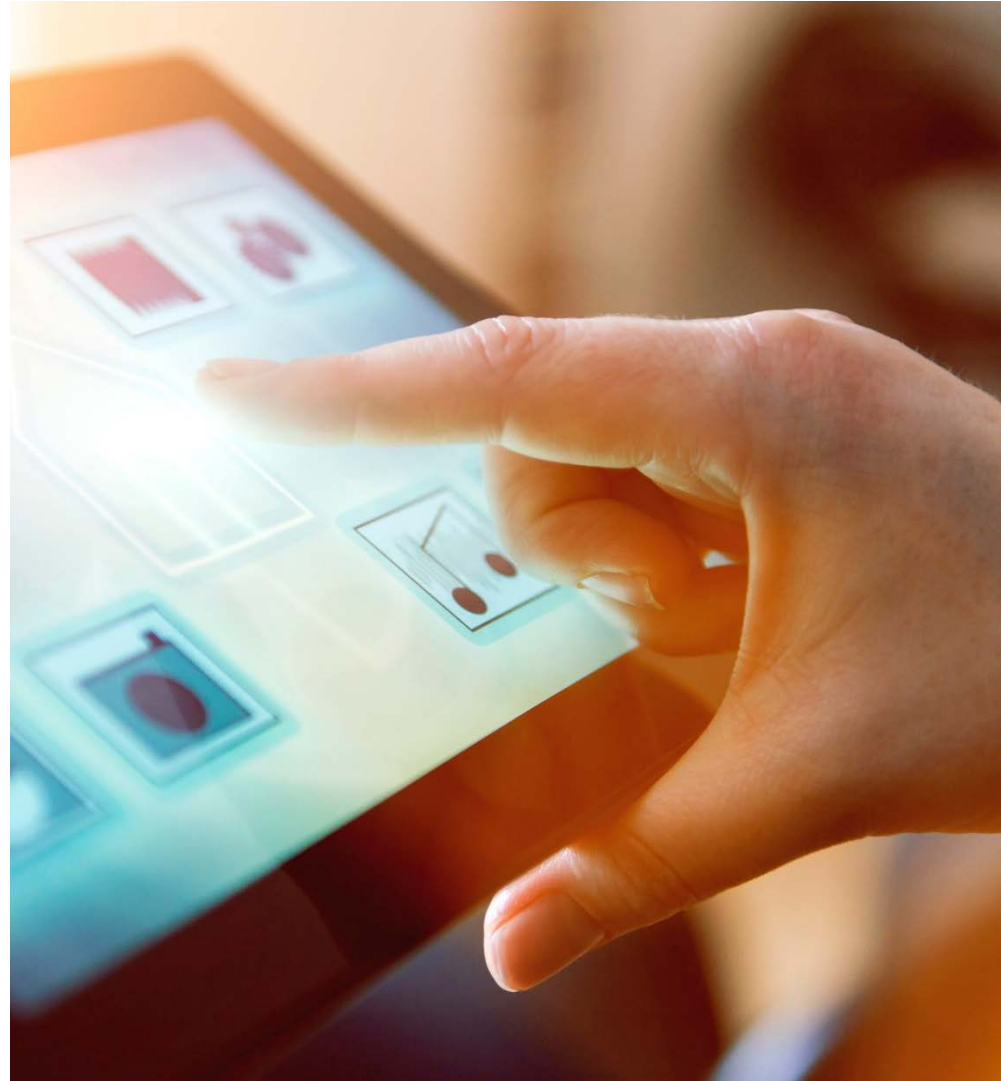
June 2019

NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company

What is the Internet of Things?

A development of the Internet in which everyday objects have network connectivity, allowing them to collect and exchange data.

