AWS
re:Invent

NOV. 28 – DEC. 2, 2022 | LAS VEGAS, NV

Energy upstream innovation: bpx on AWS

Jordie Harrell

Chief Technology Officer
bpx Energy
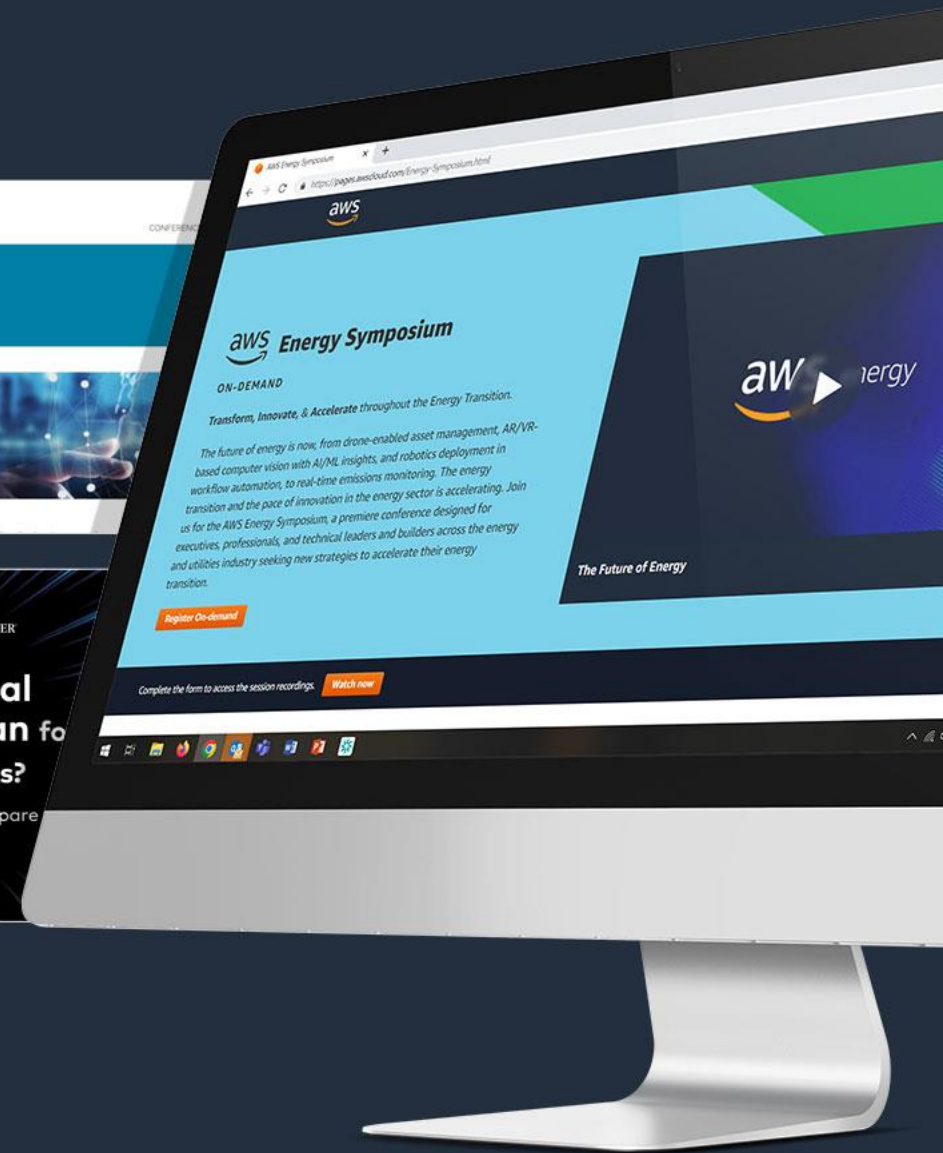
Scott Sanderson
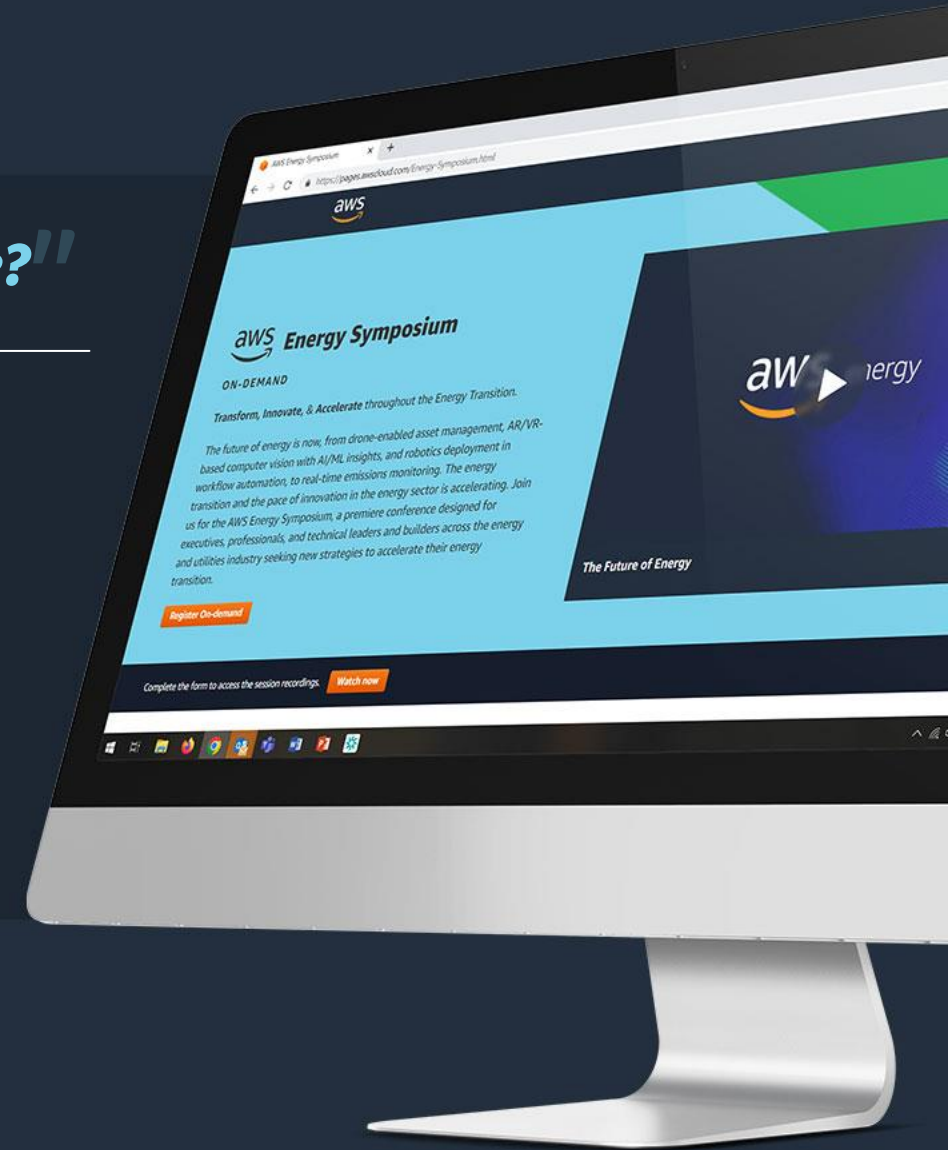
Director Business Development, Energy
AWS

Digital as a Theme in Energy

Digital as a Theme in Energy

"What, really, is the cloud, and why is it valuable to me?"

