

Power Systems



Data Science Experience (DSX)

Predictive Maintenance demo with IoT, Asset Management and AI

IBM Power Systems & IBM Cloud

Benoit MAROLLEAU - Cloud Architect
IBM Client Center Montpellier, France



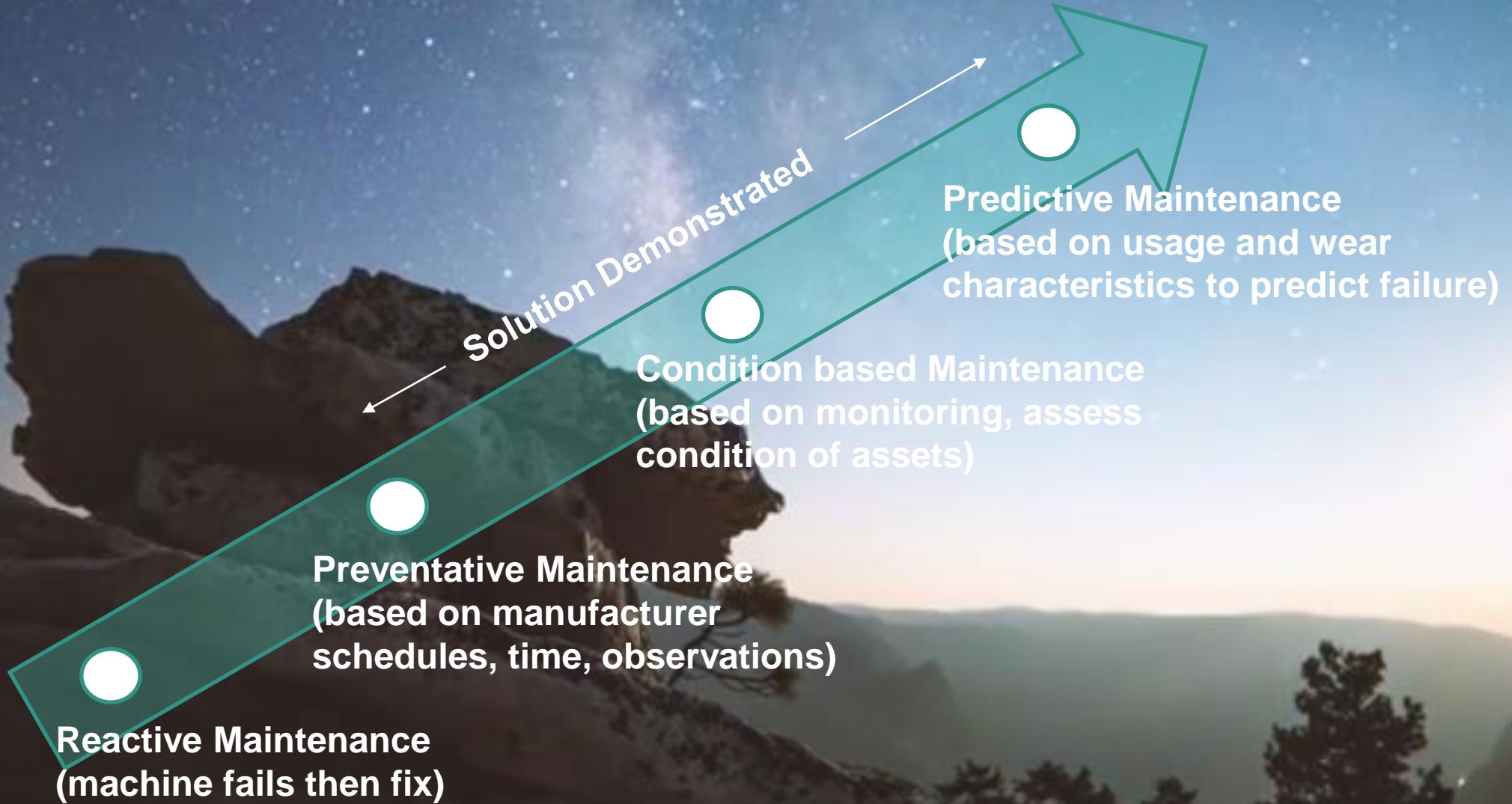
@ : Benoit.marolleau@fr.ibm.com

[linkedin.com/in/benoitmarolleau](https://www.linkedin.com/in/benoitmarolleau)

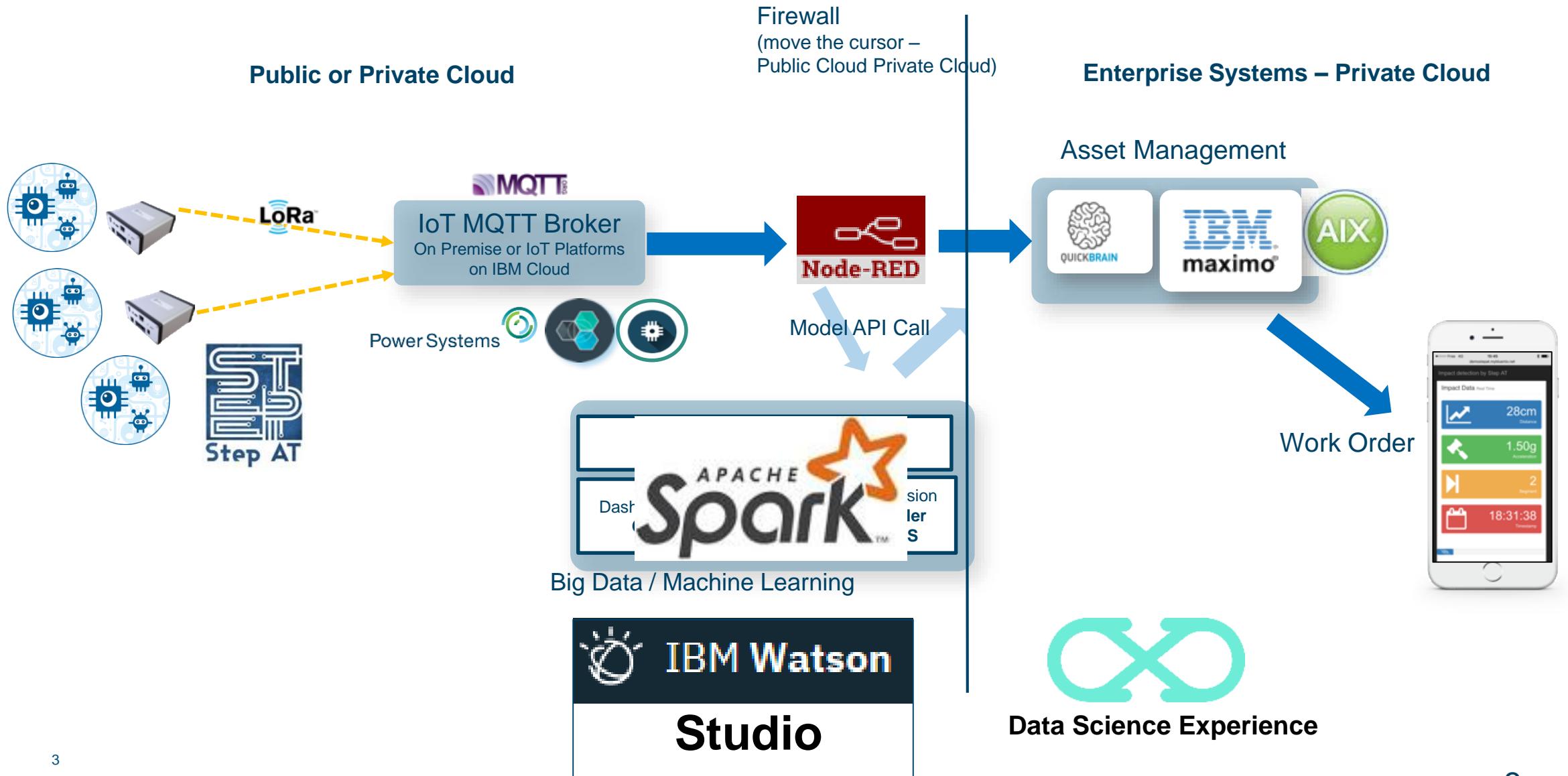
[MarolleauBenoit](https://twitter.com/MarolleauBenoit)



Online version & video : [WW Demo Portal](#)



Predictive Maintenance Demonstration



Predictive Maintenance Demo

Sensor data from 100 engines of the same model

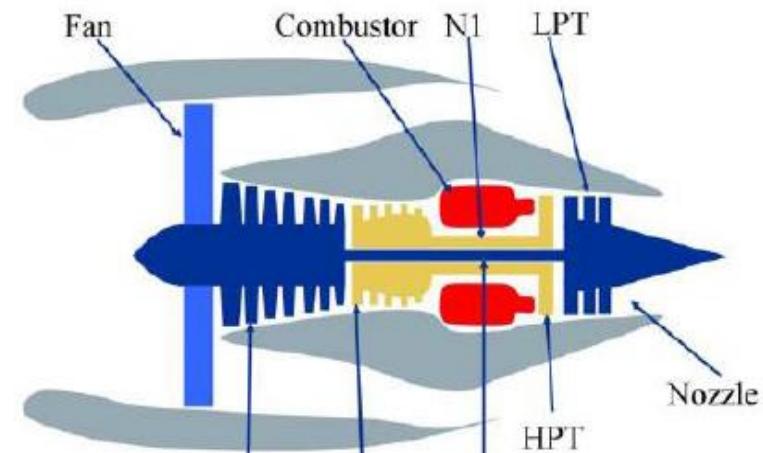
- Maintenance scheduled every 125 cycles
- Only 4 engines needed maintenance after 1st round

Predict and fix failures before they arise

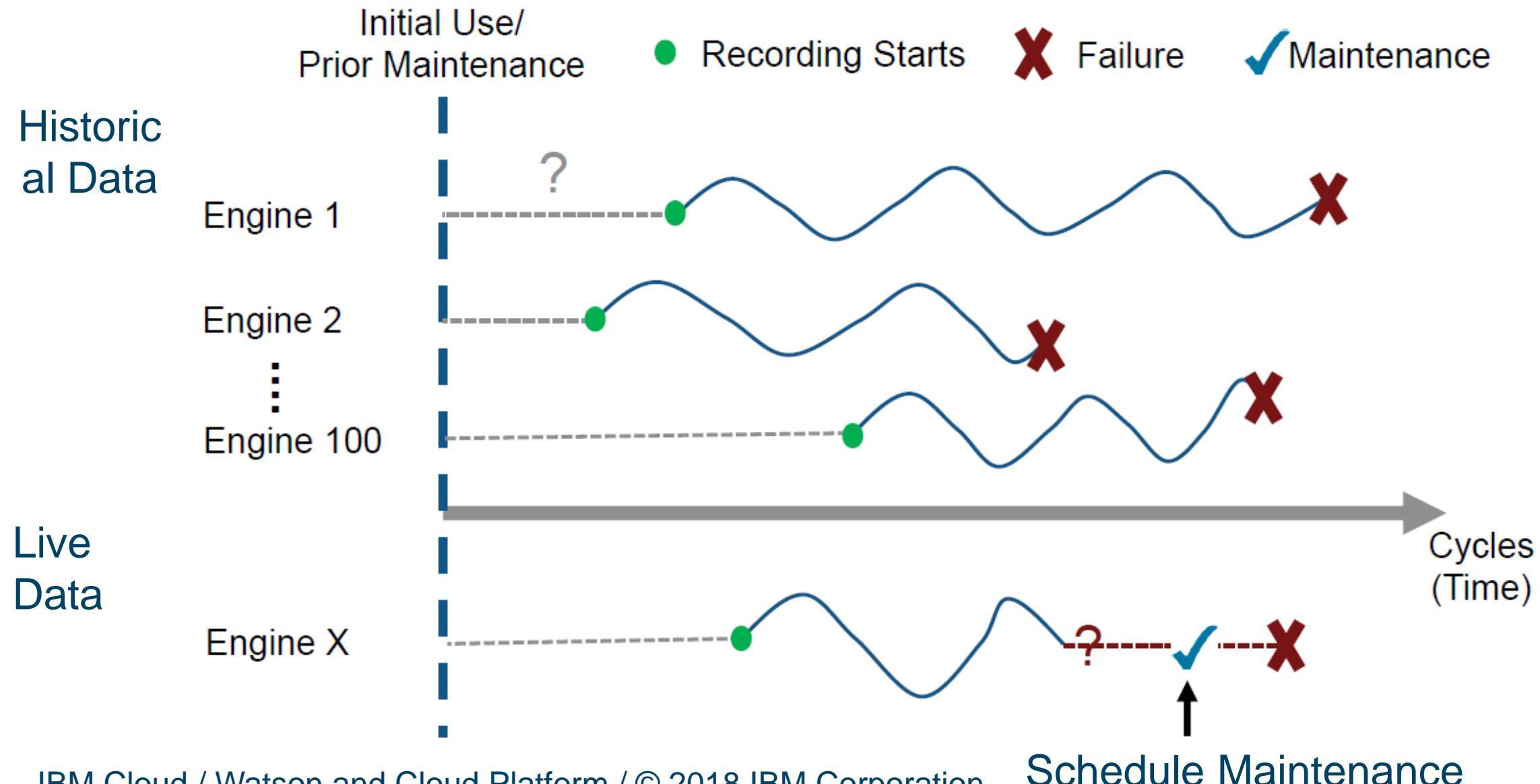
- Import and analyze historical sensor data
- Train model to predict when failures will occur
- Deploy model to run on live sensor data
- Predict failures in real time

Data provided by NASA PCoE

<http://ti.arc.nasa.gov/tech/dash/pcoe/prognostic-data-repository/>



Predictive Maintenance Demo

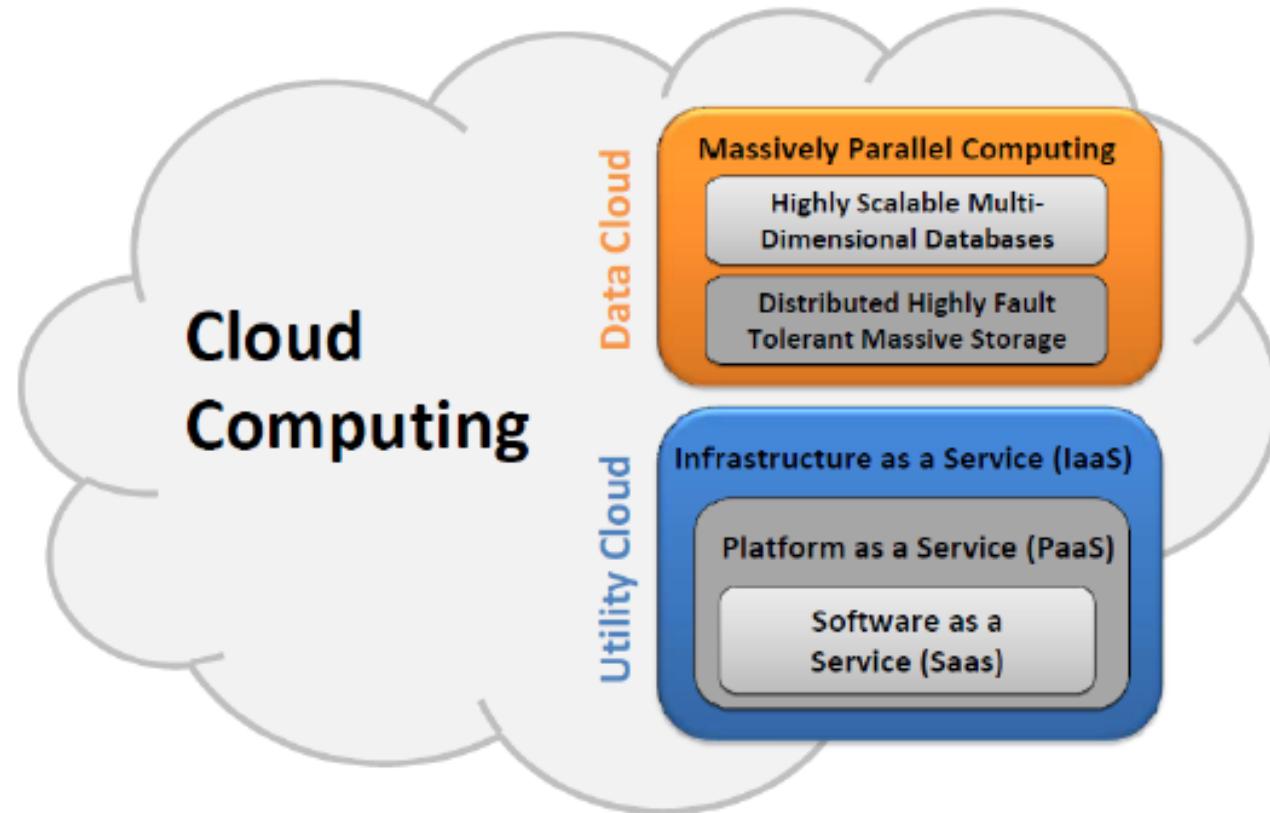


Predictive Maintenance Use case : Steps with DSX / Watson Studio

1. Data collected by NASA – 100 engines / 20 sensors each / hundreds of cycles recorded until failure
<https://ti.arc.nasa.gov/tech/dash/groups/pcoe/prognostic-data-repository/>
 - Damage Propagation [study](#)
2. Data cleaning, normalization, feature engineering (rolling avg , rolling sd) , RUL (Remaining useful life or TTF) with DSX (R , Jupyter Notebooks)
3. **Modeling with DSX**
 - Spark 2.0 via R notebook (Jupyter) & Watson ML
 - Regression models: How many more cycles an in-service engine will last before it fails?
//Random Forrest Regression, Gradient Boosting Tree , etc.
 - Binary classification: Is this engine going to fail within w1 cycles?
 - Multi-class classification: Is this engine going to fail within the window [1, w0] cycles or to fail within the window [w0+1, w1] cycles, or it will not fail within w1 cycles?
4. Training with default hyperparameters – can be tuned
5. Evaluation, **Publish** Model as a Service.
6. Integration to existing IoT Asset Management solution for predicting asset failure