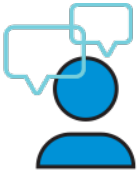




Google



2020



4 Billion

Connected
People



\$4 Trillion

Revenue
Opportunity



25+ Million

Apps



25+ Billion

Embedded and
Intelligent Systems



50 Trillion

GBs of Data

Source credit: Mario Morales, IDC

70%

**of potential IoT
value is in B2B
applications**

35%

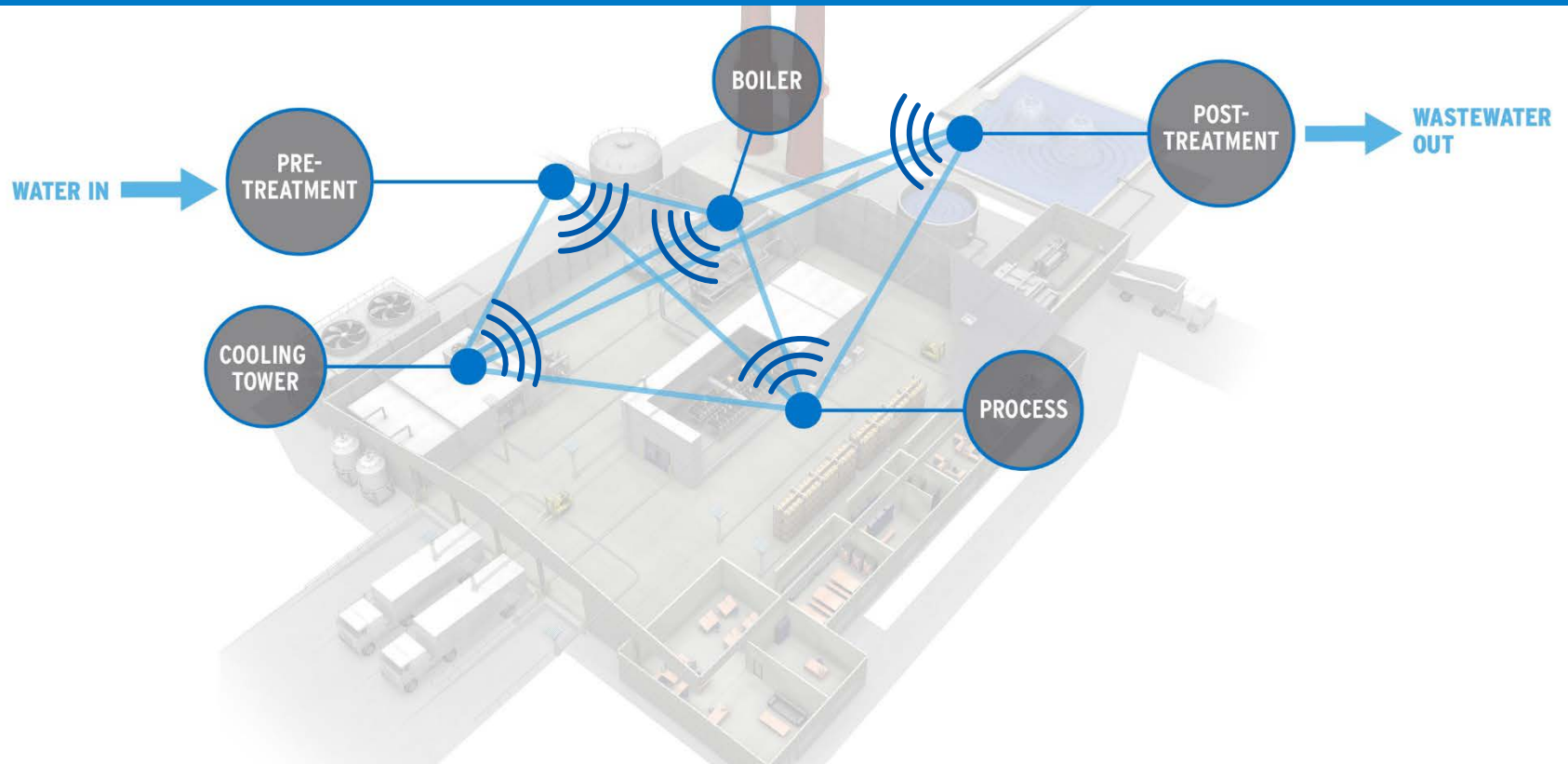
**of manufacturers
use smart sensors**

10-20%

**of IoT value is in
Utility Savings and
Labor Efficiency**

Source credit: McKinsey Global Institute, 2015

Plants that Reuse 100% Water



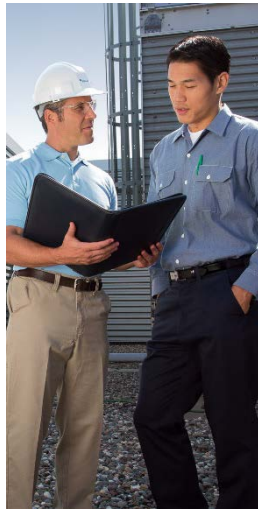
This is what we do at Ecolab.