Digital → Physical (assets)

....

Digital → Digital (workflows)

....

Two-Way Doors

Improving Physical Systems at the Margin

"We believe in Physics, not Mystics."

Improving Physical Systems at the Margin

> ❝ *We believe in Physics, not Mystics.* ❞

Applying digital and physics at the margin leads to advantages of fractions of a second, which is the difference between winning and losing.

Improving Physical Systems at the Margin

HEAD IN THE CLOUDS . . . FEET ON THE GROUND

Improving Physical Systems at the Margin

100M BBL OIL PER DAY

- More production

- Less dollars

- Faster

- Less risk

- Lower carbon footprint

Innovating Digital Workflows

**Data-Driven Workflows
Knowledge Workers
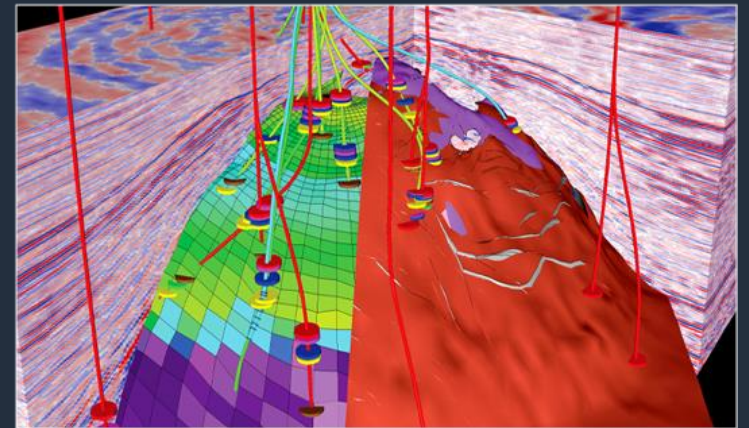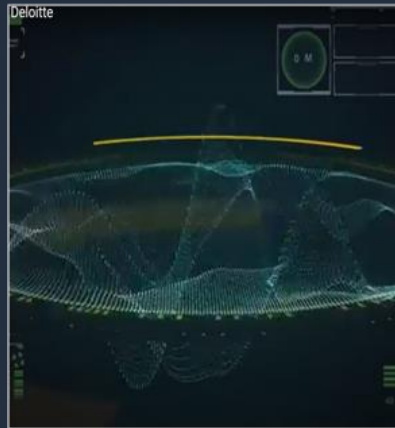Technology – Enabled**

↓

Meaningful improvements in

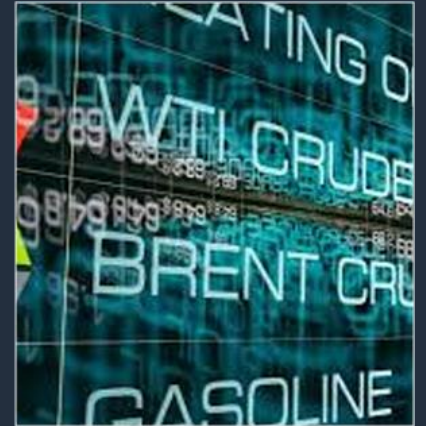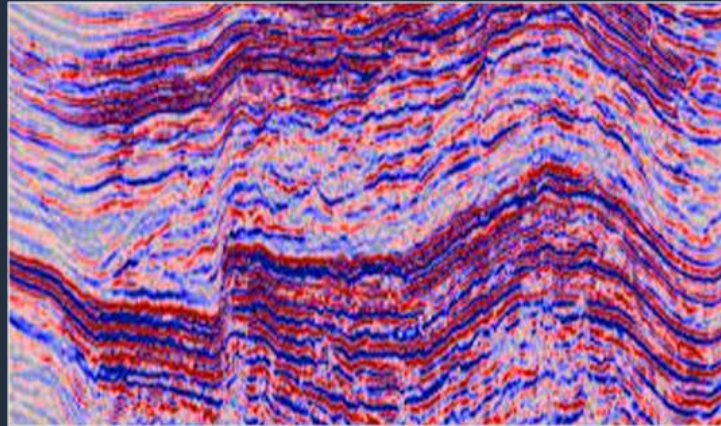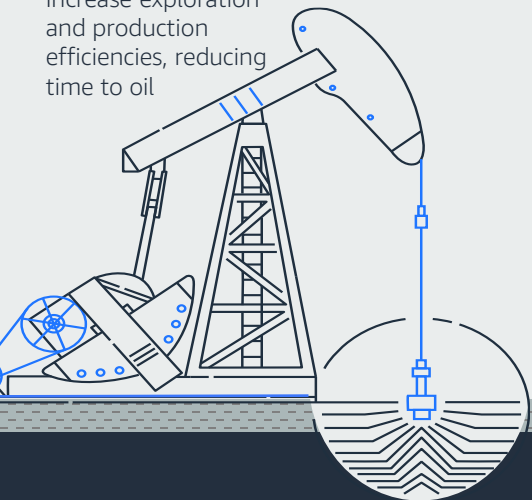| |
|---|
| Simulation |
| Modeling |
| Forecasting |
| Trading |
| Pricing |
| Optimization |
| Supply Chain |

AWS Energy

UPSTREAM

Drilling & completions
Simplify management of your rigs, increasing performance and the efficacy of completions

Production operations
Lower operating expenses, reduce downtime, and increase safety across operations

Geology & geophysics
Increase exploration and production efficiencies, reducing time to oil

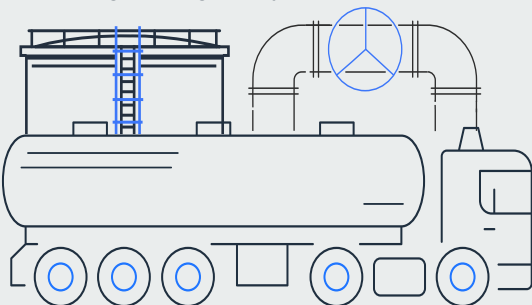## MIDSTREAM

Pipelines & logistics
Streamline monitoring and preventative maintenance of pipelines

Trading & risk
Optimize commodity trades and gain visibility across your entire portfolio

Infrastructure
Facilitate storage and delivery of products with streamlined terminal operations and gathering line systems

DOWNSTREAM

Fuels retail
Provide visibility and optimization across the customer journey

Refining & chemicals operations
Optimize production and refinery yields while streamlining facility inspections

POWER

Generation
Operations and maintenance of large-scale power generation sources, including gas-fired and nuclear plants

Transmission
Operations, monitoring, and maintenance of the grid, including upgrades toward zero-carbon grid

Solar
Optimize and maintain solar assets, including grid integration

Wind
Provide visibility and analysis of energy data and remote inspections of offshore wind infrastructure

Microgrids
Gain visibility across your microgrid generation and load resources

---
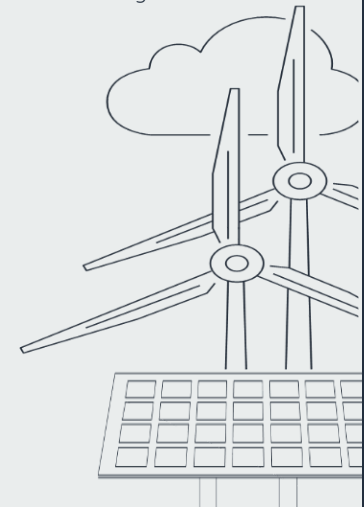
Sustainability
Achieving sustainability goals – emissions monitoring, reporting, and reduction in carbon intensity

Carbon trading
Hosted trading solution for products and carbon credits

Supply chain operations
Well operations to product logistics to enterprise SC

Back office operations
Data-heavy workloads, such as accounting, work order management, invoicing & payments, regulatory

Why is this Difficult?