DSX

IBM Cloud Private : the private Data Cloud



Think2018 Announcement: IBM Cloud Private for Data
<https://www.ibm.com/analytics/cloud-private-for-data>



IBM Cloud Floats Power9 'Volta' Servers

March 20, 2018

Posted In: AI, Cloud Computing, IBM Research-Zurich, Systems

IBM Sets Tera-scale Machine Learning Benchmark Record with POWER9 and NVIDIA GPUs; Available Soon in PowerAI

IBM Cloud Private for Data

Make your data ready for AI

Radically simplify data collection, organization and analysis, now. No assembly required

IBM Cloud Private : Content available by Edition – Data Cloud Focus

Discover and Try software available in all editions

Toolchain & Runtimes

- Microclimate Beta
- Microservice Builder
- Jenkins (open source)
- IBM WebSphere Liberty
- Open Liberty (open source)
- IBM SDK for Node.js
- Swift runtime sample (open source)
- Nginx (open source)

Messaging

- MQ Advanced for Developers
- RabbitMQ (open source)

Integration

- IBM Integration Bus for Developers
- IBM DataPower Gateway for Developers

Data Services

- IBM Db2 Dev-C
- IBM Db2 Warehouse Dev-C
- IBM Data Server Manager (for Db2 Dev-C)

- IBM Cloudant Developer Edition
- MongoDB (open source)
- PostgreSQL (open source)
- MariaDB (open source)
- Galera clustering with MariaDB (open source)
- Redis HA Topology (open source)

Data Science

- IBM Data Science Experience Developer Edition

Data Governance and Integration

- IBM InfoSphere Information Server for Evaluation

App Modernization Tooling

- IBM Transformation Advisor

Digital Business Automation

- IBM Operational Decision Manager Developer Edition

Connectivity

- IBM Voice Gateway Developer Trial

Management

- IBM Netcool -integration (Probe for ICP Services -Logging events & Monitoring alerts)

HPC / HPDA

- IBM Spectrum LSF Community Edition
- IBM Spectrum Symphony Community Edition
- IBM Spectrum Conductor Tech Preview

Tooling

- Web Terminal (open source)
- Skydive Network Analyzer (open source)

IBM Cloud Private Cloud Native IBM Cloud Private Enterprise

Catalog of Discover & Try content, plus ...

Toolchain & Runtimes

- Microservice Builder [1]
- IBM WebSphere Liberty [1]
- IBM SDK for Node.js [1]

Multi-Cloud Management

- IBM Cloud Automation Manager [1]

[1] IBM Software bundled with Cloud Native or Enterprise editions is entitled for production use with subscription and support.

Cloud Native content, plus...

Toolchain & Runtimes

- IBM WebSphere Application Server ND [1]
- [2]

Messaging

- IBM MQ Advanced [1]

Integration

- IBM API Connect Professional [1] [2]

[2] Runs on VMs outside of Kubernetes

Optional add-ons to Cloud Native or Enterprise

Data Services

- IBM Db2 Direct Advanced Edition
- IBM Db2 Warehouse Enterprise (in ICP for Data Science PN)

Data Science

- IBM Data Science Experience Local

Messaging

- IBM MQ Advanced

Integration

- IBM Integration Bus
- IBM DataPower Gateway Virtual Ed

Digital Business Automation

- IBM Operational Decision Manager

Toolchain

- IBM UrbanCode Deploy (now on ICP)

Cloud Foundry

- Includes select buildpacks

Data Services

- IBM Db2 Direct Advanced Ed. / AESE with IBM Data Server Manager
- IBM Db2 Warehouse Enterprise

Mobile

- IBM Mobile Foundation

Watson

- IBM Watson Compare & Comply: Element Classification

Available a la carte

Separate purchase or bring your existing license

Catalog content is not distributed with IBM Cloud Private. Content is distributed separately, licensed under separate terms and conditions.

Data Science is a Team Sport

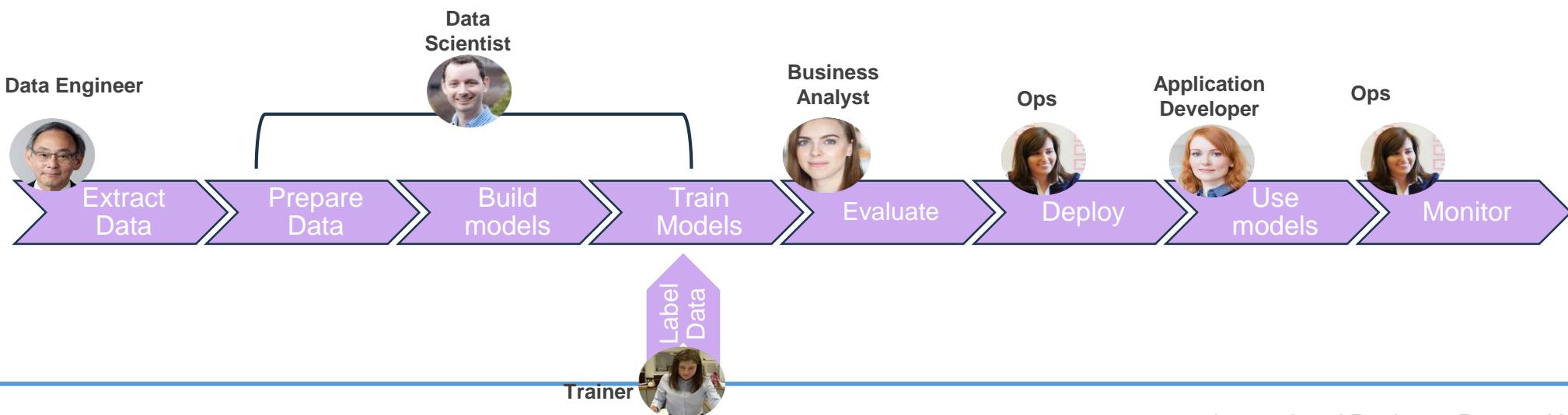
Building ML-infused apps requires multiple skillsets:

Define an ML model

Store, manage, update training data

Manage lifecycle of the trained model

Ability to do inferencing on the trained model(s)



Big Data: Machine Learning techniques

Classification: predict class from observations

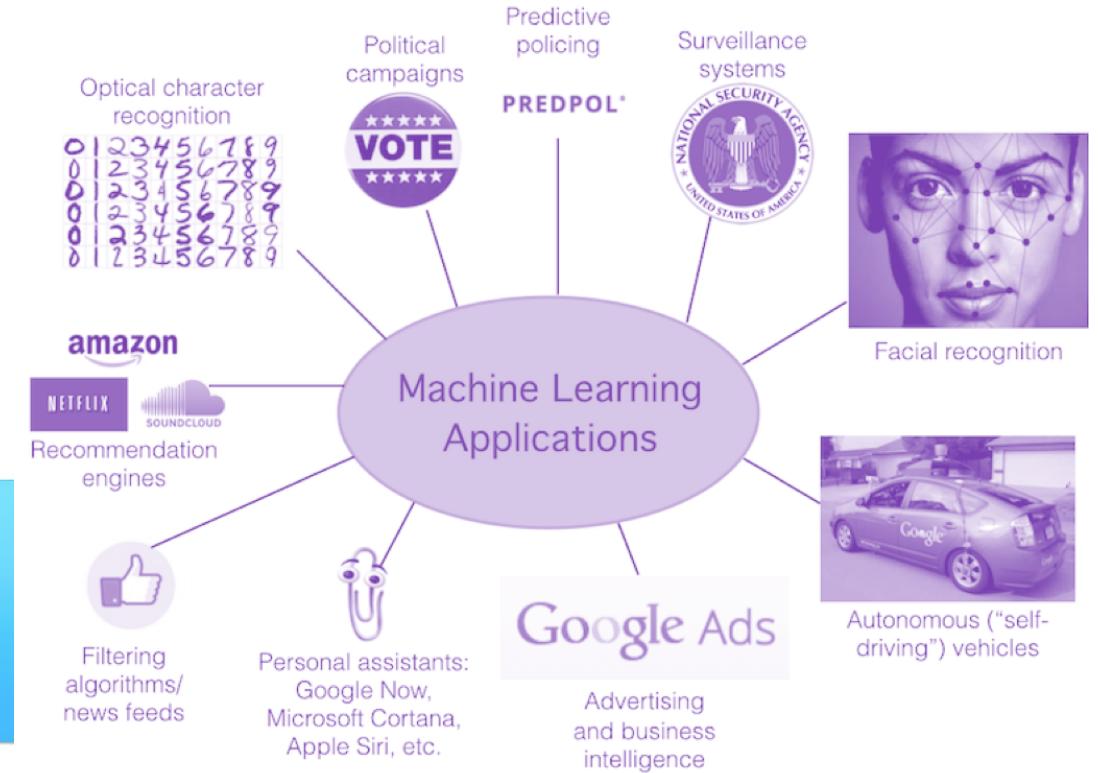
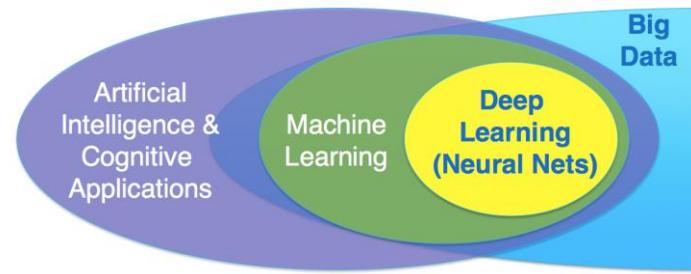
- E.g. Spam Email Detection

Clustering: group observations into “meaningful” groups

- E.g. Amazon Recommendations

Regression (prediction): predict value from observations

- E.g. Energy consumption prediction



and many different technologies and libraries are available:



Data Science Experience

IBM Data Science Experience (DSX) is a **platform** for developing and deploying analytical applications
Supports development, deployment, and model management

DSX is available

- As a cloud offering aka **Watson Studio**
- As an on-premises solution
 - **DSX Local** on x86/Power
 - Power: Scale-out LC Systems with PowerAI + GPU / Nvlink acceleration
- As a desktop application
 - Free, disconnected mode

The screenshot shows the DSX Local interface. At the top, there's a dark header bar with the DSX logo and the text "IBM Data Science Experience Local". Below this is a "Community" section title. Under "Community", there's a "Notebooks" heading followed by a grid of eight notebook cards. Each card has a small thumbnail image at the top, followed by the word "NOTEBOOK", the title, author (IBM), date (Mar 07, 2017 or Mar 07, 2017), topic (Science & Technology, Transportation, Economy & Business, Leisure), and data source (Self-Contained, External, Self-Contained, Self-Contained). A "View All >" link is located in the top right corner of the notebook grid.



Data Science Experience

- **Data Science as a Team Sport**

Lets *data scientists/engineers, analysts, stakeholders* collaborate to collect, share, explore, *analyze data* in order to *derive insights and train models, and share or deploy resulting assets*

- **Projects** - collaborate as team or work individually

- **Jupyter Notebooks + IBM value add**

- Integrated in Projects with access control
- *Spark integration with R/Python/Scala kernels*
- *Versions, comments, share link, publish to GitHub*
- *PixieDust, Brunel, ...*

- **Machine Learning integrated in Projects:**

Use ML Wizard and Flows to train Models

- **RStudio integrated with Spark**

- **DSX Integrates with Data in many places**

- Object Storage (SWIFT now, new Cloud Object Storage soon)
- Watson Data Platform Services and WDP Catalog
- Message Hub and IBM Streaming Analytics
- Can call any IBM service, e.g. Watson, Quantum, etc
- Third party data services on premise or on other clouds

- **Built on the IBM Cloud platform**

Master the art of data science

Solve your toughest data challenges with the best tools and the latest expertise in a social environment built by data scientists.

Watch Now (2:31)

Sign Up For a Free Trial

Coming Soon! Watson Machine Learning

Machine Learning lets you create and train predictive analytics models. [Learn More](#)



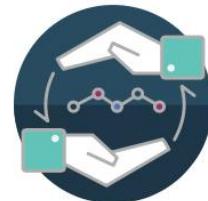
Learn

Get started or get better with built-in learning.



Create

Use the best of open source tooling with IBM innovation.

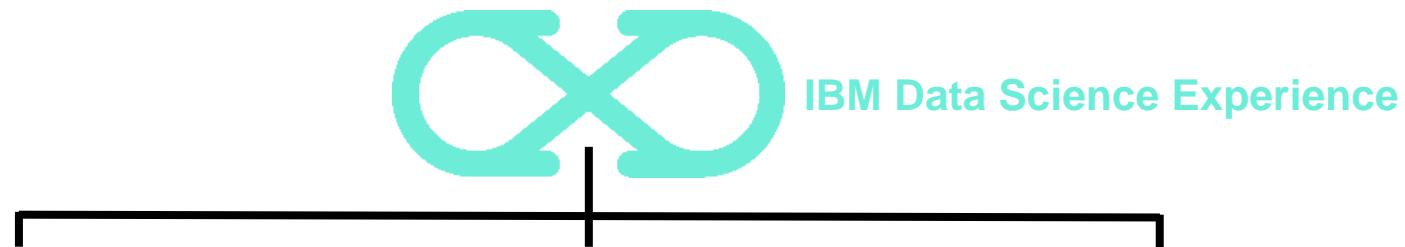


Collaborate

Work smarter using community, work faster with your team.