Energy
Services



Mining



Industrial Water
Services



Food and
Beverage




Healthcare



Retail



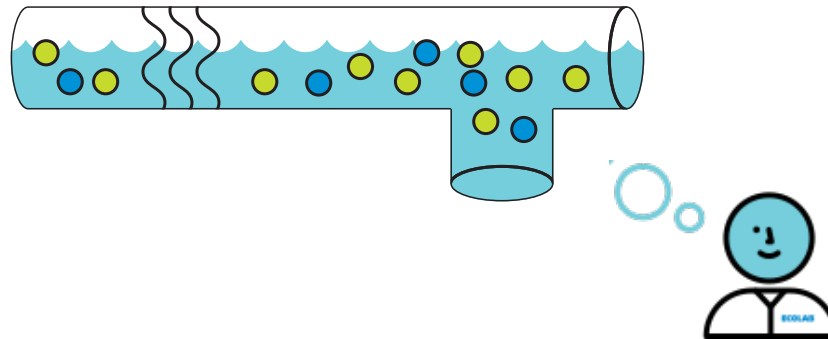
Hospitality



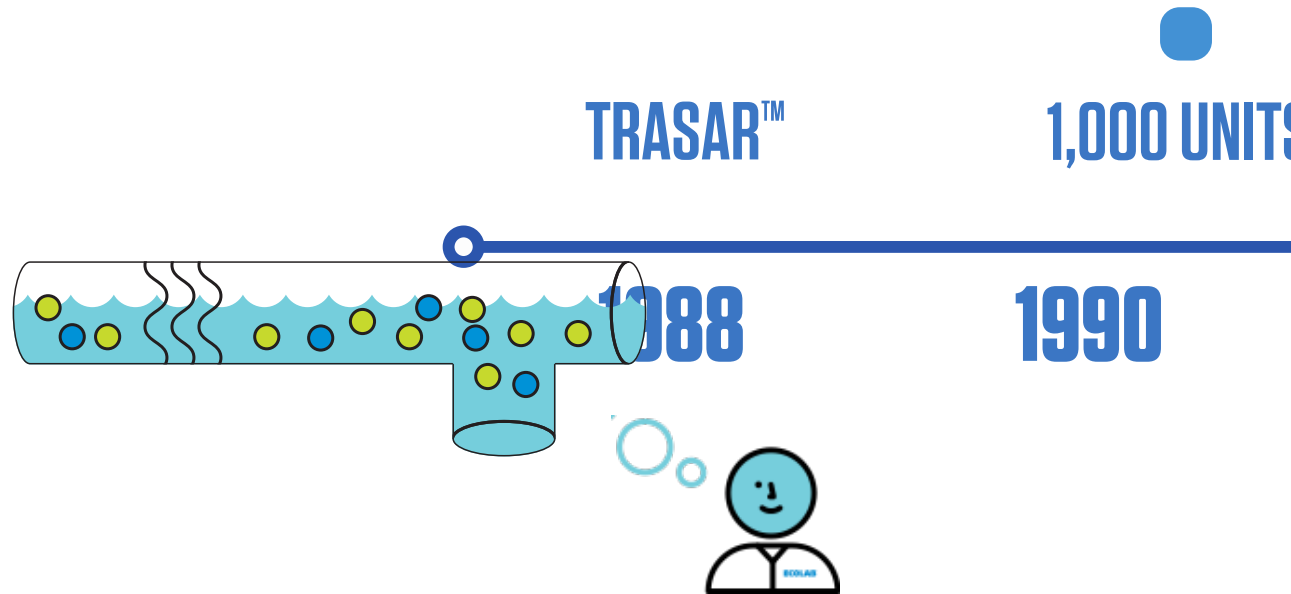
Help manage water & process technology enabling
**22% OF THE WORLD'S
ELECTRICITY GENERATION**
and 40% of all nuclear power.

Help manage
1.1 TRILLION GALLONS OF WATER.