One Way vs. Two Way Doors

Two-way doors (type 2):
Decisions that are changeable and reversible; should be made quickly by high judgement individuals or small groups. If you've made a suboptimal decision, you can reopen the door and go back through.

Why is this Difficult?

TWO-WAY DOORS

- Our industry is filled with One-Way Doors.

- Two-way doors are levers or degrees of freedom that you did not have before. It is incumbent on the industry to create and exploit them.

- Leadership from the top is required; free teams to experiment when they have a two-way door opportunity.
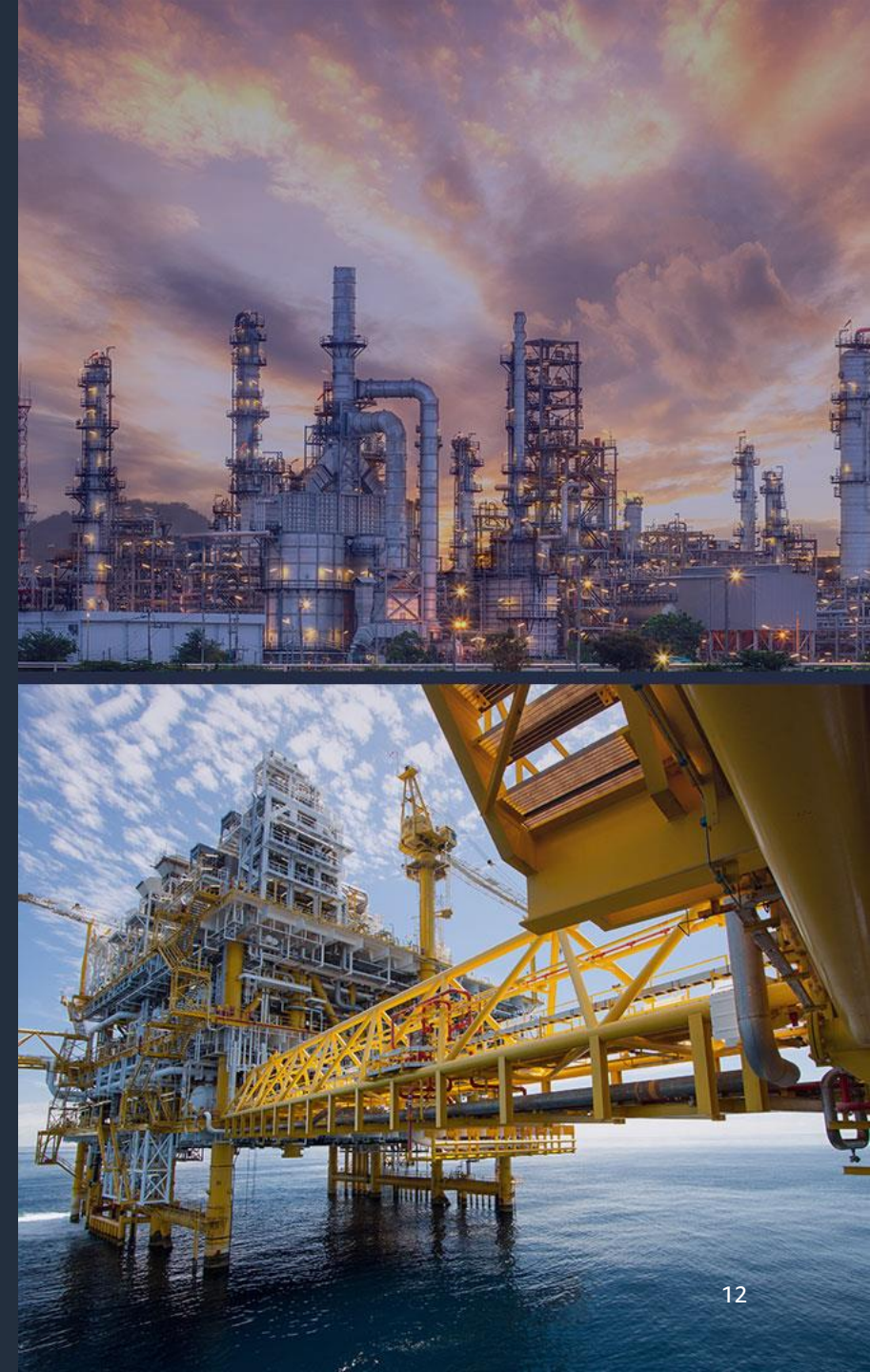
Important Steps

Demand More – Especially from your technology partners and consultants

Build Muscle – Experimentation will yield capabilities and culture

Create a Two-Way Door culture for those decisions that are reversible

Attach business outcomes to digital projects
- More Production
- Less Dollars
- Faster
- Less Risk
- Lower Carbon

Just Do it!

Think Big

Start Small

Build to Scale

Energy Upstream Innovation bpx on AWS

Mu Li – Principal Solutions Architect - AWS Energy
Mike Brogan – Enterprise Architect
David DeLorge – Lead Cloud Architect
Ustat Singh – Sr Cloud Platform Owner
Zach Wilcock – Operations Lead
Ian Gallagher – Solutions Architect
Cameron Rake – Networking Architect
Matthew McElhaney – Head of Data Science
Ayush Rastogi – Data Scientist
Thatcher Thornberry – ML Engineer

Jordie Harrell

Chief Technology Officer
bpx Energy

Reimagining energy for people and our planet

bpx energy

bp

Strategic activities

Low carbon electricity & energy

Convenience & mobility

Resilient & focused hydrocarbons

Delivering value for our stakeholder & achieving our purpose

Sources of differentiation

Integrating energy systems

Partnering with countries, cities, & industries

Driving digital & innovation

214 TWh
Traded electricity in 2020

10-15
City partners aim by 2030

38
bp ventures and Launchpad businesses in total

Reimagining energy

for people & our planet

- High-quality US onshore position

- Portfolio positioned in the core of the Permian, Eagle Ford and Haynesville shale plays

- Driving operational excellence through our focus on safety and environmental stewardship
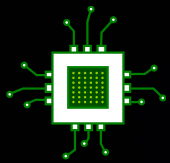

Denver, CO
bpx energy Headquarters

Haynesville
537k net acres[1]

Permian
84k net acres

Houston, TX
bpx energy Office

Eagle Ford
371k net acres

Acreage data as of YE21 [1] Excludes mineral leasehold

bpx Technology: driving x-enterprise innovation

Equip bpx with a best-in-class tech capability that actively partners with the business to enable innovation, achieve strategic objectives, and react to changing conditions