Try it yourself at <https://datascience.ibm.com>

Core Attributes of the Data Science Experience



Community

- Find tutorials and datasets
- Connect with Data Scientists
- Ask questions
- Read articles and papers
- Fork and share projects

Open Source

- Code in Scala/Python/R/SQL
- Jupyter Notebooks
- RStudio IDE and Shiny
- Apache Spark
- Your favorite libraries

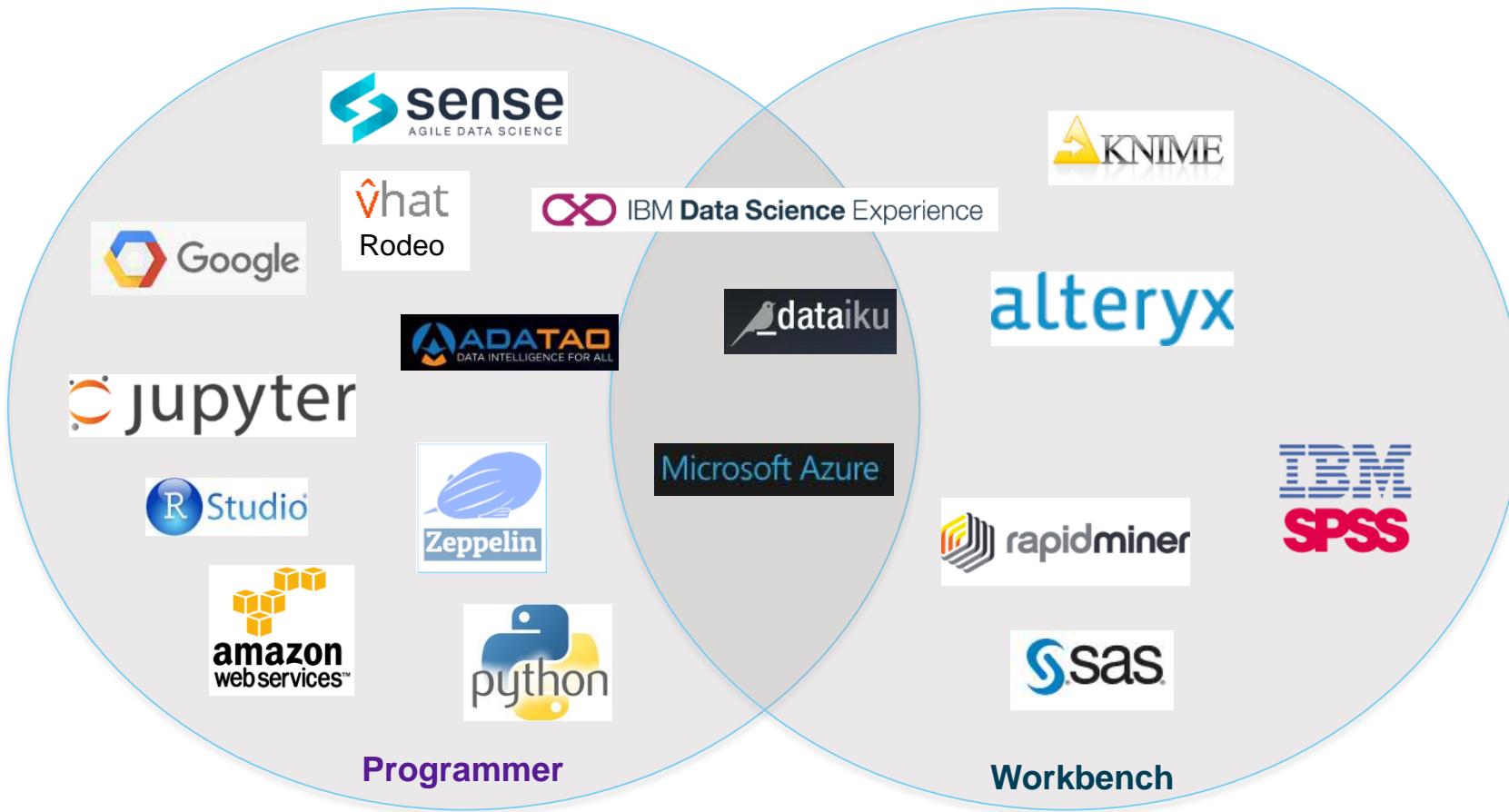
IBM Added Value

- IBM Machine Learning*
- SPSS Modeler Canvas*
- Prescriptive Analytics - DOcplexcloud
- Projects and Version Control
- Managed Spark Service

Powered by IBM **IBM Power**

* beta

Ecosystem



We've been recognized for our vision

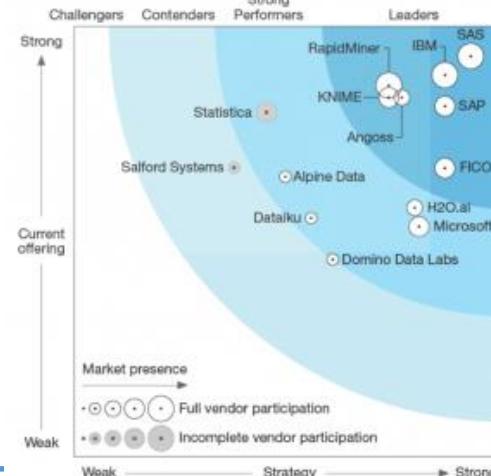
Gartner Magic Quadrant 2017 Data Science Platforms



DeveloperWeek 2017 Devie



Forrester Wave 2017 Predictive Analytics & Machine Learning



Source: <https://www.gartner.com/doc/reprints?id=1-3TKD8OH&ct=170215&st=sb>
<http://www.developerweek.com/awards/2017-devies-award-winners/>

Internal and Business Partner Use Only



IBM® Data Science Experience Collaboration



Screenshot of the IBM Data Science Experience Collaboration interface.

The top navigation bar includes: Data Science Experience, Projects (selected), Tools, Data Services, Community, and US South.

The main area shows "My Projects" with a search bar and a dropdown menu set to "All Projects".

A table lists five projects:

NAME	ROLE	COLLABORATORS	CREATOR	LAST MODIFIED
Projet Watson Analytics	Admin		Serge Retkowsky	9 May 2017
IncidentsPaiements	Admin		Serge Retkowsky	9 May 2017
IBM Streams	Admin	BC ZA +2	Serge Retkowsky	9 May 2017
Formation DSX	Admin	ZA BC +3	Serge Retkowsky	9 May 2017

A modal window titled "Collaborators" is displayed, showing a list of users and their roles:

NAME	EMAIL	PERMISSION	ACTIONS
BC Béatrice Cochard	beatrice.cochard@fr.ibm.com	Admin	...
CB Christophe Burgaud	christophe.burgaud@fr.ibm.com	Editor	...
JP Johan Picard	johan.picard@fr.ibm.com	Editor	...
SR Serge Retkowsky	serge.retkowsky@fr.ibm.com	Admin	...
ZA Zied Abidi	zied.abidi@fr.ibm.com	Editor	...

Buttons for "Add collaborators" and "Edit" are visible at the bottom of the modal.

DSX has RStudio built into the experience thanks to our strategic partnership

The screenshot displays the RStudio interface integrated into the IBM Data Science Experience (DSX) platform. The top navigation bar includes File, Edit, View, Workspace, Plots, Help, and a Source on Save button. The left pane shows a code editor with R script content:

```
library(openair)
## import some example data
bloomsbury <- importKCL(site = "blo10", year = 2005:2010, met = TRUE)
## have a look at the data
summaryPlot(bloomsbury)
## trend in o3 by wd
smoothTrend(bloomsbury, pollutant = "o3", deseason = TRUE, type = "wd")
## polarPlot of nox
polarPlot(bloomsbury, pollutant = "o3", type = "daylight")
## calendar plot
calendarPlot(bloomsbury, pollutant = "o3", ...)
```

A tooltip for the `annotate` argument in the `calendarPlot` function is displayed, explaining its purpose: "This option controls what appears on each day of the calendar. Can be: "date" - shows day of the month; "wd" - shows vector-averaged wind direction, or "ws" - shows vector-averaged wind direction scaled by wind speed." The bottom of the code editor shows the console output:

```
>
>
>
>
> library(openair)
## import some example data
bloomsbury <- importKCL(site = "blo10", year = 2005:2010, met = TRUE)
## have a look at the data
summaryPlot(bloomsbury)
## trend in o3 by wd
smoothTrend(bloomsbury, pollutant = "o3", deseason = TRUE, type = "wd")
## polarPlot of nox
polarPlot(bloomsbury, pollutant = "o3", type = "daylight")
```

The workspace panel shows the `bloomsbury` dataset with 50804 observations and 18 variables. The bottom right panel displays a heatmap titled "O₃ in 2006" showing ozone levels across months and days of the year 2006, with a color scale from 20 to 100.

IBM® Data Science Experience

Integration with services Watson (NLP/Deep Learning, ...)



My Projects > DSX Features > Watson API Alchemy Language

```
In [35]: print(json.dumps(alchemy_language.targeted_emotion(text='I love apples. I hate bananas', target_s=['apples','bananas'], language='english'), indent=2))
```

```
{  
    "status": "OK",  
    "usage": "By accessing AlchemyAPI or using information generated by AlchemyAPI, you are agreeing to be bound by the AlchemyAPI Terms of Use: http://www.alchemyapi.com/company/terms.html",  
    "totalTransactions": "1",  
    "results": [  
        {  
            "text": "apples",  
            "emotions": {  
                "anger": "0.01915",  
                "joy": "0.759622",  
                "fear": "0.022622",  
                "sadness": "0.07209",  
                "disgust": "0.017391"  
            }  
        },  
        {  
            "text": "bananas",  
            "emotions": {  
                "anger": "0.797749",  
                "joy": "0.000599",  
                "fear": "0.061471",  
                "sadness": "0.120308",  
                "disgust": "0.091096"  
            }  
        }  
    ]  
}
```

IBM® Watson Machine Learning

Automatic Machine Learning & Deployment API



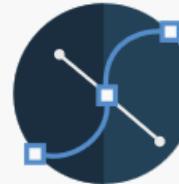
SIMPLE

IBM Watson Machine Learning guides you through the steps to create, train, evaluate, and deploy based on your desired outcome.



POWERFUL

Select the algorithms best suited for your needs, or get help selecting the ones that would work best for your data.



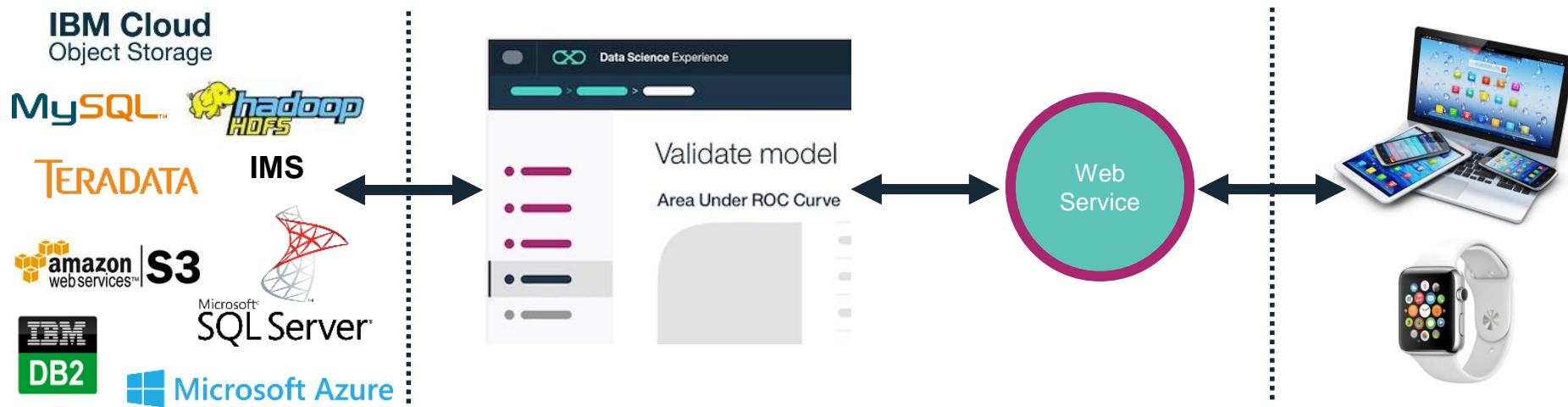
FLEXIBLE

Test and deploy your models as APIs for application development, share with colleagues, and retrain as needed.

Build Predictive models with DSX

DSX Local with IBM Machine Learning

IBM Machine Learning



Data Access:

- Easily connect to Behind-the-Firewall and Public Cloud Data
- Catalogued and Governed Controls through Watson Data Platform

Creating Models:

- Single UI and API for creating ML Models on various Runtimes
- Auto-Modelling and Hyperparameter Optimization

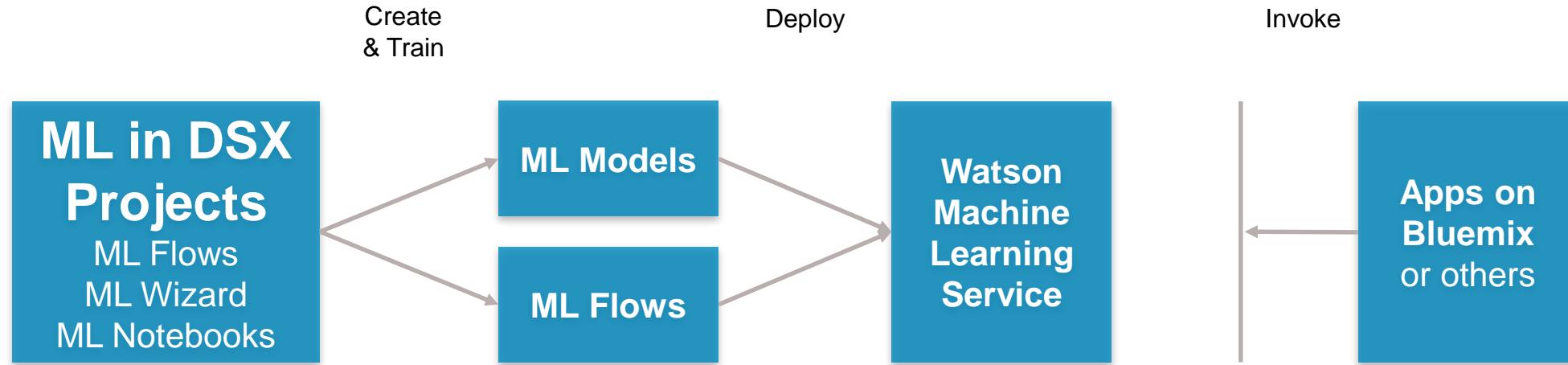
Web Service:

- Real-time, Streaming, and Batch Deployment
- Continuous Monitoring and Feedback Loop

Intelligent Apps:

- Integrate ML models with apps, websites, etc.
- Continuously Improve and Adapt with Self-Learning