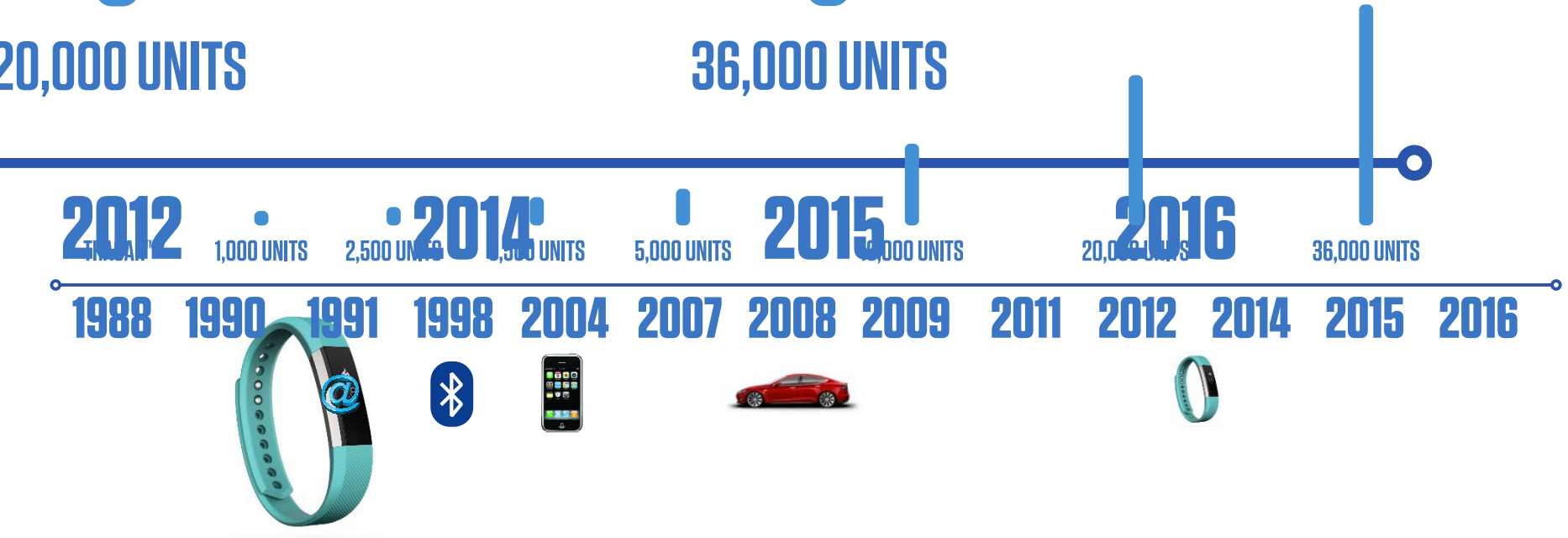
Pioneering connected technology for nearly 30 years



Pioneering connected technology for nearly 30 years



Pioneering connected technology for nearly 30 years



How it Works from Pipes to People





40,000

Water systems
currently deployed
worldwide

72 BILLION

Data points
collected
per year

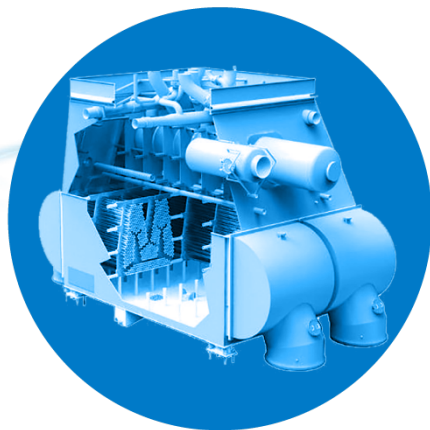
188 BILLION

Gallons
of water saved

Data is like oil.

SURFACE CONDENSERS

are the heart of your
production efficiency



Keeping the CONDENSER at
design performance:



minimizes
fuel costs &
environmental impact

&



maximizes
profitability

1" of increased
condenser
backpressure

1% increase in
energy use
for combined
cycle plants

\$700K
per year in
fuel cost
savings

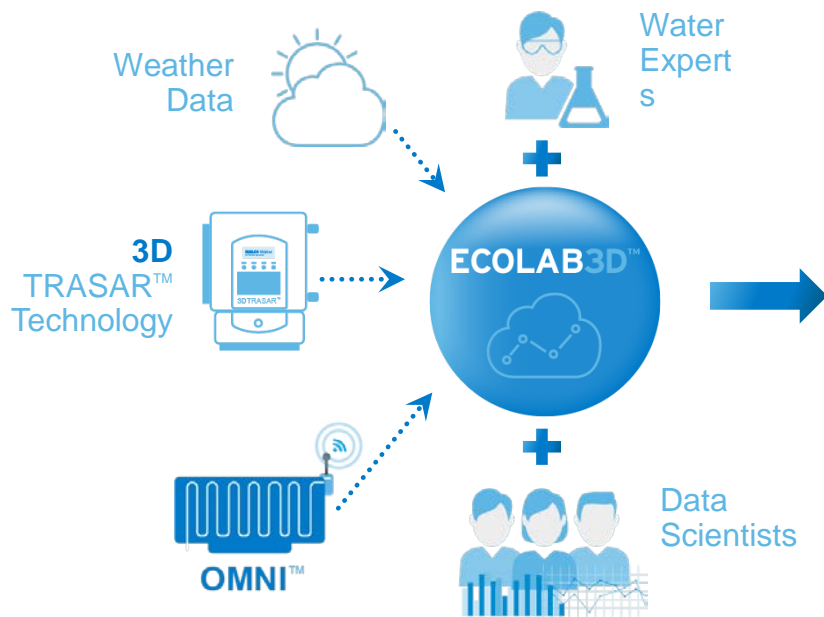
NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company