Operations Exploration & Development Safety Environmental & Sustainability

Technology Operations End User Compute Service Management Application Support

Infrastructure Cybersecurity Innovation Network Data Data Science & Reporting

Cloud Enabled / Aligned
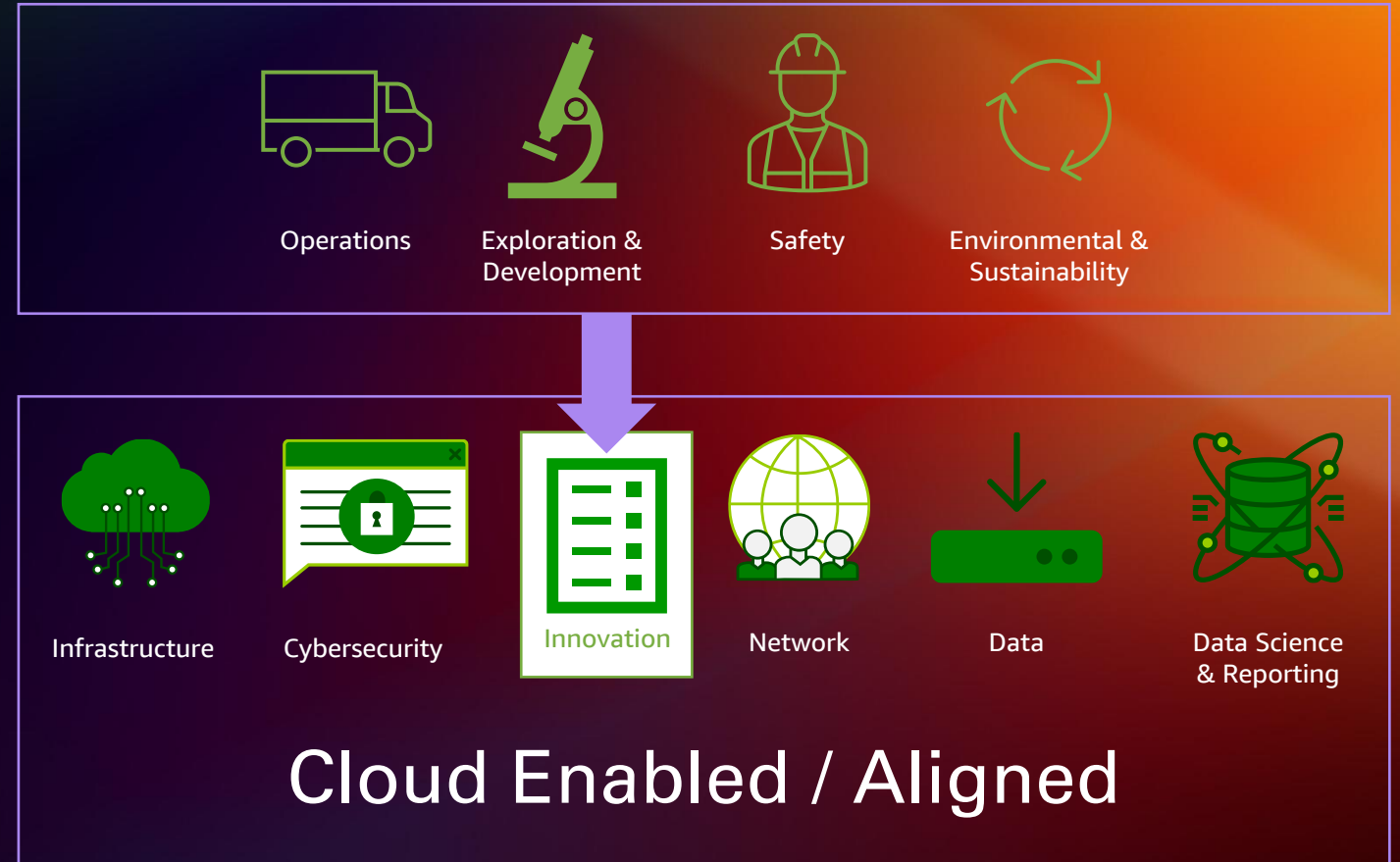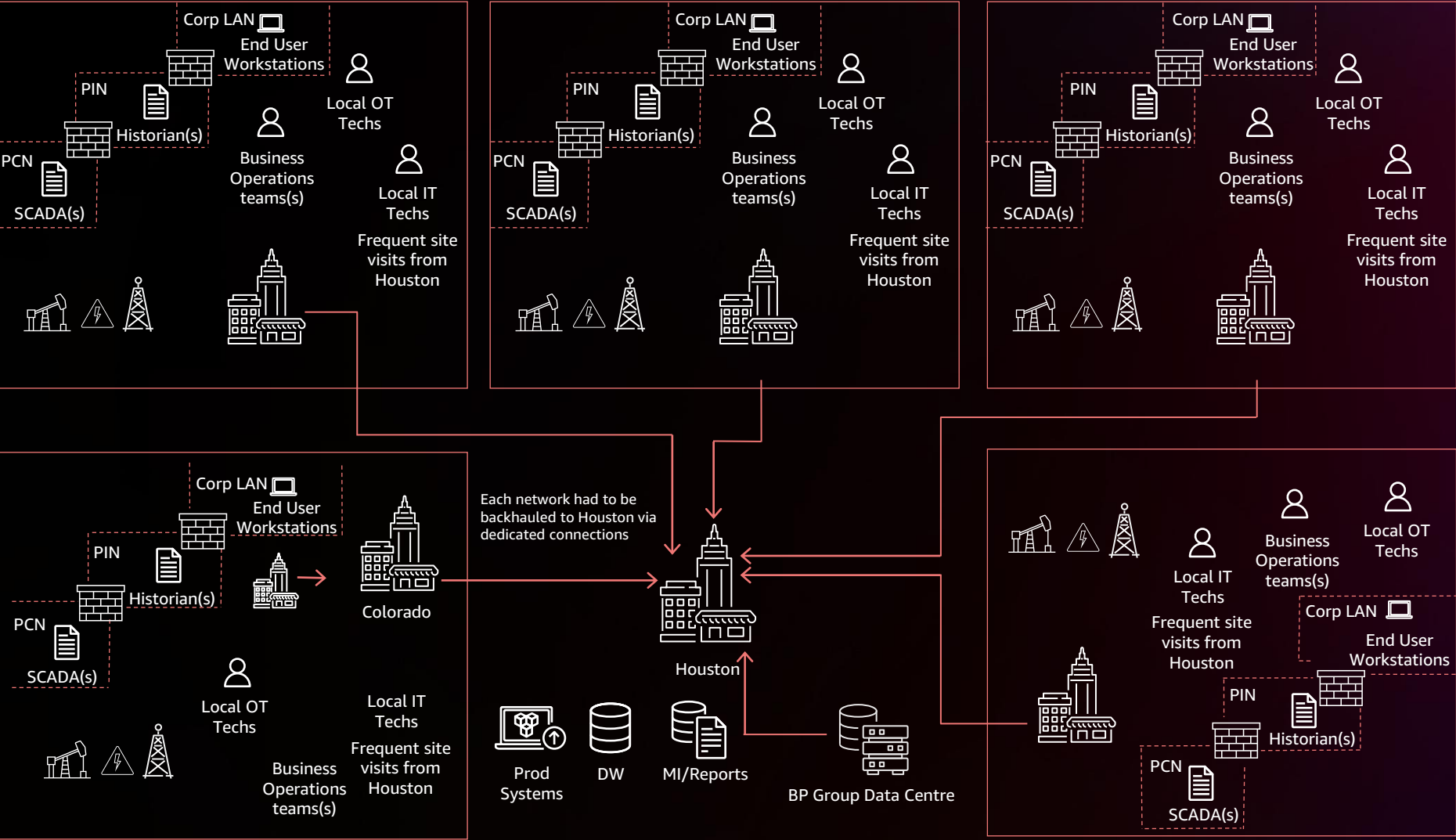
Migration of Operational Technology (OT) to AWS