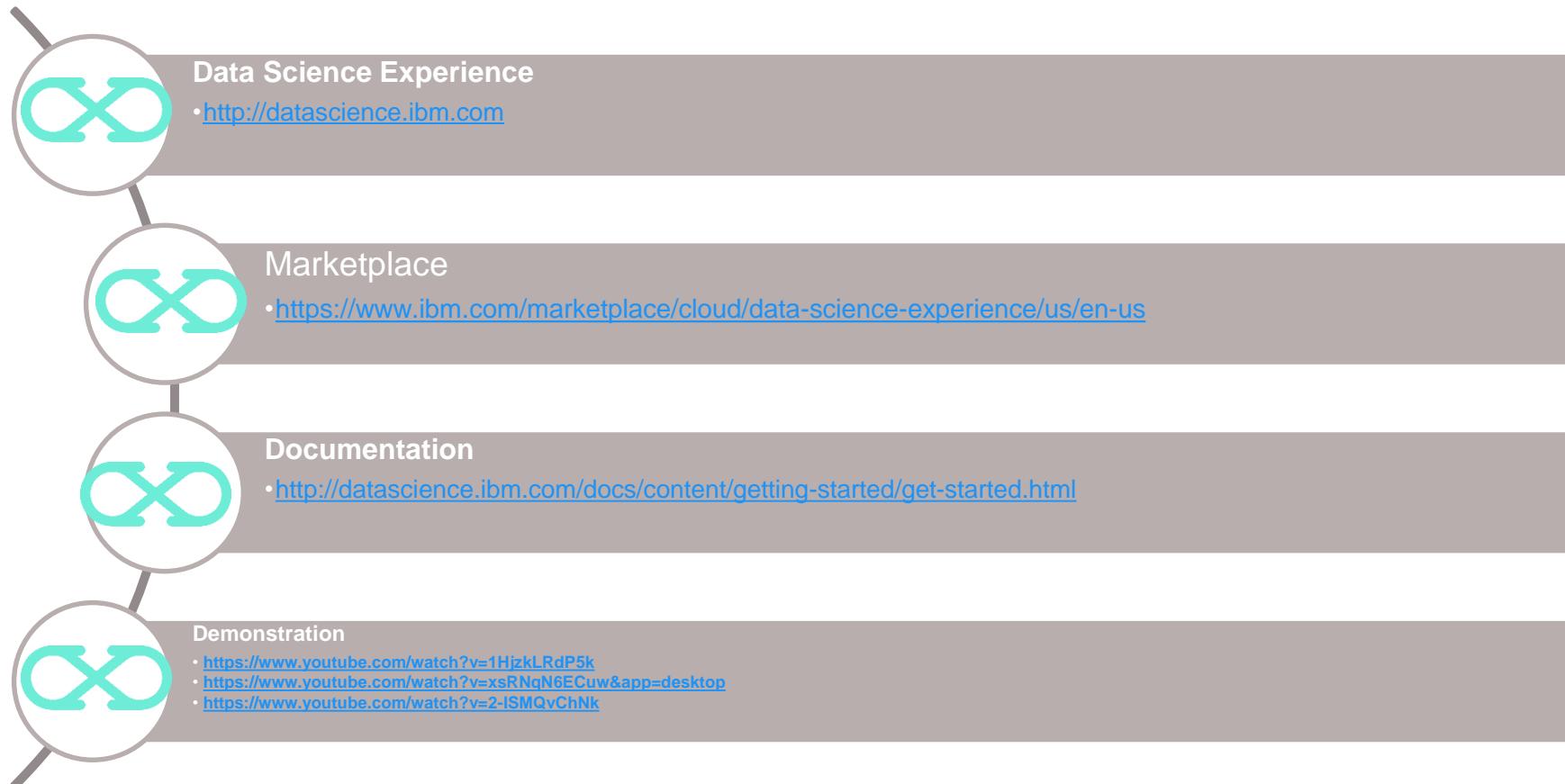
DSX - Machine Learning in Projects, deploying to WML



- Data Scientists can train ML models in DSX using data in Projects to create and train models
- Use ML Wizard for assisted creation and training of models using common patterns and algorithms
- Use Notebooks or Flows to train models for more advanced use cases and more flexibility
- Deploy models to Watson Machine Learning (WML) service in Bluemix to run them in production
- Use WML REST API to invoke your models for online scoring / predictions

IBM® Data Science Experience

Useful Links



DSX Local on Power Hardware

- **Available today.**
- **Data Science Experience is one product, with multiple distribution methods**

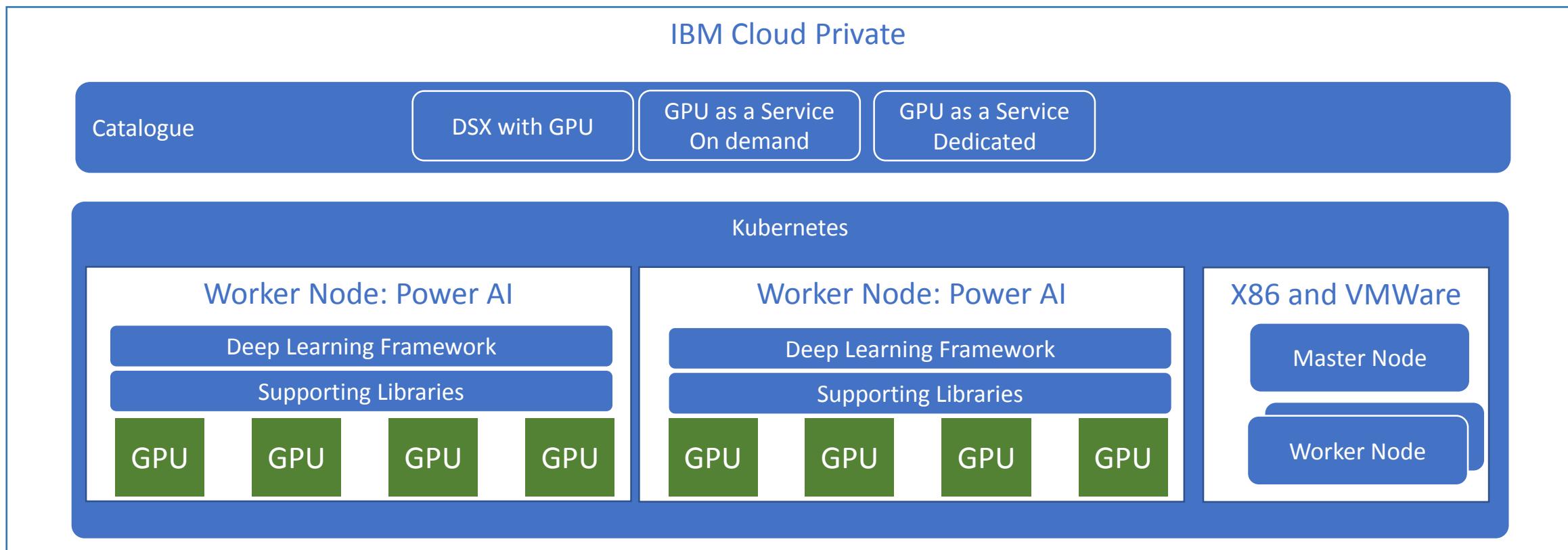
Similar functionality and user experience between DSX in Public cloud and on DSX local platforms including DSX on Power Linux
- **DSX local leverages the additional capabilities available through Power hardware**

Uses PowerAI Deep Learning libraries and frameworks optimized for Power HW
Transparently supports GPUs when available on S822 LC HPC hardware
Drives performance for deep learning Workloads

Drivers for an On Premises Offering

- While organizations are increasingly embracing the public cloud, many require analytics operating locally within their firewall.
- There are a number of reasons customers require this:
 - Sensitivity of corporate data
 - Gravity of enterprise data sources
 - Performance from low latency, local data access
 - Industry specific security requirements
 - Conservatism
 - Etc.
- DSX Local leverages IBM's competitive differentiator of deep domain expertise within verticals and our proprietary data.
- DSX Local brings the power and flexibility of DSX to the customer premises.

Architecture



DSX Dev & Local in ICP

- ❑ DSX Dev (desktop like version) is available out of the box in the ICP Catalog (x86 only). Equivalent to the DSX Desktop offering.
- ❑ DSX Local is the end to end collaborative & complete DSX Solution on premises.
It can be deployed standalone or using ICP (Helm Chart).

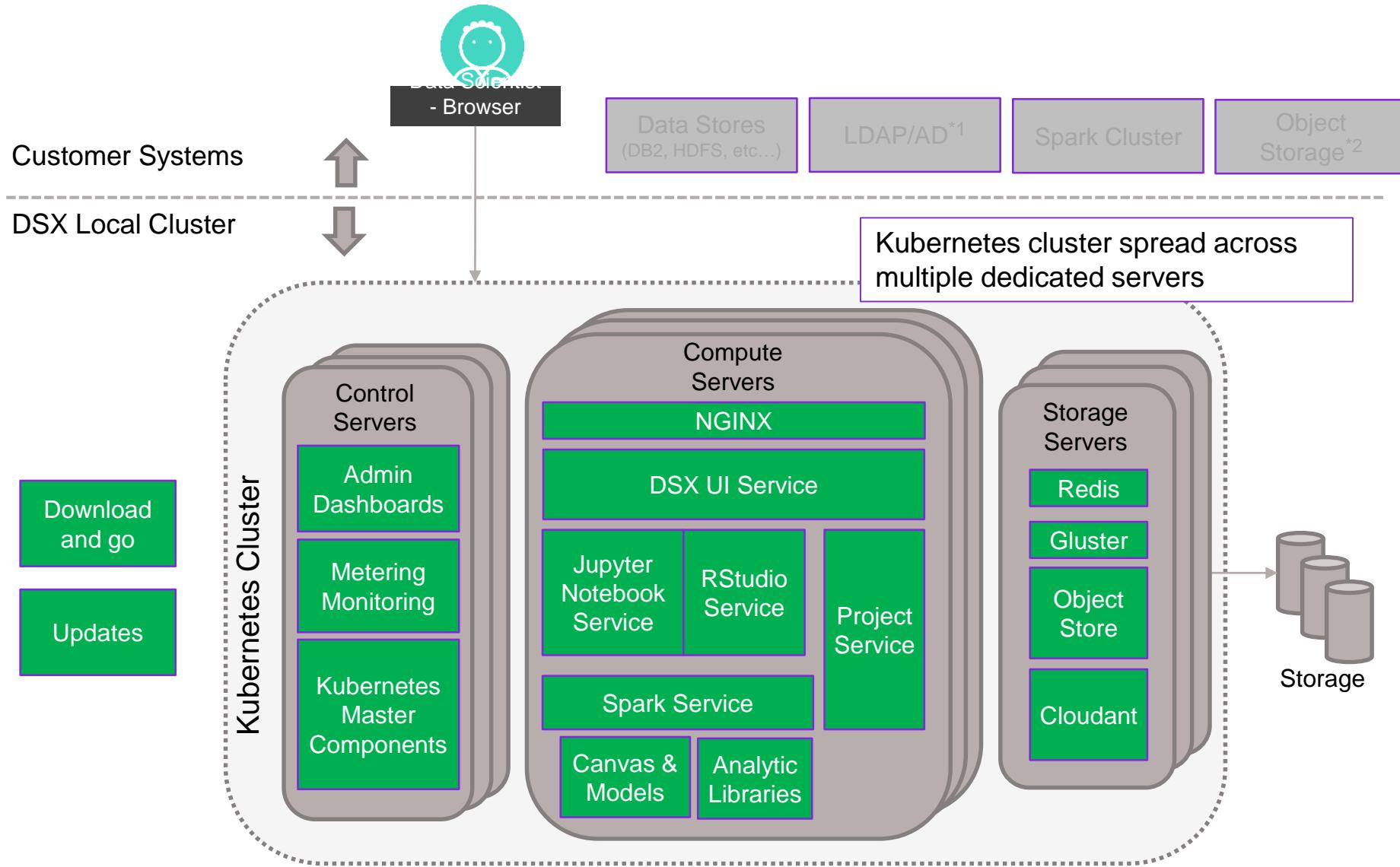
The screenshot shows the IBM Cloud Private Catalog interface. At the top, there's a dark header bar with the IBM Cloud Private logo, a search bar, and links for 'Create resource', 'Docs', and 'Support'. Below the header is a light blue navigation bar with the word 'Catalog'. The main area is a white space containing a search bar with a magnifying glass icon and the placeholder 'Search items', a 'Filter' button with a gear icon, and a sub-header 'Deploy your applications and install software packages'. There are six software packages listed in two rows of three:

- ibm-cloudant-dev**: Cloudant for Linux. (Icon: Beehive)
- ibm-datapower-dev**: IBM DataPower Gateway. (Icon: Blue diamond)
- ibm-db2oltp-dev**: IBM Db2 Developer-C Edition 11.1.3.3. (Icon: Blue circle with 'Db2')

- ibm-db2warehouse-dev**: Db2 Warehouse Developer-C for Non-Production v2.5.0. (Icon: Blue bar chart)
- ibm-dsm-dev**: IBM Data Server Manager Developer-C Edition. Note that there can only be one DSM deployed per cluster. (Icon: Beehive)
- ibm-dsx-dev**: IBM Data Science Experience (DSX) Developer Edition brings together best of breed open source. (Icon: Teal infinity symbol)

Each package entry includes a 'View details' button and a 'Chart' button under the 'ibm-charts' label.

DSX Local Cluster Architecture



^{*1} Only for user authentication in initial release

^{*2} Support planned for a future release

DSX Local Cluster & ICP – Internals (as of today: DSX 1.1.1.00 ppc64le)

Namespaces:

sysibmadm-data , sysibm-adm , dsxl-ml , ibm-private-cloud

PODs:

cloudant, redis, usermgmt, dsx-core, and ibm-nginx

Images:

27 images

Listing of key Components in DSX Local

(see under /wdp/k8s in the master node)

- **devtest-helpers** - Utility scripts to help with deployments
- **dsx-local-proxy** - the primary NGINX based server– serves up port 443 and reverse proxies to all other DSX Local service URLs
- **docker-registry** - Docker registry running as a Daemon Set in all hosts and service all needed docker images
- **cloudant-repo** - Cloudant repository database used to house metadata and projects etc.
- **redis-repo** - Redis in-memory Key value store – used for session storage in the web/UI micro services
- **swift-objectstore** - Openstack Swift container used to store csv data assets
- **usermgmt** - Supports management of users, authentication and working an external LDAP server
- **spark** - Spark cluster – master & worker daemon set
- **wdp-deploy-dashboard** – Backend and Front-end Admin components (IBM Data Platform Manager)
- **wdp-logs-elk** - Elastic Search, Logstash and Kibana – for Logging, Indexing
- **wdp-metrics-prometheus** - Monitoring metrics with Prometheus
- **dsx-local-k8s** - web-ui and api microservices (such as portal-main, projects api etc.)
- **docplexcloud-service** - Decision optimization / Deep Learning deployment

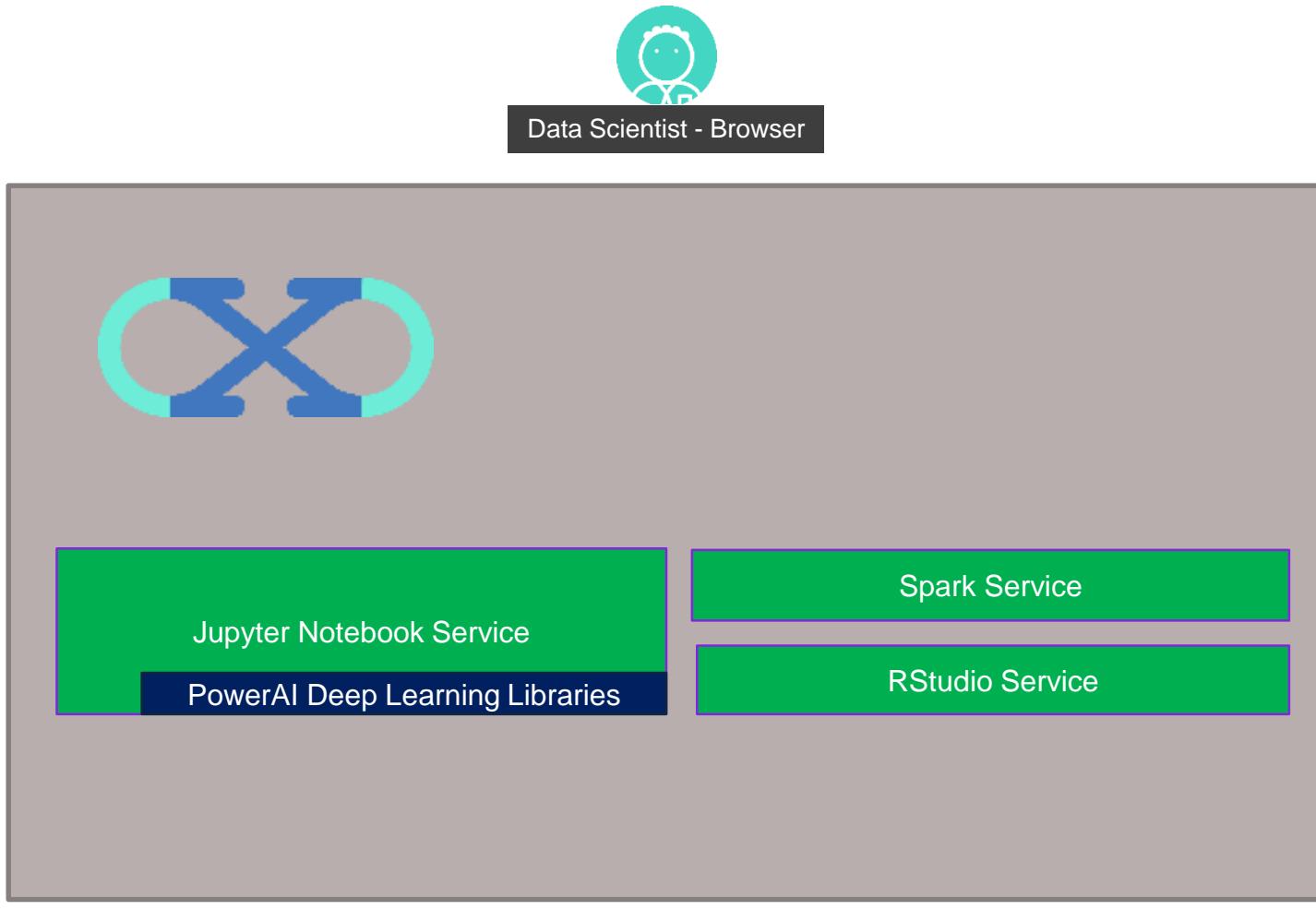
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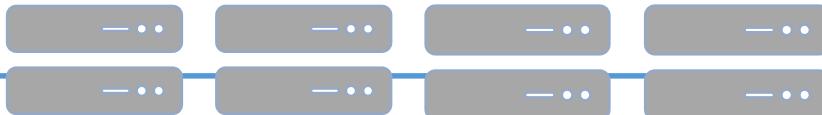
Good news: ICP/K8s manages everything for you ☺