OMNI™ CONDENSER PERFORMANCE

Combining chemistry, automation, sensors & data analytics

OMNI Analytics



Predict performance of critical assets

Prevent unscheduled downtime & lost production

Prolong asset life & production runtime

NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company

SUCCESS IMPERATIVES

OMNI Analytics



Real-time
Monitoring



Secure
Networks



Predictive
Analytics



24/7
Response



On-site
Expertise

NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company



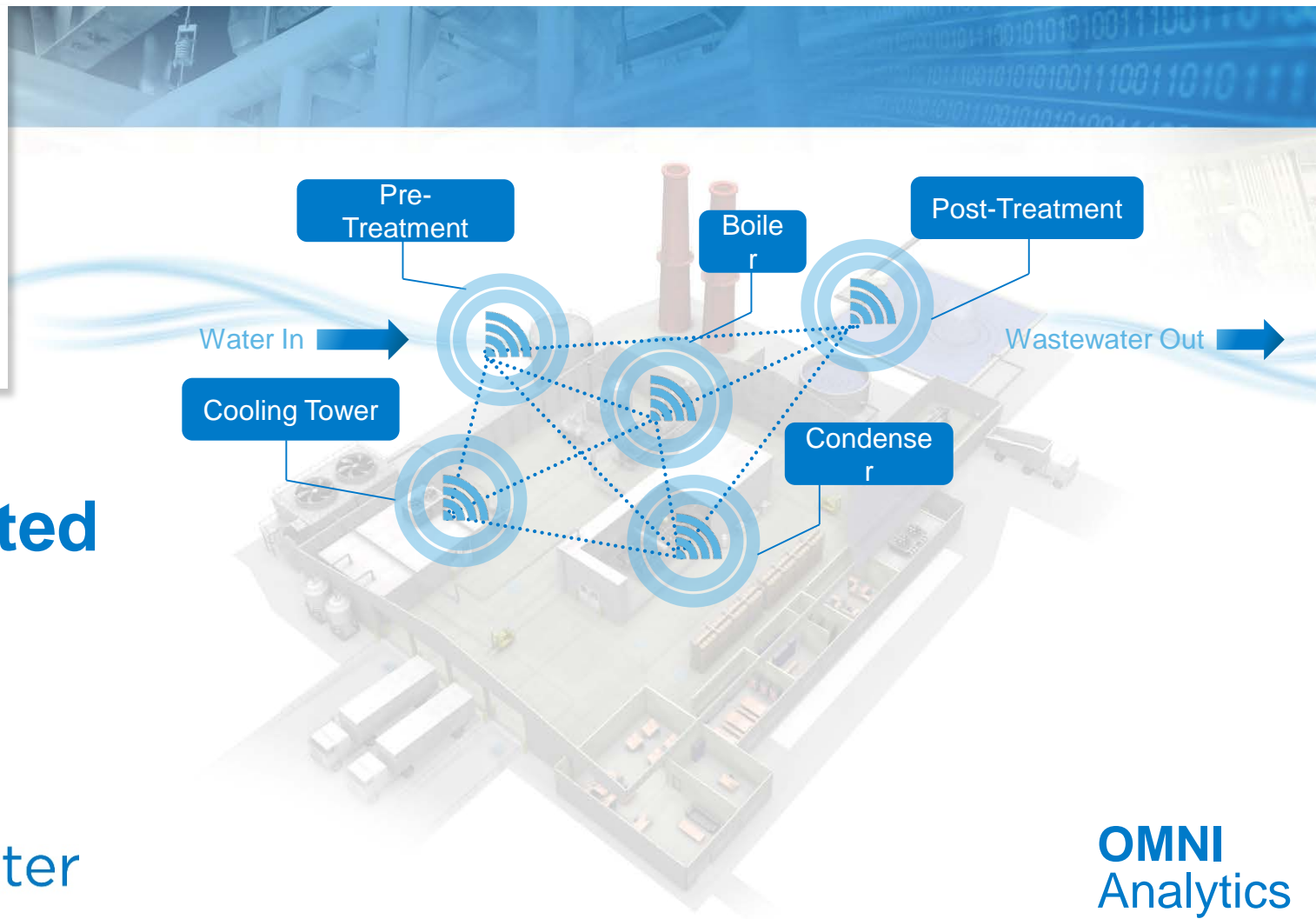
Real-time
Monitorin
g

Connected Power

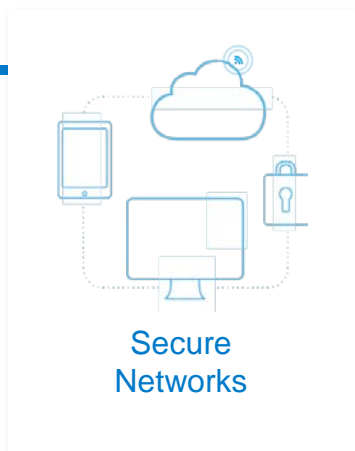
Leads to Reliable
High Performance

NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company



OMNI
Analytics



Secure
Networks

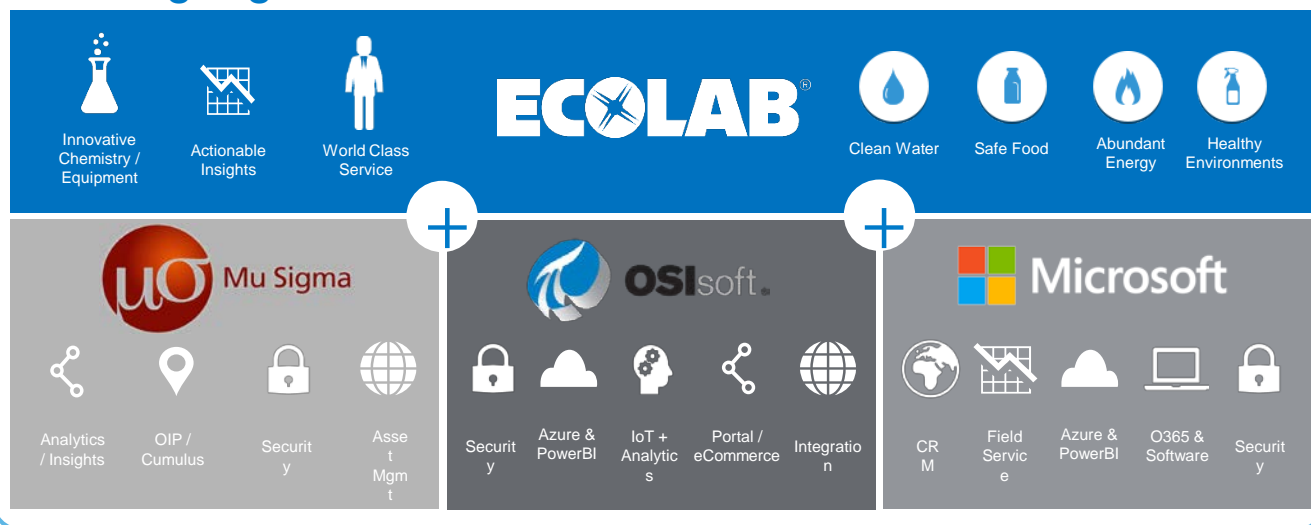
Built
through a
partnership

of global leaders

NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company

Working together



to deliver secure, intelligent and scalable
solutions to minimize water, maximize
results and optimize total cost of operations