Challenge: Duplicative infrastructure and applications

Complex and fragmented technology infrastructure

- Multiple States

- Multiple BUs

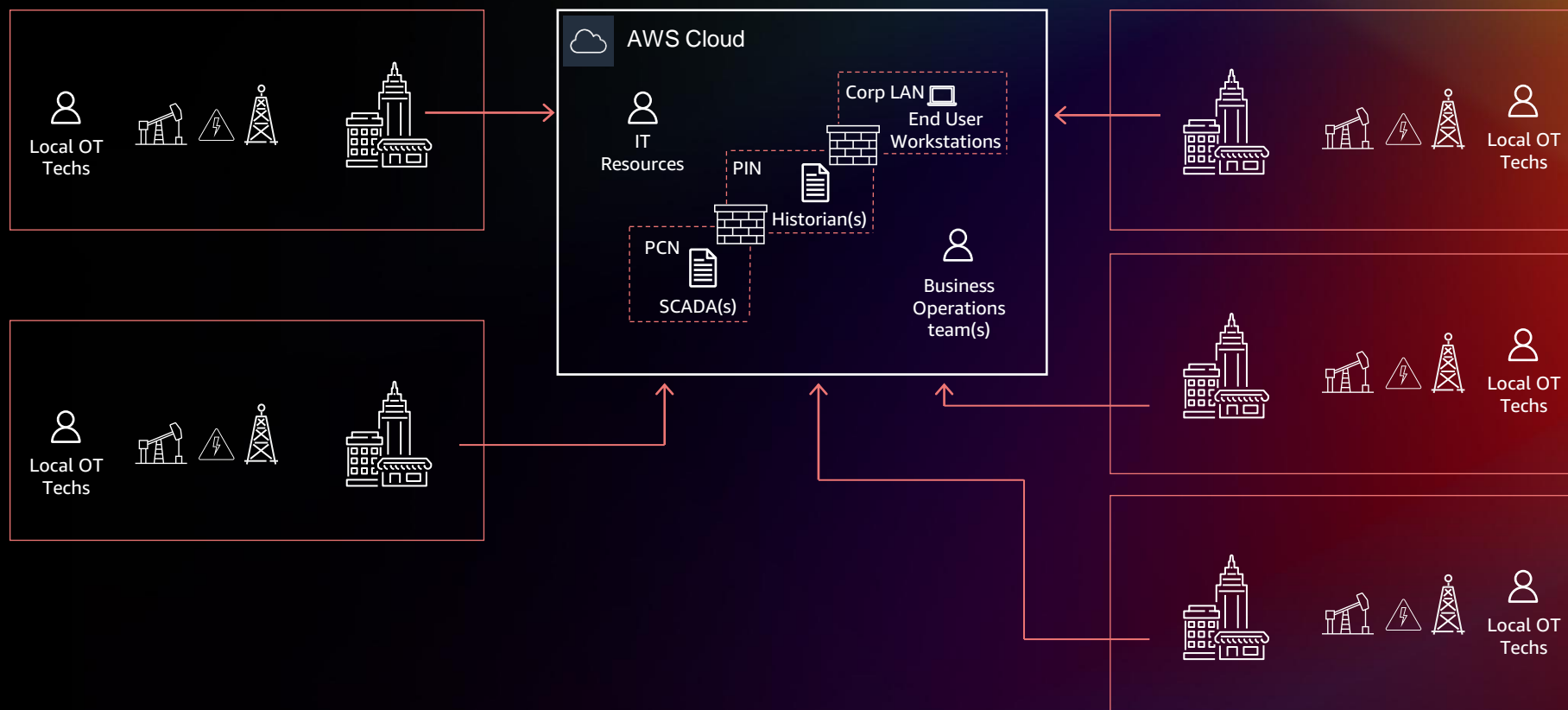- 27 SCADA & RTU Management contracts

High IT/OT TCO

Disparate and localized data sets

No real-time asset visibility across the organization

Solution: Centralized, cloud-hosted OT & IT

bpx energy

bp

AWS Cloud

IT Resources

Corp LAN
End User Workstations

PIN
Historian(s)

PCN
SCADA(s)

Business Operations team(s)

Local OT Techs

Local OT Techs

Local OT Techs

Local OT Techs
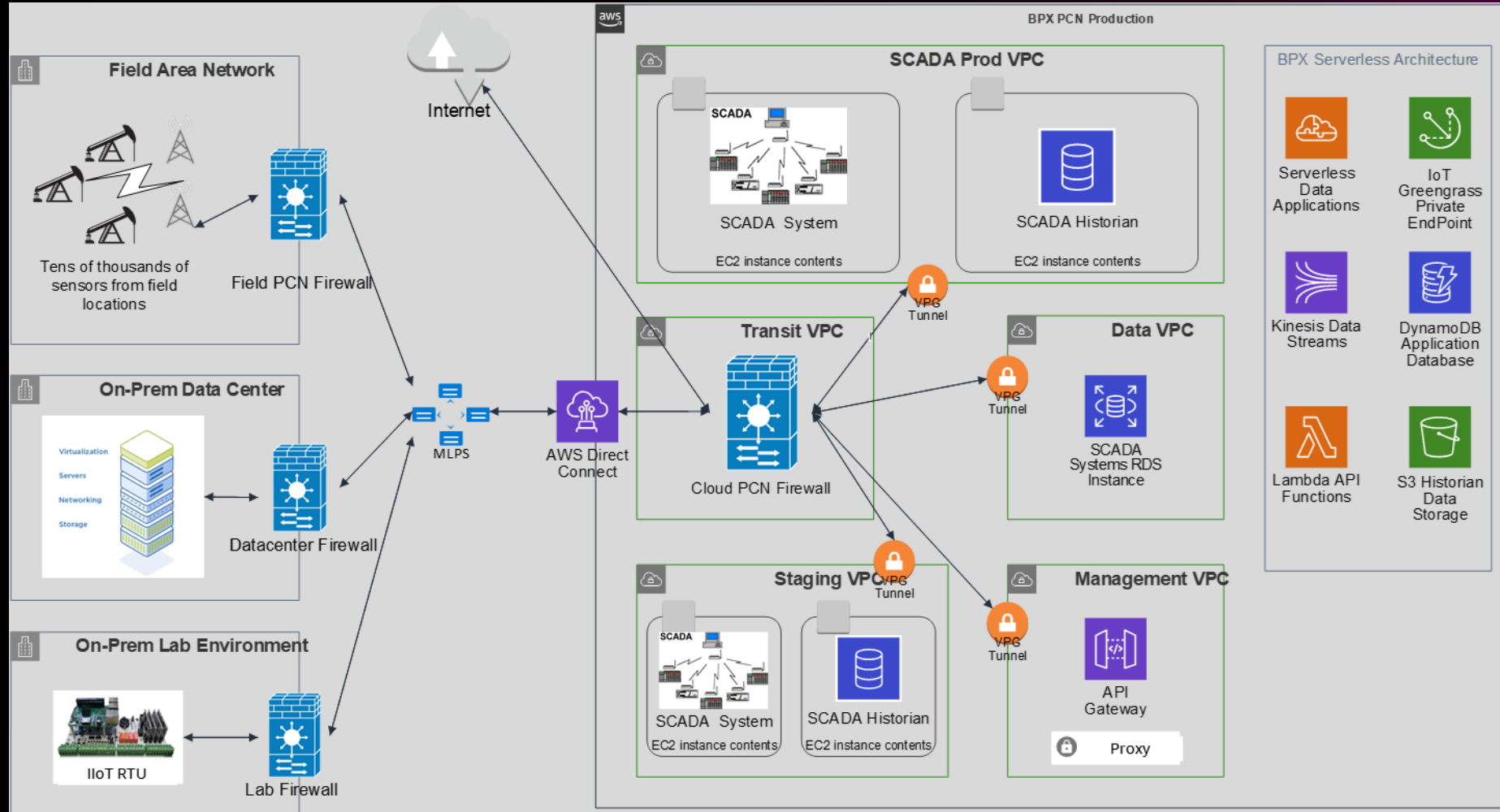
Local OT Techs

Results:

- Single Upstream SCADA
- Single Upstream Historian
- 3 Management Contracts
- On-premises data center nearly eliminated

PCN and PIN on AWS to Segregate Security Enclaves

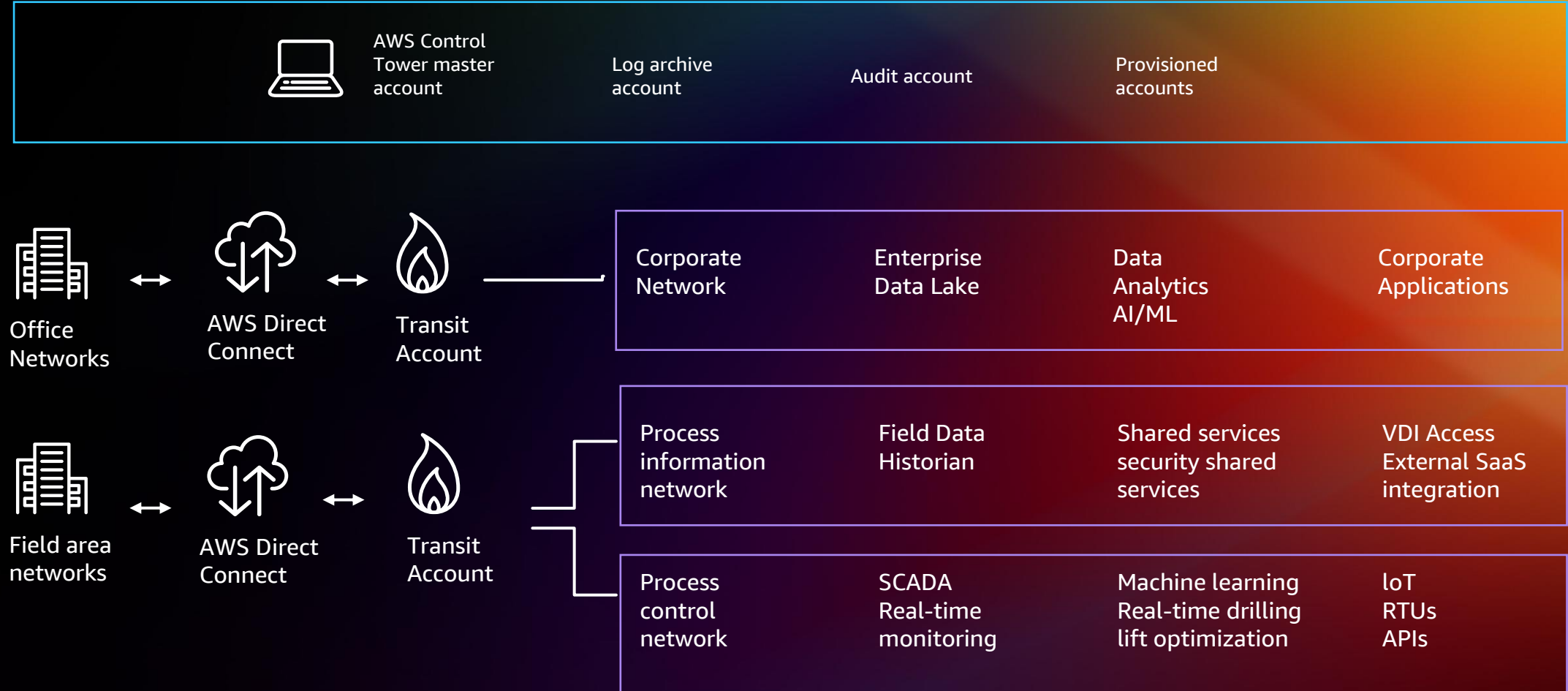Consolidated dataset in historian

Positioned for data analytics and AI/ML

Initial Architecture

Scaled Architecture

bpx energy

bp

| AWS Control Tower master account | Log archive account | Audit account | Provisioned accounts |

Office Networks ↔ **AWS Direct Connect** ↔ **Transit Account**

| Corporate Network | Enterprise Data Lake | Data Analytics AI/ML | Corporate Applications |

Field area networks ↔ **AWS Direct Connect** ↔ **Transit Account**

| Process information network | Field Data Historian | Shared services security shared services | VDI Access External SaaS integration |

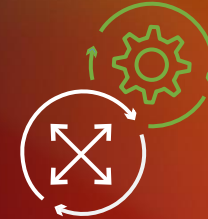| Process control network | SCADA Real-time monitoring | Machine learning Real-time drilling lift optimization | IoT RTUs APIs |

aws

bpx realized benefits utilizing AWS Cloud based OT

Real-time asset visibility across the organization **across** **thousands of wells on a single platform**

Improved capability for **real-time analysis and optimization**

Reduced equipment downtime, better maintenance practices, **reduced opex**

Creating a **unified real-time and historical data repository for standardization, centralization, and simplification**

Capture and transfer of data straight from sensor to cloud, **improved cyber security**

45% reduction in IT/OT TCO

Enabling Edge Automation and Sensing/Control on AWS

With AWS, bpx energy has a more powerful edge strategy

At bpx energy the edge isn't a field office or a factory floor. Our edge is a 4-hour drive from the closest airport, 2-hours from the nearest gas station and 30 minutes from the last set of powerlines

- At bpx, devices are running critical processes on solar power & private networks

- Vendor lock-in is a major issue with both high capital & operational costs

- These vendors have deprioritized innovation in lieu of maintaining the status quo

- High cost & low innovation prevent bpx from adapting to new requirements & opportunities

- With AWS, bpx has been able to use hardware & sensors from outside our industry to meet these new requirements & opportunities at a fraction of the cost

- This has enabled an entire platform of present and future solutions that are more dynamic, secure, extensible and cost-effective
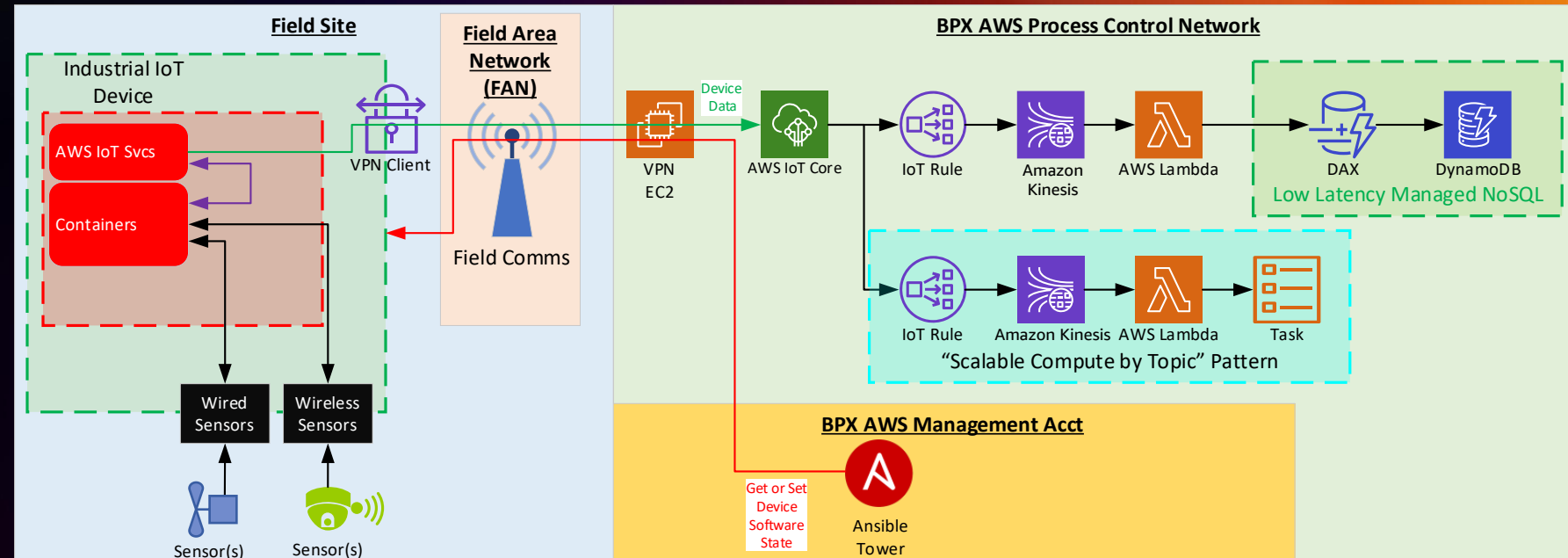
bpx energy bp