Prefix/Suffix	image.repository	image.tag
cloudantRepo	privatecloud-cloudant-repo	v3.13.428
dsxConnectionBack	dsx-connection-back	1.0.4
dsxCore	dsx-core	v3.13.10
dsxScriptedML	privatecloud-dsx-scripted-ml	v0.01.2
filemgmt	filemgmt	1.0.2
hdpzeppelinDsxD8a2ls2x	hdpzeppelin-dsx-d8a2ls2x	v1.0.10
jupyterDsxD8a2ls2x	jupyter-dsx-d8a2ls2x	v1.0.11
jupyterDsxD8a3ls2x	jupyter-dsx-d8a3ls2x	v1.0.7
jupyterGpuPy35	jupyter-gpu-py35	v1.0.9
mlOnlineScoring	privatecloud-ml-online-scoring	v3.13.6
mlPipelinesApi	privatecloud-ml-pipelines-api	v3.13.4
mllib	ml-libs	v3.13.30
nginxRepo	privatecloud-nginx-repo	v3.13.6
pipeline	privatecloud-pipeline	v3.13.3
portalMachineLearning	privatecloud-portal-machine-learning	v3.13.20
portalMlaas	privatecloud-portal-mlaas	v3.13.17
redisRepo	privatecloud-redis-repo	v3.13.431
repository	privatecloud-repository	v3.13.2
rstudio	privatecloud-rstudio	v3.13.8
spark	spark	1.5.1
sparkClient	spark-client	v1.0.2
sparkaaSApi	sparkaaS-api	v1.3.14
spawnerApiK8s	privatecloud-spawner-api-k8s	v3.13.5
usermgmt	privatecloud-usermgmt	v3.13.5
utilsApi	privatecloud-utils-api	v3.13.5
wmlBatchScoring	wml-batch-scoring	v3.13.2
wmlIngestion	privatecloud-wml-ingestion	v3.13.2

DSX and PowerAI worker node – High-Level View



Cluster of Power Servers – GPU / Non-GPU

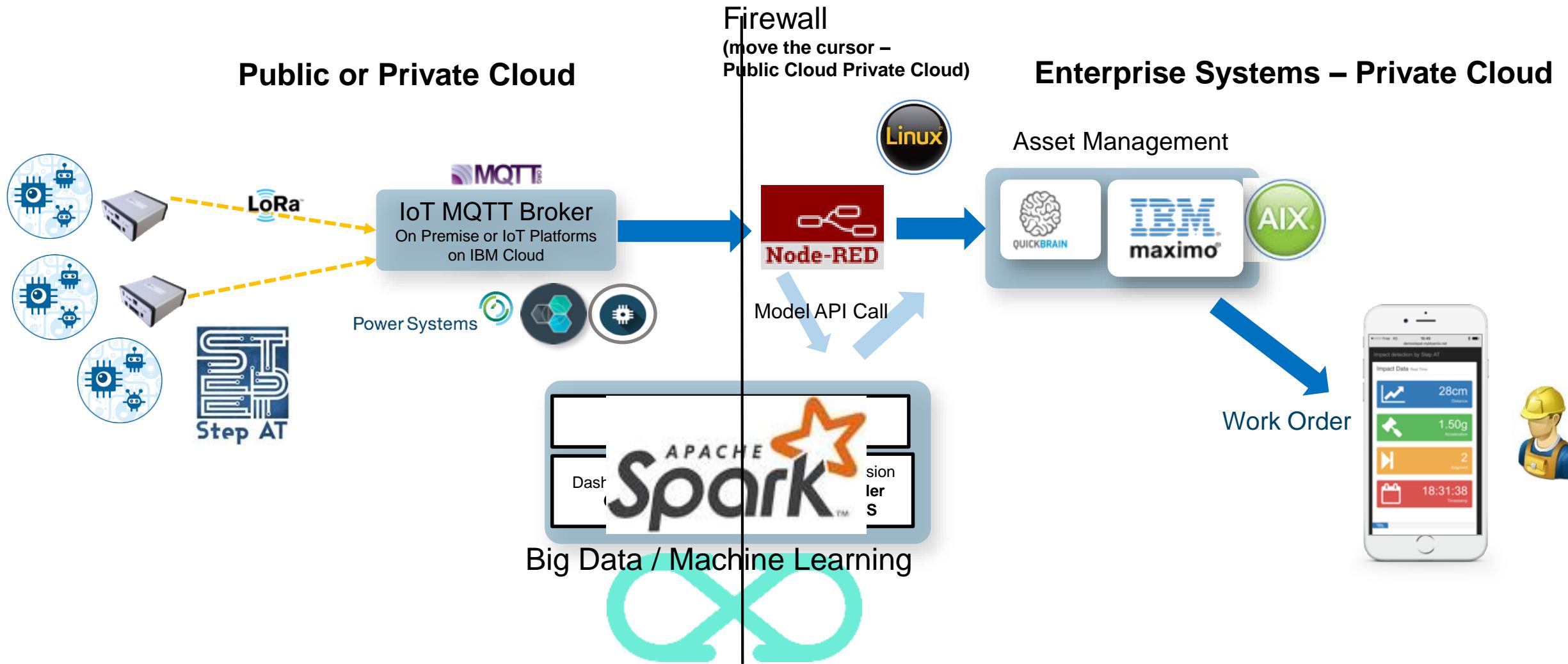


Power Specific Capability

Internal and Business Partner Use Only

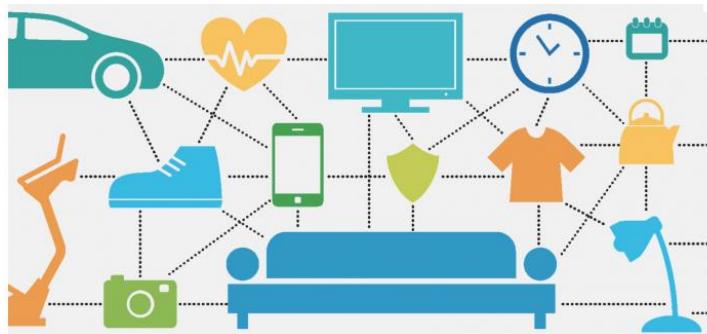


Predictive Maintenance Demonstration



Demonstration Video Replay:

<https://ibm.ent.box.com/v/power-iot-dsx-video-mp4>

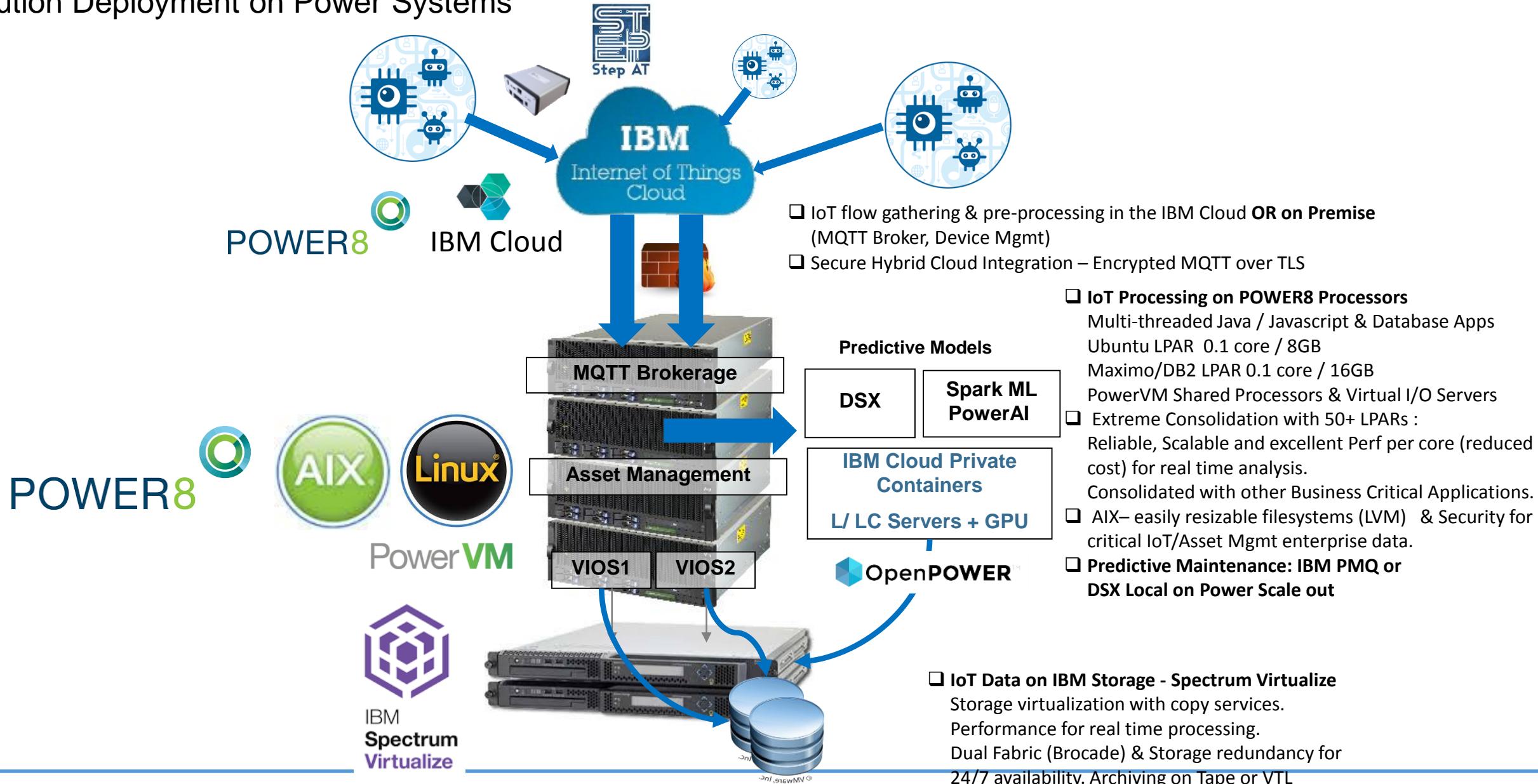


Demo: Predictive Maintenance on Power with DSX

IIoT + Predictive Maintenance solution augmented with AI & predictive capabilities

1. Data Collection & Asset Instrumentation
 - ❑ Sensors, LoRa, IoT Box & MQTT – IBM Cloud & Watson IoT – Node.RED
2. Asset Management with hybrid Cloud integration
 - ❑ IBM Maximo Asset Management on AIX (rock solid & secure)
 - ❑ Avoid a majority of outages with Condition Based Maintenance + Preventative Maintenance
3. AI , ML/DL for Predictive Maintenance : Bespoke ML/DL models with the good precision vs. Business objectives
 - ❑ Predict an Engine outage using DSX & Spark ML on Power Systems
 - ❑ Use of collaborative tools, Jupyter notebooks (R or Python)
 - ❑ Training, Test & validation using DSX, IBM Machine Learning & Spark ML
 - ❑ Model Inference: asset failure predictive model as a service – REST API

Solution Deployment on Power Systems



Connection to the Pipeline Dashboard

The dashboard displays the following key metrics:

- Impact Data (Real Time):
 - Distance: 178cm
 - Acceleration: 3.38g
 - Segment: 7
 - Timestamp: 19:36:29
- Relative impact distance chart (Bar Distance):
 - Y-axis: 5, 10, 15, 20
 - X-axis categories: 1, 2, 3, 4, 5, 6, 7
 - Legend: Nb Impact: 13
- Impact historic chart:
 - Y-axis: 2, 4, 6, 8
 - X-axis: 19:36:29 (highlighted)
 - Annotation: Accel: 3.38
- Contact information for Step Automation & Test:
 - P: +33 4 94 62 86 82
 - F: +33 4 94 24 09 85
 - M: lionel.girod@stepat.com
 - 70 Avenue de Rome
83500 La Seyne sur mer
FRANCE

A large image on the right shows a yellow construction vehicle working on a long pipeline in a field.

<http://demostepat.mybluemix.net/>

Watson IoT Platform



IBM Watson™ IoT Platform for Bluemix gives you a versatile toolkit that includes gateway devices, device management, and powerful application access. By using Watson IoT Platform, you can collect connected device data and perform analytics on real-time data from your organization.