OMNI
Analytics



Predictive
Analytics

OMNI Analytics

Predictive Indication of:

Scaling Conditions

Microbial Fouling

Identification of:

Air Inleakage

Macrofouling

Tube Leaks

Misc Issues:

Low CW Flow

- Sensor Error
- Operational Limits
- Rapid Trend Changes
- Design Limits

High CW Temp

NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company



Predictive
Analytics

Predicting Scaling

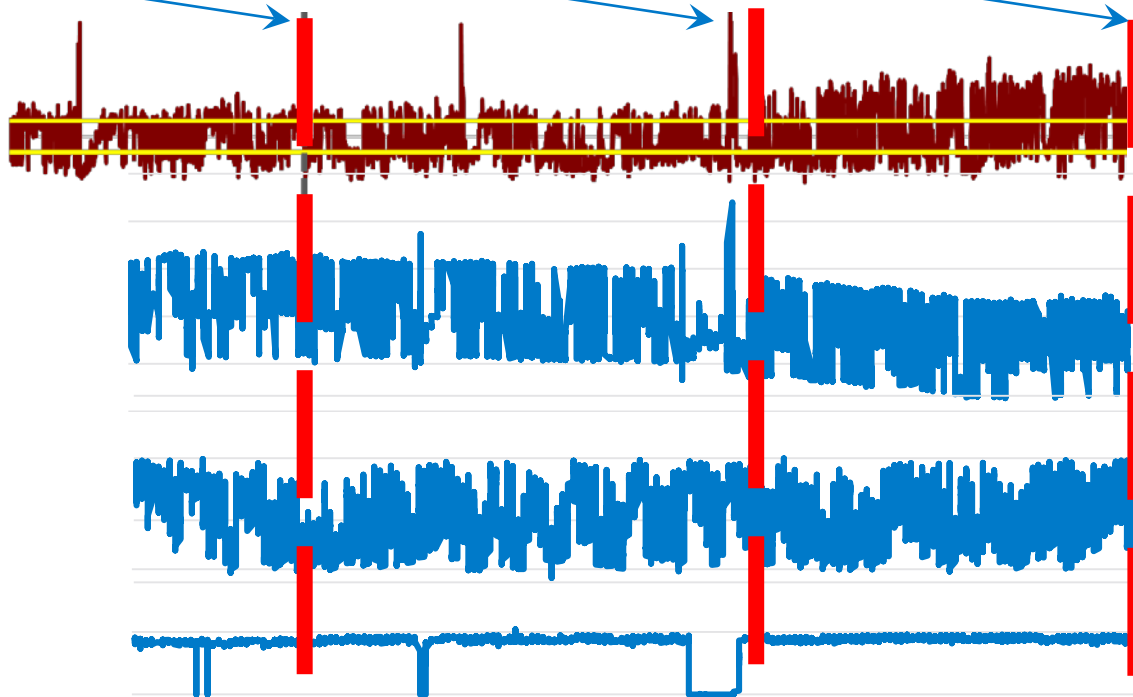
NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company

March – Data modeling
predicts formation of
scaling in condenser

May – KPI analysis
shows scale formation
beginning in
condenser

Aug – Scale formation
discovered during
customer inspection





24/7
Response

Site Performance
Enterprise Performance
Value Delivered

ECOLAB3D Digital Platform



NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company

OMNI
Analytics



On-site
Expertise

The AI + Human Factor

Technology can bring
“**personalized service**” to
a whole new level

- Technology “**does the work**”
- The human being provides “**essential expertise**”



NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company

OMNI
Analytics

OUTCOMES

2 Unit Nuclear Power Plant

- Uses brackish water for once through condenser cooling
- OMNI identified inlet tube sheet fouling leading to higher temperature rise and backpressure on the condenser



Reduced labor costs for cleaning

\$100,000



\$3M

Generating revenue restored



Reduced costs to mitigate reactivity control risks

NALCO Water
An Ecolab Company

NALCO Water
An Ecolab Company

OMNI
Analytics

THANK YOU!

XENIA MASTROPETROU

XENIA.MASTROPETROU@ECOLAB.COM

Questions?