aws

Architecture designed for the future

AWS collaboration gives bpx energy the confidence to deploy today knowing that we will be ready to support whatever comes tomorrow

- Our architecture allows us to combine OT & IT in a single environment

- We can use a container strategy over MQTT while historicizing in the cloud and statefully managing our edge hardware

- This type of architecture allows us to deploy low-cost hardware today and still be ready to enable new solutions in the future

Field Site

Industrial IoT Device

AWS IoT Svcs

Containers

VPN Client

Wired Sensors · Wireless Sensors

Sensor(s) · Sensor(s)

Field Area Network (FAN)

Field Comms

VPN EC2

Device Data

AWS IoT Core

BPX AWS Process Control Network

IoT Rule · Amazon Kinesis · AWS Lambda · DAX · DynamoDB
Low Latency Managed NoSQL

IoT Rule · Amazon Kinesis · AWS Lambda · Task
"Scalable Compute by Topic" Pattern

BPX AWS Management Acct

Get or Set Device Software State

Ansible Tower

bpx realized benefits utilizing AWS for Edge Automation

Private end-points for **enhanced security**

Operations Efficiency
through automated
business & OTA updates

Secure Connectivity
through AWS service
AWS IoT Core

MLOps Unlocked by Amazon SageMaker

Forecasting production is important

How many t-shirts will we sell next quarter?

How many hamburgers will we need next week?

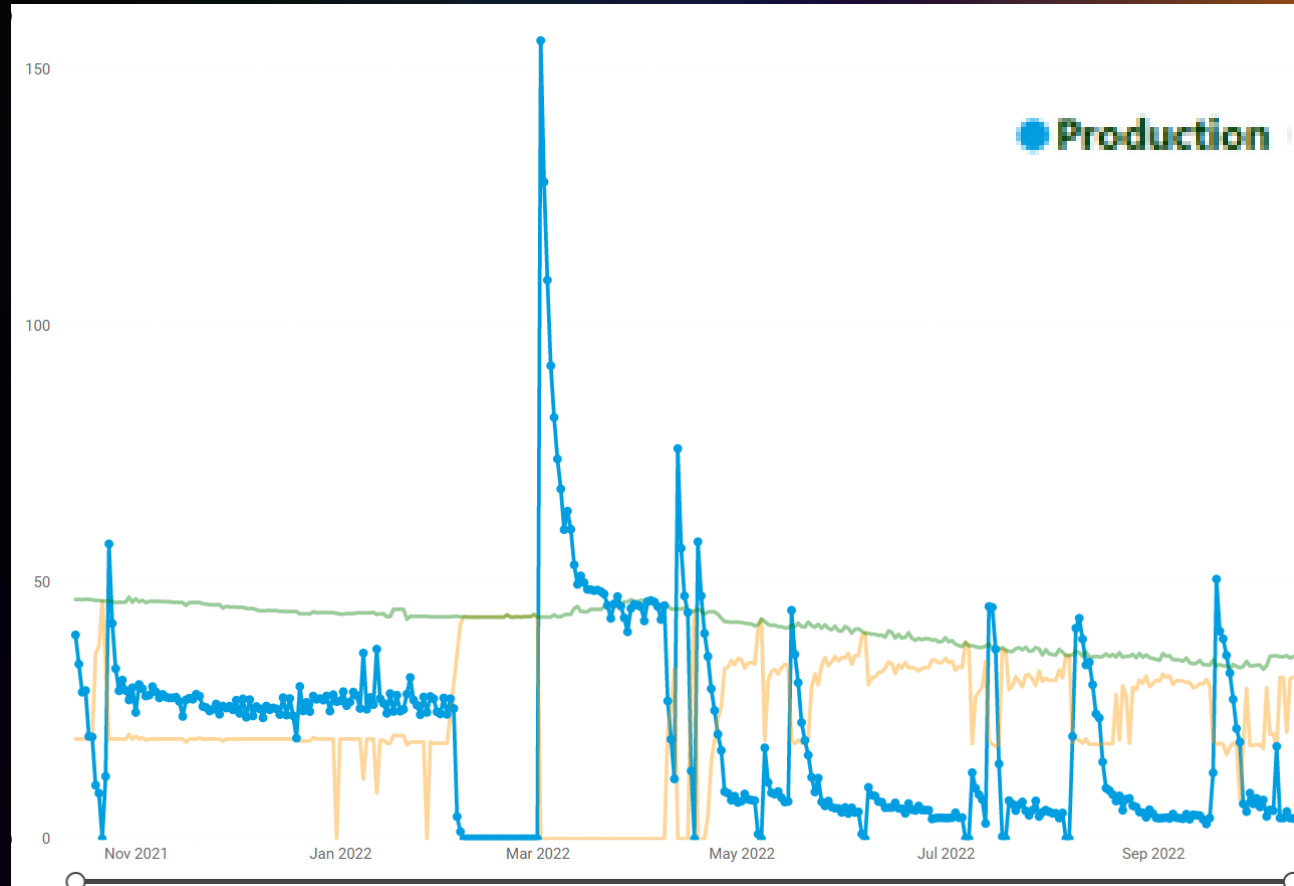How much oil will we produce?
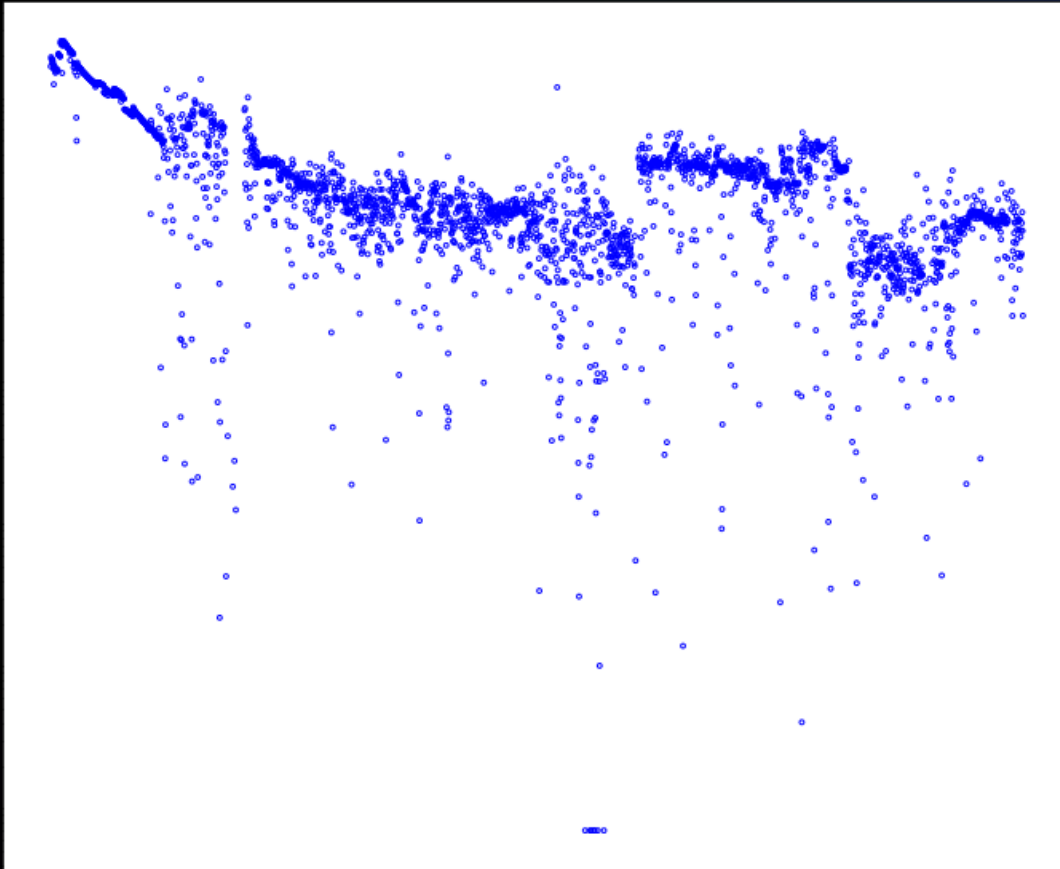
But forecasting in oil and gas is hard...