Welcome to Watson IoT Platform

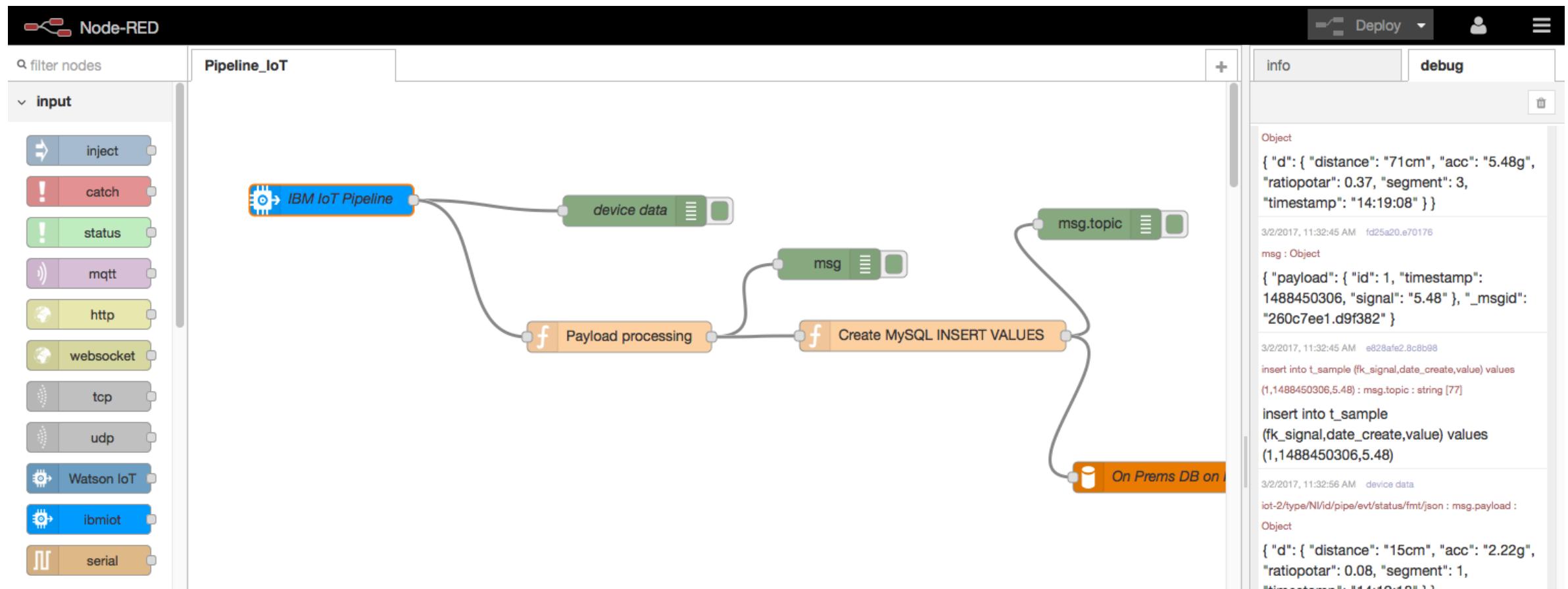
The screenshot displays the IBM Watson IoT Platform interface across four main sections:

- Left Sidebar:** A dark sidebar with a navigation menu including: BOARDS, DEVICES, MEMBERS, APPS, USAGE, RULES, SECURITY, SETTINGS, and EXTENSIONS.
- Devices Section:** Shows a list of devices with columns for Device ID, Device Type, Class ID, and Date Added. It includes links for Browse, Diagnose, Action, Device Types, Manage Schemas, Refresh, and + Add Device.
- Apps Section:** Shows a list of API Keys and Bluemix Apps, with filters for Key, Roles, Last Edited By, Expiry Date, and Comment.
- Device-Centric Analytics Section:** A detailed view for the device "pipe". It includes tabs for Devices (Care About), Device Info, and Device Properties. The Device Properties tab shows the following data:

Property	Value	Last Updated
Device name	pipe	8m 1.77g
Hardware Version	-	8 seconds ago
Software Version	-	8 seconds ago
Descriptive Location	-	17/08/2016 12:08:00
segment	2	8 seconds ago
latency	0.22	8 seconds ago
timestamp	14:21:08	8 seconds ago
value	1	17/08/2016 12:08:00

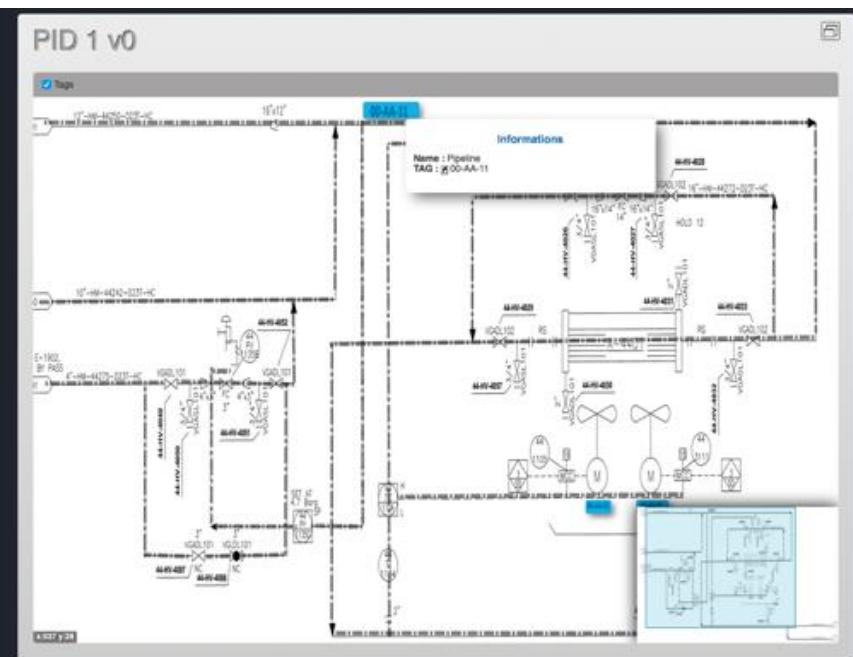
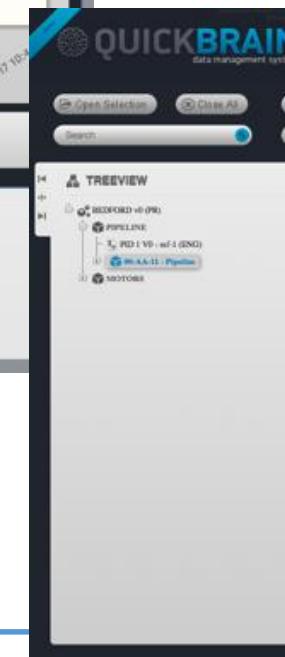
Integration with Node-Red

Node.js visual scripting tool that runs on premise on Ubuntu POWER8. Use an IBM IoT Client node to get the events from the Watson IoT Service, parse them, and insert them in the QUICKBRAIN MySQL database.



Ennovia QuickBrain

A complete solution for interactive documentation & maintenance management and includes an integration module to Maximo.



ENNOVIA Smart Industrial Solutions

QB4MX Quickbrain feature:

- Easy import of data from a plant or any industry (assets, items, sensors) in Maximo
 - Easy connection between IoT Sensors (from the IoT box) and Maximo Meters
 - Connection & import done via IBM Maximo REST API.

IBM Maximo

IBM® Maximo® Asset Management is a comprehensive solution for managing physical assets on a common platform in asset-intensive industries. Integrated in Ennovia solutions.

The screenshot displays the IBM Maximo Asset Management interface, featuring several integrated modules:

- Welcome, Mike Wilson**: A dashboard with a "IMPACT FORCE 1= WARNING 2= WORK ORDER" card showing a gauge from 0 to 5 with a value of 2.35, and a "COUNT NEW WORK ORDER" card showing 1 new work order.
- Assets**: A module for managing assets, currently viewing "PIPELINE 1" (Pipeline) at site "BEDFORD". It includes tabs for Asset, Spare Parts, Safety, Meters, Specifications, Relationships, Work, Topology, Service Address, and Map.
- Meters**: A sub-module under Assets, showing a single meter entry for "IMPACT FORCE METER" (Gauge) at site "BEDFORD". It displays the last reading of 2.83 and the last reading date of 3/2/17 11:42 AM.
- Condition Monitoring**: A module for monitoring asset conditions. It shows a point "1008" named "IMPACT FORCE" located on "PIPELINE 1" (Pipeline). It includes sections for Upper Limits (Upper Warning Limit: 1.000, Upper Action Limit: 2.000, Upper Limit PM: 1020, Upper Limit Job Plan: PIPE INSPECTION) and Lower Limits (Lower Warning Limit: 0.001, Lower Action Limit: 0.000, Lower Limit PM: 1020, Lower Limit Job Plan: PIPE INSPECTION).

IBM Partners Solutions

Step AT – IoT Solution with IBM Cloud



- ❑ **Sensors** to instrument a facility. In that case, a connected pipeline reporting events after a first filtering by the **IoT Box** (Step AT) algorithms running on FPGA. 2 Accelerometers are placed on the pipe for that demo for shock detection AND localization.
- ❑ **Step AT IoT Box:** a MQTT device which subscribes to a specific topic on the MQTT Broker running in Bluemix (can be on premise). The role of the IoT Box is to make a first real time (high performance) filtering close to the sensors with specific algorithms (specific to the pipeline shock detection) and only report 'real shocks' events to the MQTT Broker. Compatible with many kinds of sensors/machine tool.
- ❑ **In the Real life:** sensors = microphones dispatched every 10 km, each attached to an IoT Box on the pipeline (desert, extreme temperatures). Communication = LoRa (Long Range) radio connection + MQTT (lightweight). All IoT Boxes are synchronized for a more accuracy shock detection (complex algorithms)

Ennovia / Crazylog – Predictive Maintenance on Power Systems



- ❑ **Node-Red:** Node.js visual scripting tool that runs on premise on Ubuntu POWER8. This app uses an IBM IoT Client node to get the events from the **Bluemix IoT Platform Service**, parse them, and insert them in the **QUICKBRAIN MySQL database**.
- ❑ **QuickBrain:** This Web App is a complete solution for documentation management (including 2D 3D views, maps), event & maintenance management and includes an integration module to **IBM Maximo Asset Management** for alerting and maintenance tasks.
- ❑ Possible Integration with **IBM Cognos**, **IBM PMQ** ...for further analysis & asset productivity.

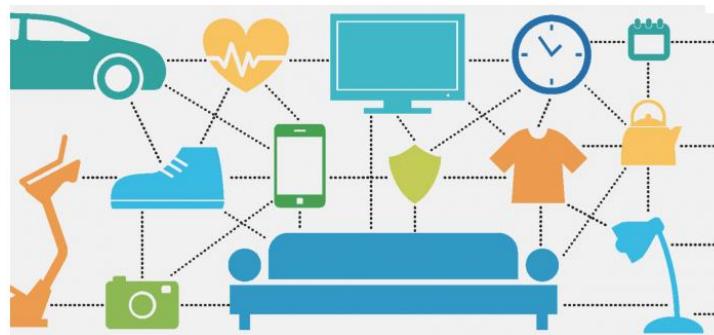
Predictive Maintenance Use case : Steps with DSX

1. Data collected by NASA – 100 engines / 20 sensors each / hundreds of cycles recorded until failure
<https://ti.arc.nasa.gov/tech/dash/groups/pcoe/prognostic-data-repository/>
 - Damage Propagation [study](#)
2. Data cleaning, normalization, feature engineering (rolling avg , rolling sd) , RUL (Remaining useful life or TTF) with DSX (R , Jupyter Notebooks)
3. **Modeling with DSX**
 - Spark 2.0 via R notebook (Jupyter) & Watson ML
 - Regression models: How many more cycles an in-service engine will last before it fails?
//Random Forrest Regression, Gradient Boosting Tree , etc.
 - Binary classification: Is this engine going to fail within w1 cycles?
 - Multi-class classification: Is this engine going to fail within the window [1, w0] cycles or to fail within the window [w0+1, w1] cycles, or it will not fail within w1 cycles?
4. Training with default hyperparameters – can be tuned
5. Evaluation, **Publish** Model as a Service.
6. Integration to existing IoT Asset Management solution for predicting asset failure

DSX

Backup Slides

Demonstration Screenshots



Data Science Experience

Import or use Raw data (csv files, object storage, jdbc ...) using connectors

IBM Data Science Experience | Projects Tools Data Services Community

My Projects > Predictive Maintenance v1

Add to project

Overview Assets Bookmarks Deployments Collaborators Settings

What assets are you looking for?

Data assets

NAME	TYPE	SERVICE	LAST MODIFIED	ACTIONS
train_FD001.csv	CSV	Object Storage (Swift API)		⋮
RUL_FD001.csv	CSV	Object Storage (Swift API)		⋮
test_FD001.csv	CSV	Object Storage (Swift API)		⋮

Notebooks

NAME	SHARED	SCHEDULED	STATUS	LANGUAGE	LAST EDITOR	LAST MODIFIED	ACTIONS
PrepareData			○	R 3.3.2	BENOIT MAROLLEAU	14 Nov 2017	✍️ ⋮

Models

New model

Data Science Experience

Work on your data (Statistics, Analytics, Plots,...) & prepare your models using R or Python libraries – R Studio / Jupyter Notebooks

The screenshot shows the IBM Data Science Experience interface. At the top, there's a navigation bar with the IBM logo, 'IBM Data Science Experience', and links for 'Projects', 'Tools', 'Data Services', and 'Community'. Below that is a breadcrumb navigation: 'My Projects > Predictive Maintenance v1 > PrepareData'. On the right side of the header are edit and share icons.

The main area contains a Jupyter Notebook cell. The code in the cell is:

```
df <- data.frame(matrix(unlist(m), nrow=length(m), byrow=T), stringsAsFactors=FALSE)

# generate column names for the data frame
colnames <- c("id","cycle","setting1","setting2","setting3","s1","s2","s3","s4",
             "s5","s6","s7","s8","s9","s10","s11","s12","s13","s14","s15","s16","s17",
             "s18","s19","s20","s21")
names(df) <- colnames

# generate output data
data.set <- df
# Select data.frame to be sent to the output Dataset port
#maml.mapOutputPort("data.set");
```

A red box highlights the last line of the code: '# Select data.frame to be sent to the output Dataset port #maml.mapOutputPort("data.set");'.

Below the code cell is another cell labeled 'In [2]:' containing:

```
#Raw Data from Sensors CSV file
#dataset
#Formatted data
data.set
```

At the bottom, there's a preview of the data in a table:

	id	cycle	setting1	setting2	setting3	s1	s2	s3	s4	s5	...	s12	s13	s14	s15	s16	s17	s18	s19	s20
1	1	0.0023	0.0003	100.0	518.67	643.02	1585.29	1398.21	14.62	...	521.72	2388.03	8125.55	8.4052	0.03	392	2388	100.00	38.8	
1	2	-0.0027	-0.0003	100.0	518.67	641.71	1588.45	1395.42	14.62	...	522.16	2388.06	8139.62	8.3803	0.03	393	2388	100.00	39.0	
1	3	0.0003	0.0001	100.0	518.67	642.46	1586.94	1401.34	14.62	...	521.97	2388.03	8130.10	8.4441	0.03	393	2388	100.00	39.0	
1	4	0.0042	0.0000	100.0	518.67	642.44	1584.12	1406.42	14.62	...	521.38	2388.05	8132.90	8.3917	0.03	391	2388	100.00	39.0	
1	5	0.0014	0.0000	100.0	518.67	642.51	1587.19	1401.92	14.62	...	522.15	2388.03	8129.54	8.4031	0.03	390	2388	100.00	38.9	
1	6	0.0012	0.0003	100.0	518.67	642.11	1579.12	1395.13	14.62	...	521.92	2388.08	8127.46	8.4238	0.03	392	2388	100.00	38.9	
1	7	-0.0000	0.0002	100.0	518.67	642.11	1583.34	1404.84	14.62	...	522.01	2388.06	8134.97	8.3914	0.03	391	2388	100.00	38.8	
1	8	0.0006	-0.0000	100.0	518.67	642.54	1580.89	1400.89	14.62	...	522.09	2388.06	8125.93	8.4213	0.03	393	2388	100.00	39.0	
1	9	-0.0036	0.0000	100.0	518.67	641.88	1593.29	1412.28	14.62	...	522.03	2388.05	8134.15	8.4353	0.03	391	2388	100.00	39.1	



IBM ML (Automatic Model Builder) demo
**(Can be done programmatically
from a notebook or Flow Designer too)**
Use of Spark & Spark ML
Input: clean dataset
Hyper parameters can be changed
Split dataset in test, training
Training, Evaluation, and Test
Create the model in your project
Publish your model as a REST API

New model BETA

Name

PredictiveRUL

87

Description*Model description*

300

Machine Learning Service

WatsonML

**Spark Service**

DSX-Spark

**Automatic**

Prepare my data and create a model
automatically

Manual

Let me prepare my data and select which
models to train



Data Science Experience

Features (input data from IoT sensors)

cycle	setting1	setting2	s2	s3	s4	s6	s7	s8	s9	s11	s12
0	0.45977	0.166667	0.183735	0.406802	0.309757	1	0.726248	0.242424	0.109755	0.369048	0.633262
0.00277	0.609195	0.25	0.283133	0.453019	0.352633	1	0.628019	0.212121	0.100242	0.380952	0.765458
0.00554	0.252874	0.75	0.343373	0.369523	0.370527	1	0.710145	0.272727	0.140043	0.25	0.795309
0.00831	0.54023	0.5	0.343373	0.256159	0.331195	1	0.740741	0.318182	0.124518	0.166667	0.889126
0.01108	0.390805	0.333333	0.349398	0.257467	0.404625	1	0.668277	0.242424	0.14996	0.255952	0.746269
0.01385	0.252874	0.416667	0.268072	0.292784	0.272113	1	0.776167	0.181818	0.125415	0.184524	0.637527
0.01662	0.557471	0.583333	0.38253	0.46392	0.261985	1	0.723027	0.181818	0.167818	0.303571	0.773987
0.019391	0.304598	0.75	0.406627	0.259865	0.316003	1	0.644122	0.151515	0.085569	0.232143	0.80597
0.022161	0.545977	0.583333	0.274096	0.434707	0.21185	1	0.618357	0.227273	0.110967	0.261905	0.660981