Neural networks models can address this

Decline Curve Analysis - Gas Well

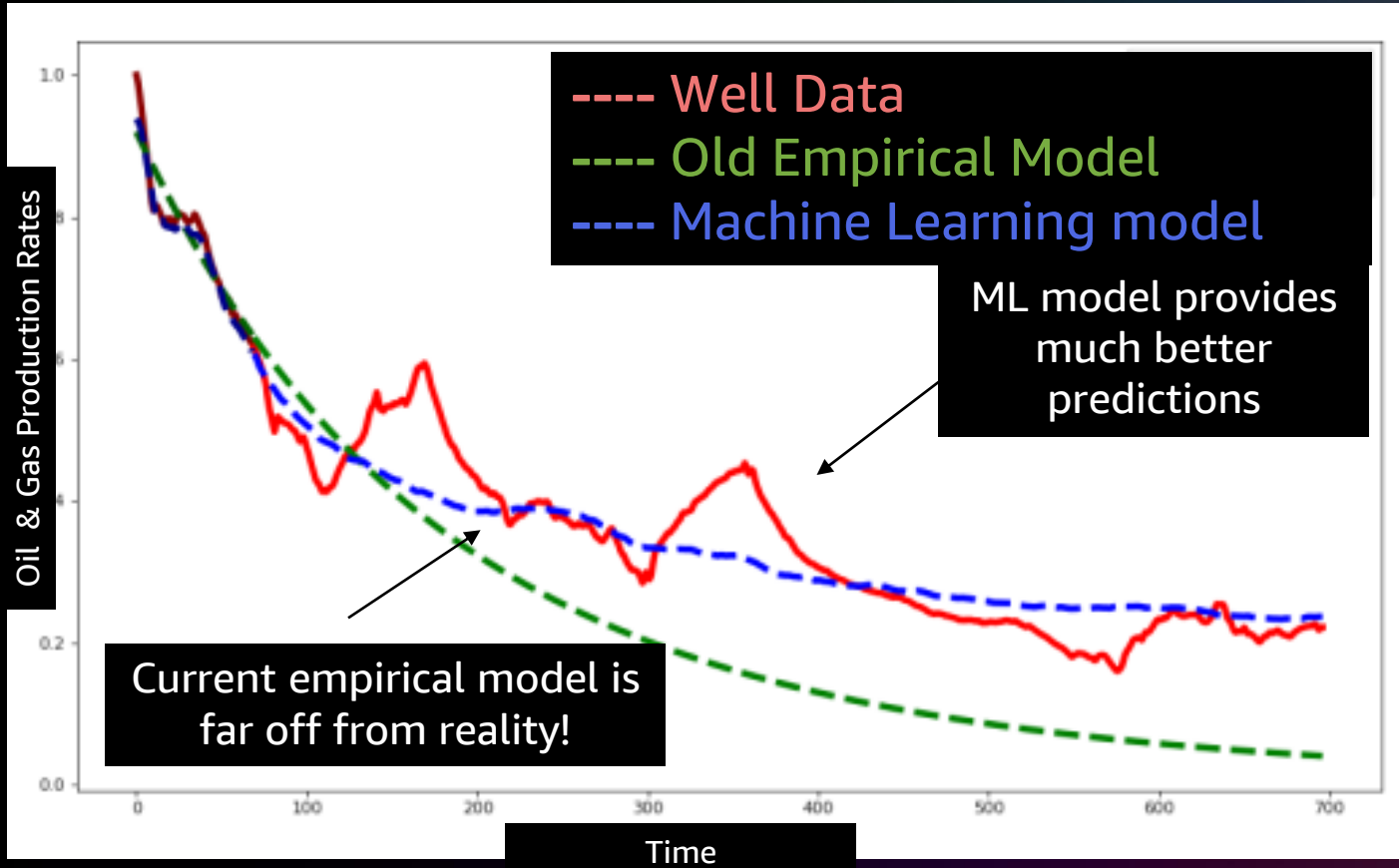Standard Regressions Would Be Thrown Off By This Data Set

For Neural Networks We Would Need

- Access to the newest algorithms, but they're hard to set up and maintain

- GPU hardware, but only for 5 minutes per day

- To distribute embarrassingly parallel tasks – same workflow for 2,000 wells

- Needs to run on demand – but how?

Use case Amazon SageMaker

Legend:
- ---- Well Data
- ---- Old Empirical Model
- ---- Machine Learning model

ML model provides much better predictions

Current empirical model is far off from reality!

Oil & Gas Production Rates

Time

1   Improved Accuracy

2   State of the art algorithms

3   Faster distributed training through GPUs

4   Leverage each well's unique performance with Multi model endpoints

bpx realized benefits of MLOps using Amazon SageMaker

Challenges ➔ Opportunities
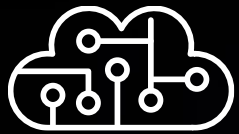
Scalability

Parallel training
with optimal
compute resources

30%

Time reduction
in deployment

Observability

Failure identification
via automated
notifications

60%

Model accuracy
Improvement

CI/CD + CT/CM

Model Monitoring
and re-training for
improved
performance

40%

ROI increase potential

bpx collaboration with AWS has enabled acceleration in the following areas:

OT/SCADA systems

Edge sensing/control with AWS IoT

Data science and artificial intelligence

Thank you!

Jordie Harrell

Chief Technology Officer

bpx energy

Please complete the session
survey in the **mobile app**