NASA Source : <https://ti.arc.nasa.gov/tech/dash/groups/pcoe/prognostic-data-repository/>

Close

Use This Data

Data Science Experience

Columns to predict (labels)

sd9	sd11	sd12	sd13	sd14	sd15	sd17	sd20	sd21	RUL	label1	label2	
0	0	0	0	0	0	0	0	0	191	0	0	
70464	0.118087	0.057199	0.488189	0.160656	0.508246	0.132258	0	0.130435	0.017365	190	0	0
99652	0.364881	0.492044	0.450405	0.120224	0.374753	0.116172	0.408248	0.169323	0.237961	189	0	0
48784	0.305764	0.694286	0.552267	0.133773	0.307559	0.427568	0.353553	0.234642	0.202745	188	0	0
11827	0.361364	0.610985	0.481694	0.11762	0.267278	0.394651	0.387298	0.226338	0.178837	187	0	0
4034	0.330369	0.572418	0.473725	0.106567	0.096645	0.391221	0.403113	0.157365	0.167828	186	0	0
14257	0.31812	0.380491	0.473987	0.098513	0.064834	0.356987	0.403113	0.266604	0.115497	185	0	0
18326	0.544759	0.374642	0.478738	0.098513	0.115857	0.341797	0.295804	0.265894	0.183678	184	0	0
12048	0.56648	0.296663	0.379835	0.040643	0.323137	0.315382	0.295804	0.237146	0.207884	183	0	0

Close

Use This Data

Data Science Experience

IBM Machine Learning Wizard:
Column to predict
Features

My Projects > Predictive Maintenance v1 > PredictiveRUL

Train Evaluate

Column value to predict (Label Col)

RUL (Integer) ▼

Feature columns

cycle (Decimal), setting1 (Decimal), setting2 (Decimal), s2 (Decimal), s3 (Decimal), s4 (Decimal), s6 (Integer), s7 (Decimal), s8 (Decimal), s9 (Decimal), s11 (Decimal), s12 (Decimal), s13 (Decimal), s14 (Decimal), s15 (Decimal), s17 (Decimal), s20 (Decimal), s21 (Decimal), a2 (Decimal), a3 (Decimal), a4 (Decimal), a6 (Decimal), a7 (Decimal), a8 (Decimal), a9 (Decimal), a11 (Decimal), a12 (Decimal), a13 (Decimal), a14 (Decimal), a15 (Decimal), a17 (Decimal), a20 (Decimal), a21 (Decimal), sd2 (Decimal), sd3 (Decimal), sd4 (Decimal), sd6 (Decimal), sd7 (Decimal), sd8 (Decimal), sd9 (Decimal), sd11 (Decimal), sd12 (Decimal), sd13 (Decimal), sd14 (Decimal), sd15 (Decimal), sd17 (Decimal), sd20 (Decimal), sd21 (Decimal) ×

sd15 (Decimal)

sd17 (Decimal)

sd20 (Decimal)

sd21 (Decimal)

label1 (Integer)

label2 (Integer)

sted technique.

egression

es from a set of values. ur label column large number of

Data Science Experience

IBM Machine Learning

Wizard:

Assisted ML algorithms choice

My Projects > Predictive Maintenance v1 > PredictiveRUL

Train Evaluate Column value to predict (Label Col)
RUL (Integer)

Feature columns

cycle (Decimal), setting1 (Decimal), setting2 (Decimal), s2 (Decimal), s3 (Decimal), s4 (Decimal), s6 (Integer), s7 (Decimal), s8 (Decimal), s9 (Decimal), s11 (Decimal), s12 (Decimal), s13 (Decimal), s14 (Decimal), s15 (Decimal), s17 (Decimal), s20 (Decimal), s21 (Decimal), a2 (Decimal), a3 (Decimal), a4 (Decimal), a6 (Decimal), a7 (Decimal), a8 (Decimal), a9 (Decimal), a11 (Decimal), a12 (Decimal), a13 (Decimal), a14 (Decimal), a15 (Decimal), a17 (Decimal), a20 (Decimal), a21 (Decimal), sd2 (Decimal), sd3 (Decimal), sd4 (Decimal), sd6 (Decimal), sd7 (Decimal), sd8 (Decimal), sd9 (Decimal), sd11 (Decimal), sd12 (Decimal), sd13 (Decimal), sd14 (Decimal), sd15 (Decimal), sd17 (Decimal), sd20 (Decimal), sd21 (Decimal)

Suggested technique.

Binary Classification

Classify new data into defined categories based on existing data. Choose if your label column contains two distinct categories.

Multiclass Classification

Classify new data into defined categories based on existing data. Choose if your label column contains a discrete number of categories.

Regression

Predict values from a continuous set of values. Choose if your label column contains a large number of values.

Data Science Experience

IBM Machine Learning Wizard:

- ML algorithm choice
- Pre-set but tunable Hyperparameters

Select estimator(s)

 What type of estimator are you looking for?



Linear Regression

Models the linear relationship between a scalar-dependent variable y and one or more explanatory variables (or independent...)



Decision Tree Regressor

Maps observations about an item (represented in the branches) to conclusions about the item's target value (represented in...)



Random Forest Regressor

Constructs multiple decision trees to produce the mean prediction of each decision tree. It supports both continuous and c...



Gradient Boosted Tree

Regressor

Produces a regression prediction model in the form of an ensemble of decision trees. It supports both continuous and categ...



Isotonic Regression

Models the isotonic relationship of a sequence of observations by fitting a free-form line to the observations under the f...

Cancel

Add

Data Science Experience

IBM Machine Learning
Wizard:
Data Split
Training & Evaluation

Validation Split



My Projects > Predictive Maintenance v1 > PredictiveRUL

Select Data

Train

Evaluate

Select model

ESTIMATOR TYPE	STATUS	PERFORMANCE	ROC ERF
GBTRRegressor	Training...
RandomForestRegressor	Queued...
DecisionTreeRegressor	Queued...

Data Science Experience

IBM Machine Learning

Wizard:

Select a Spark model once trained & evaluated

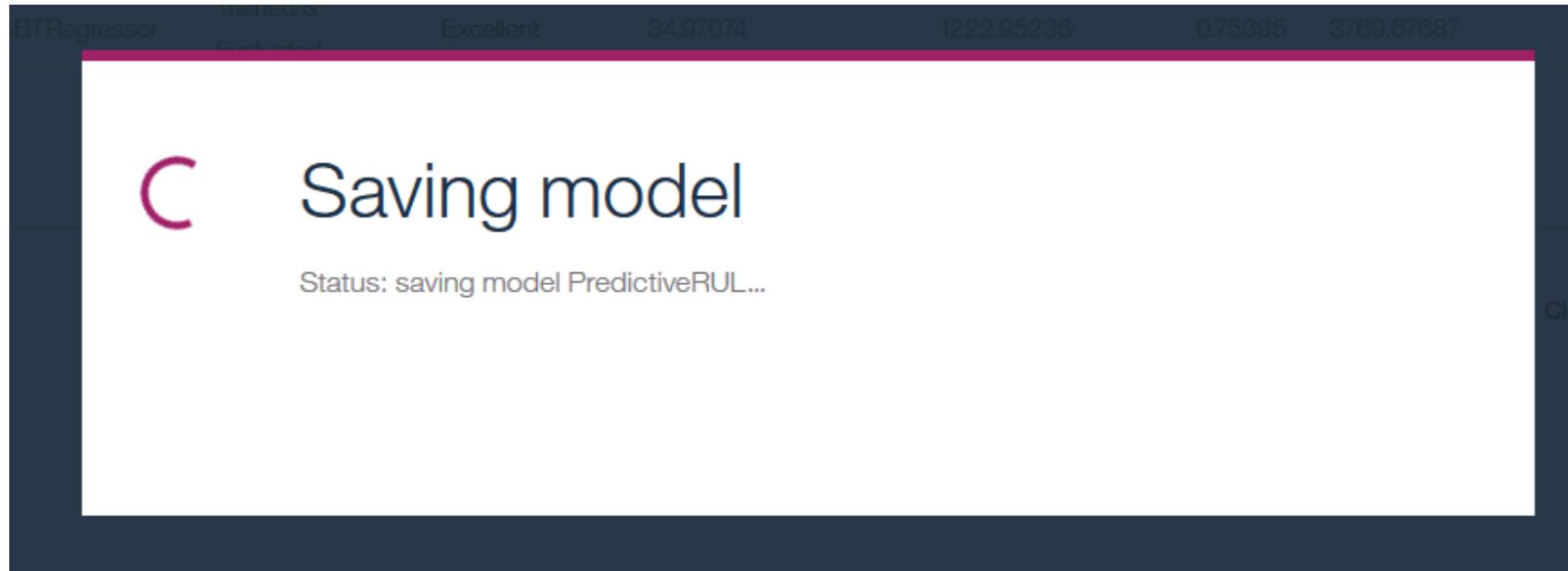
The screenshot shows the IBM Data Science Experience interface. At the top, there's a navigation bar with the logo, "IBM Data Science Experience", and links for "Projects", "Tools", "Data Services", and "Community". Below the navigation bar, the breadcrumb navigation shows "My Projects > Predictive Maintenance v1 > PredictiveRUL". On the left, there's a sidebar with "Select Data", "Train", and "Evaluate" buttons. The "Evaluate" button is highlighted with a grey background. The main content area is titled "Select model" and displays a table of three estimators:

	ESTIMATOR TYPE	STATUS	PERFORMANCE	ROOT MEAN SQUARED ERROR	MEAN SQUARED ERROR	R2
<input type="radio"/>	DecisionTreeRegressor	Trained & Evaluated	Excellent	36.54021	1335.1867	0.71254
<input type="radio"/>	RandomForestRegressor	Trained & Evaluated	Excellent	35.56394	1264.79411	0.7277
<input checked="" type="radio"/>	GBTRegressor	Trained & Evaluated	Excellent	34.44071	1186.16245	0.74463

Data Science Experience

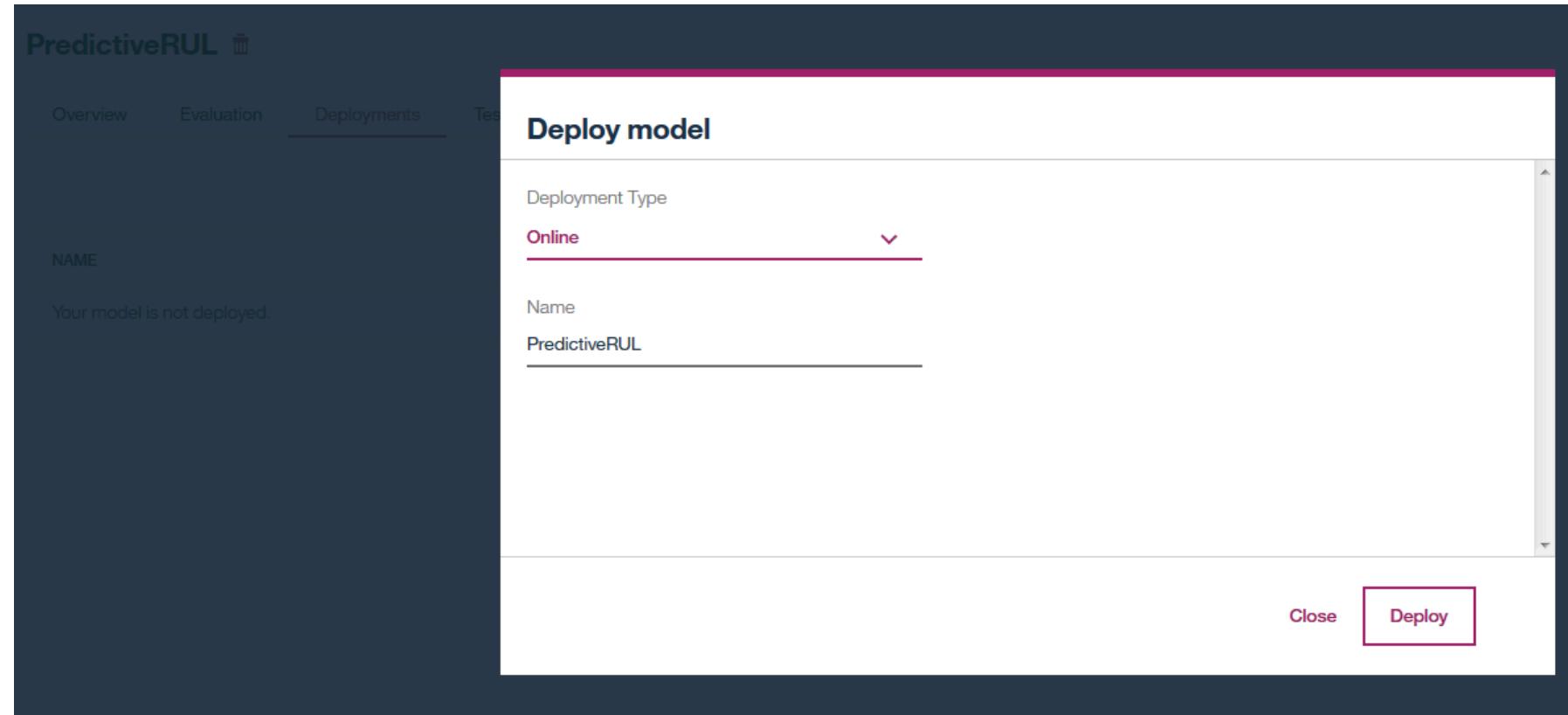
IBM Machine Learning
Wizard:

Saving Model - Can be shard with other Data Scientists for use in their project



Data Science Experience

IBM Machine Learning
Wizard:
Model Deployment



Data Science Experience

IBM Machine Learning Wizard:

Model unit testing GUI

Overview Evaluation Deployments **Test**

The predictor simulates scoring your prediction data with an undeployed model.

Spark service

DSX-Spark ▾

Prediction input data

sd6	0
sd7	0
sd8	0.778606
sd9	~

Predicted value for

Category	Predicted Value (%)
1	99.77%
2	0.23%
3	0.00%

Data Science Experience

- IBM Machine Learning Wizard:
 - Deployment metadata

EstimateRUL

Overview

Implementation

Test

Deployment

Name	EstimateRUL
Type	online
Deployment ID	cd750520-cd53-4af5-979b-c93c5ed2be19
Status	ACTIVE
Machine learning service	WatsonML
Created	15 Nov 2017 06:24pm
Last modified	15 Nov 2017 07:28pm

Data Science Experience

IBM Machine Learning

Wizard:

Deployment metadata: REST API Specs & Credentials (Endpoint, Bearer Token)

Input = IoT sensor data for a particular cycle

3 Models deployed:

EstimatedRUL estimates the remaining number of cycles for a particular engine

EstimatedRULBinary (next slides) : will the asset fail within the next 30 cycles? Return 0 if no else 1 (yes)

EstimatedRULMulti : will the asset fail within the next [0 ;15] cycles: returns 2 , [15,30] cycles: 1 else 0

EstimateRUL

Overview **Implementation** Test

Implementation

[View API Specification](#)

Scoring End-point

https://ibm-watson-ml.mybluemix.net/v3/wml_instances/366f855c-745d-4820-9b10-975dac91d5f7/published_models/3b616609-2445-4e5b-9a36-dfbe4156d264/deployments/cd750520-cd53-4af5-979b-c93c5ed2be19/online

Authorization: Bearer <token>

See code snippets below for information on how to retrieve the WML Authorization Token to be passed with scoring requests.

Content-type: application/json

Required if the request body is sent in JSON format.

Data Science Experience : Augment your apps with AI

Predictive Model Call – Input IoT sensor measurement data

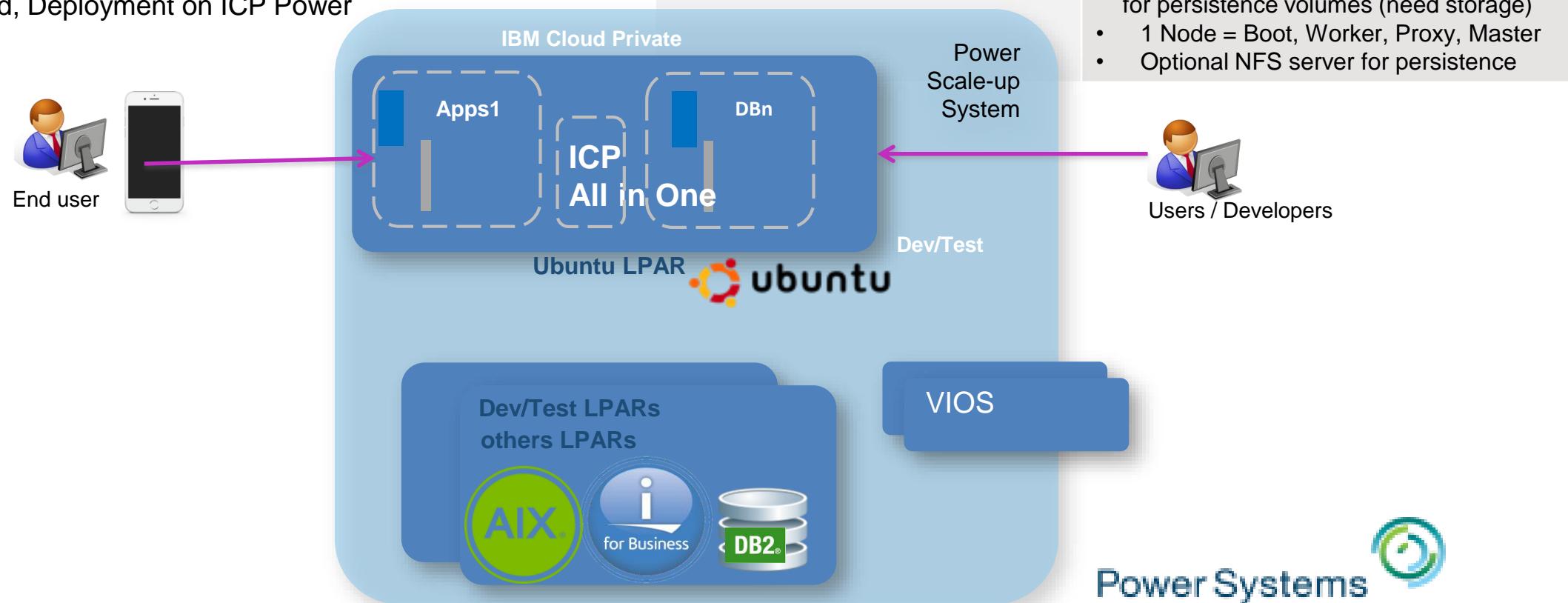
```
curl -X POST --header 'Content-Type: application/json' --header 'Accept: application/json' --header "Authorization: Bearer $WML_AUTH_TOKEN" -d '{"fields": ["cycle", "setting1", "setting2", "s2", "s3", "s4", "s6", "s7", "s8", "s9", "s11", "s12", "s13", "s14", "s15", "s17", "s20", "s21", "a2", "a3", "a4", "a6", "a7", "a8", "a9", "a11", "a12", "a13", "a14", "a15", "a17", "a20", "a21", "sd2", "sd3", "sd4", "sd6", "sd7", "sd8", "sd9", "sd11", "sd12", "sd13", "sd14", "sd15", "sd17", "sd20", "sd21", "RUL", "label2"], "values": [[0.265927977839335, 0.770114942528736, 0.5, 0.237951807228909, 0.304992369740571, 0.265530047265362, 1, 0.789049919484708, 0.16666666666896, 0.203849950641659, 0.244047619047617, 0.66737739872069, 0.205882352941039, 0.260295180101149, 0.290111581377453, 0.25, 0.627906976744188, 0.642502071251035, 0.357976653696491, 0.324850213980028, 0.265546881852467, 1, 0.78114035087718, 0.206896551723752, 0.204432392758116, 0.196428571428568, 0.733582487987172, 0.230392156862669, 0.275497 225442631, 0.324438996794269, 0.131578947368421, 0.707627118644065, 0.731805157593125, 0.378634290993906, 0.152807743951573, 0.179817603790296, 0, 0.3612304950 12475, 0.0905132666517087, 0.318190892880094, 0.288273458338208, 0.393968412975247, 0.0942273534372436, 0.485523113310845, 0.245122143639341, 0.25, 0.2407062701 85501, 0.419131972504728, 117, 0, 0]]}' https://ibm-watson-ml.mybluemix.net/v3/wml_instances/366f855c-745d-4820-9b10-975dac91d5f7/published_models/fearaae33e-a74a-4916-b0fb-926f2479d9ea/deployments/c3ef5bfe-6ce7-4119-8654-abdbb182fc57/online

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```

How to get started?

Starter configuration – Single node “All in one”

- CE (Free) Edition. For Dev/Test, no HA.
- Cloud or Enterprise Edition not needed as no HA
- ICP on PowerVM (LPAR) or 1 Scale-out L / LC / CS System (VM)
- Cloud Foundry plugin not available in Q4 2017
CF on IBM Cloud, Deployment on ICP Power



IBM Cloud Private on Power Systems

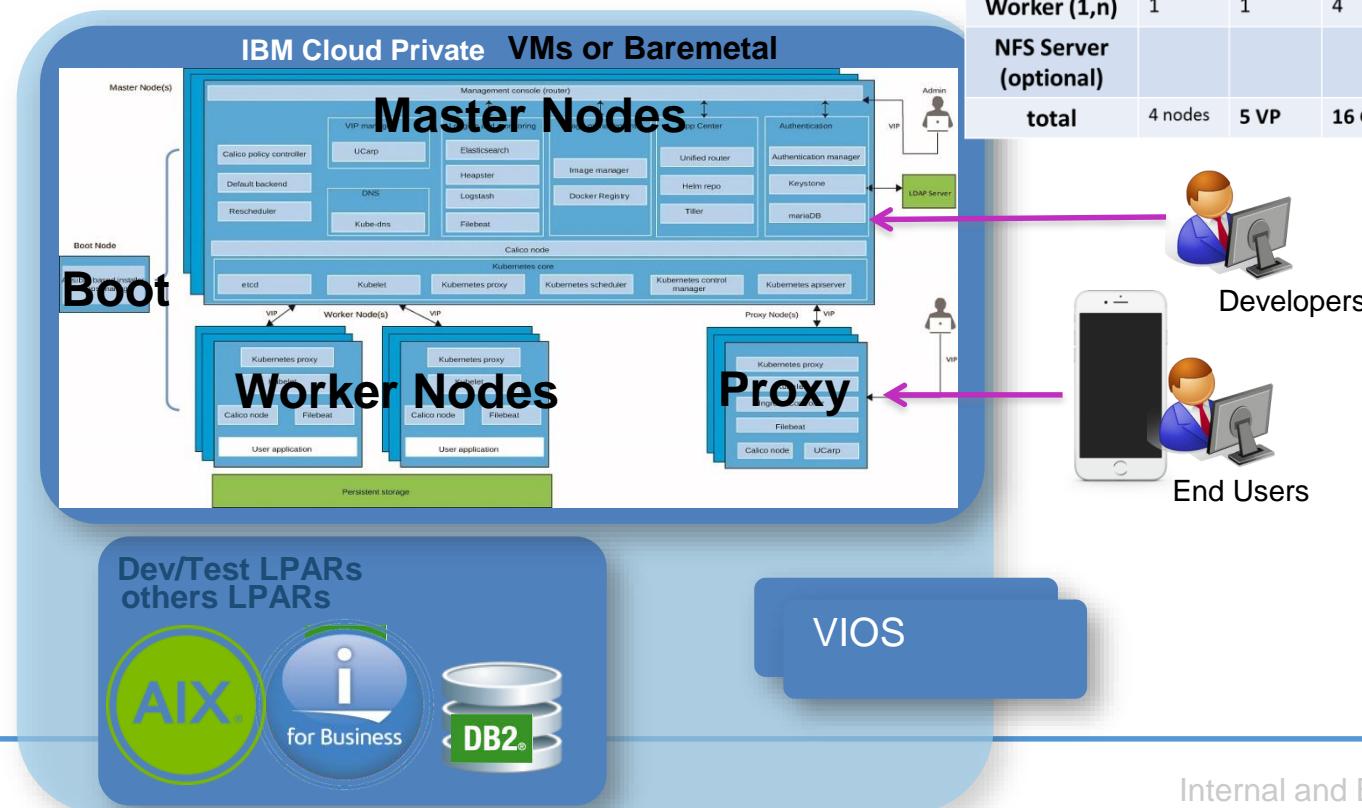
Multi-VM config with HA

- ICP on PowerVM (LPARs) or Scale-out Systems / Nutanix HCI
- HA Mode for Master & Proxy nodes

Note: Worker nodes can support mixed architectures. You can add worker nodes into a single cluster that run on Linux™ 64-bit, Linux™ on Power® 64-bit LE and IBM® Z platforms.

- Persistence:
 - NFS v4
 - Prefer Glusterfs
- Node = VM (LPAR or KVM VM) or Baremetal
- Example on PowerVM:
 - 11 nodes on 11 LPARs
- Example on L / CS / LC servers:
 - 11 nodes on 4 servers

Current		Target*						
IBM i / AIX / Linux LPARs production		IBM i / AIX / Linux LPARs production						
		ICP 2.1 on Power - Cloud or Enterprise Edition 11 x OS: Ubuntu 16.04 LTS or RHEL 7.2+						
		Minimal 4 Node Config					11 Node Config Example	
Role	#Nodes	CPU (VP)	Mem (GB)	Disk (GB)	#Nodes	CPU (VP)	Mem (GB)	Disk (GB)
Boot (1)	1	1	4	100	1	2	8	80
Master(1,3,5)	1	1	4	150	3	4	16	60
Proxy (1,3,5)	1	2	4	50	3	2	4	60
Management (1, optional)	0	4	8	100	1	8	16	150
Worker (1,n)	1	1	4	100	3	2	8	100
NFS Server (optional)					1	2	8	1024
total	4 nodes	5 VP	16 GB	400 GB	11 nodes	32 VP	116 GB	900 GB



Thank You

benoit.marolleau@fr.ibm.com

Benoit MAROLLEAU - Cloud Architect
IBM Client Center Montpellier, France



@ : [Benoit.marolleau@fr.ibm.com](mailto:benoit.marolleau@fr.ibm.com)

 [linkedin.com/in/benoitmarolleau](https://www.linkedin.com/in/benoitmarolleau)

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OSDB @ Montpellier Cognitive Systems Lab

Power System Linux Center

Engage with Clients, ISVs & Partners to leverage the benefits of Linux on Power, using **Open Sources** Solutions



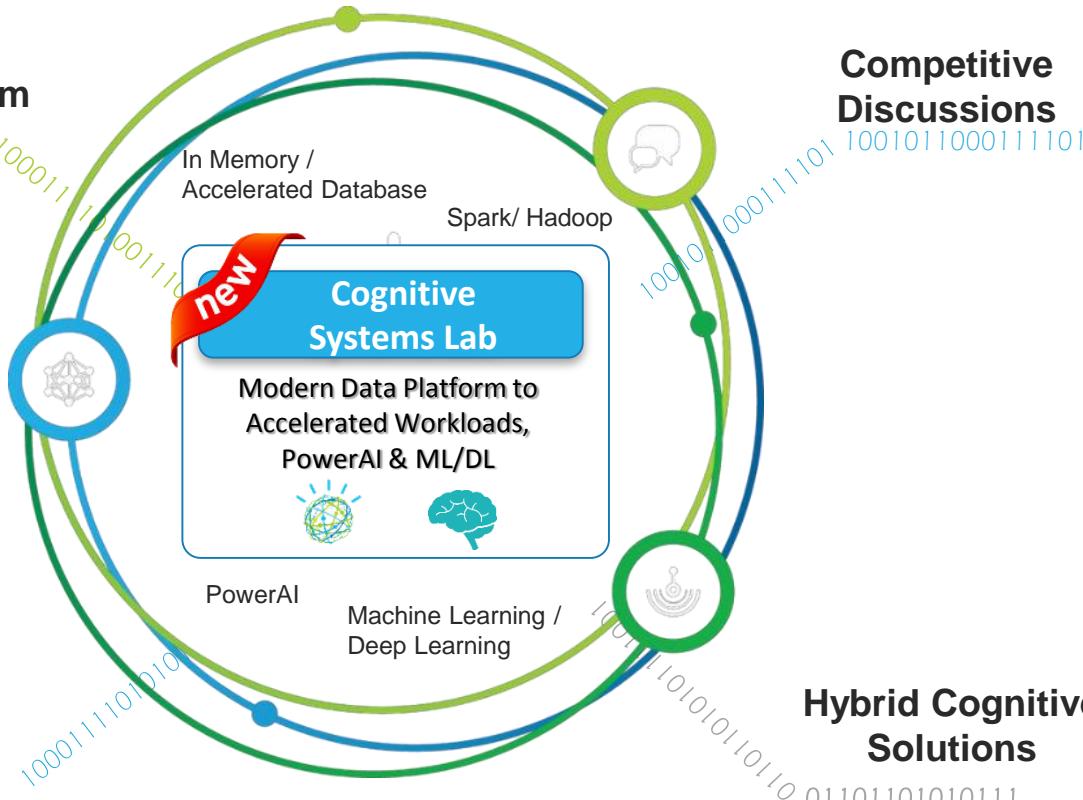
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Software Defined Infrastructure

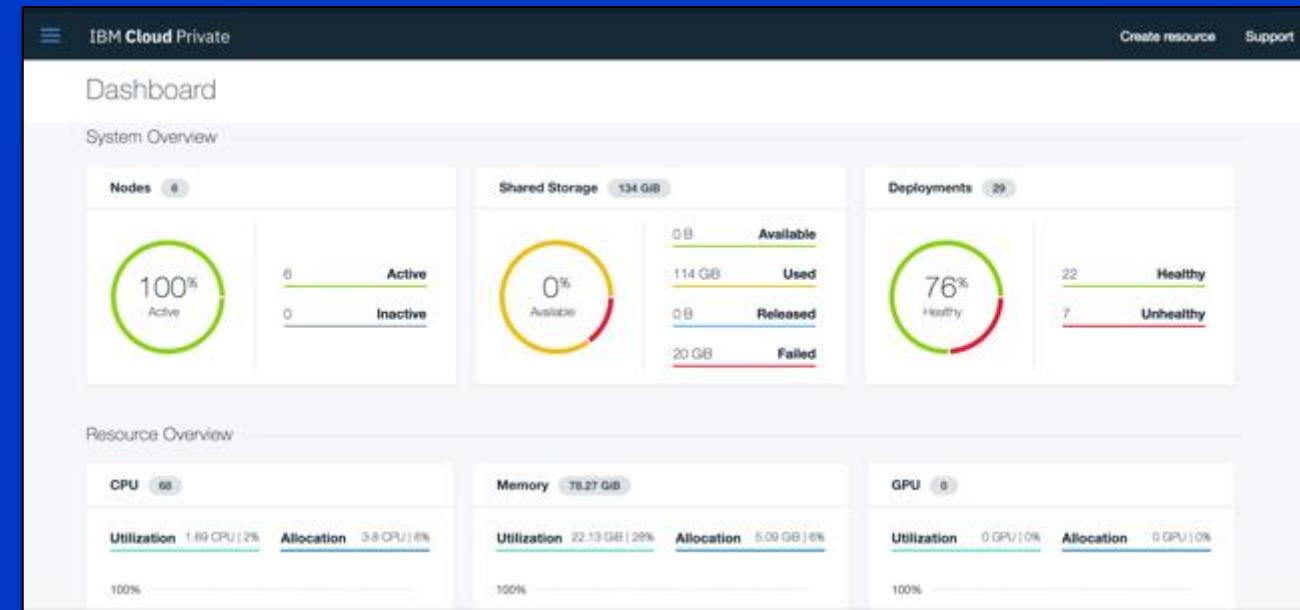
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