July 16, 2020

Autonomous Driving with Airflow

Where big-data meets high performance computing

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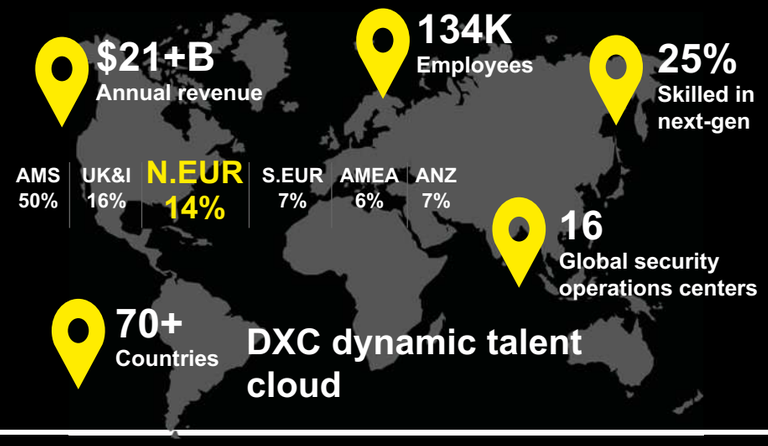
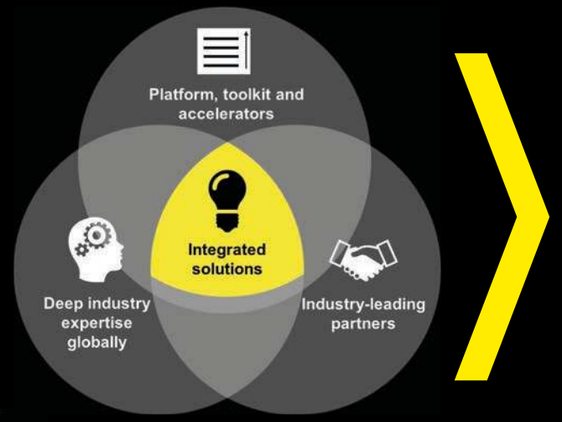
Scale & Skills



DXC Value for AD



Accelerate time to market

Reduce cost and risk

Improve market leadership

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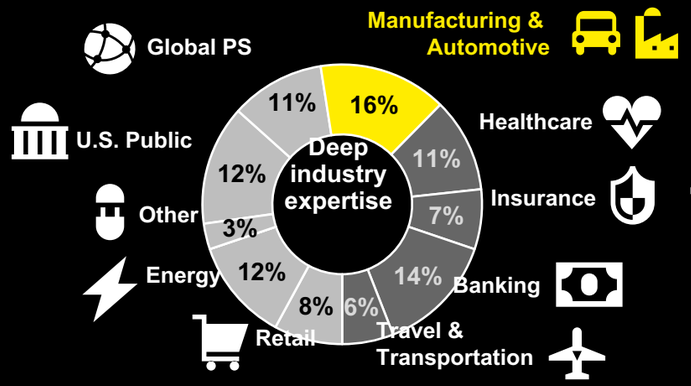
Customer Intimacy



Excellent client coverage across the globe …

~6,000 Clients

200+ F500 clients

36 NPS

… enhanced through world-class partner network

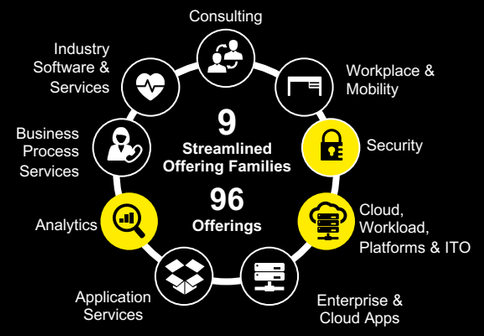
Technology-Driven Innovation

$4B Digital revenue

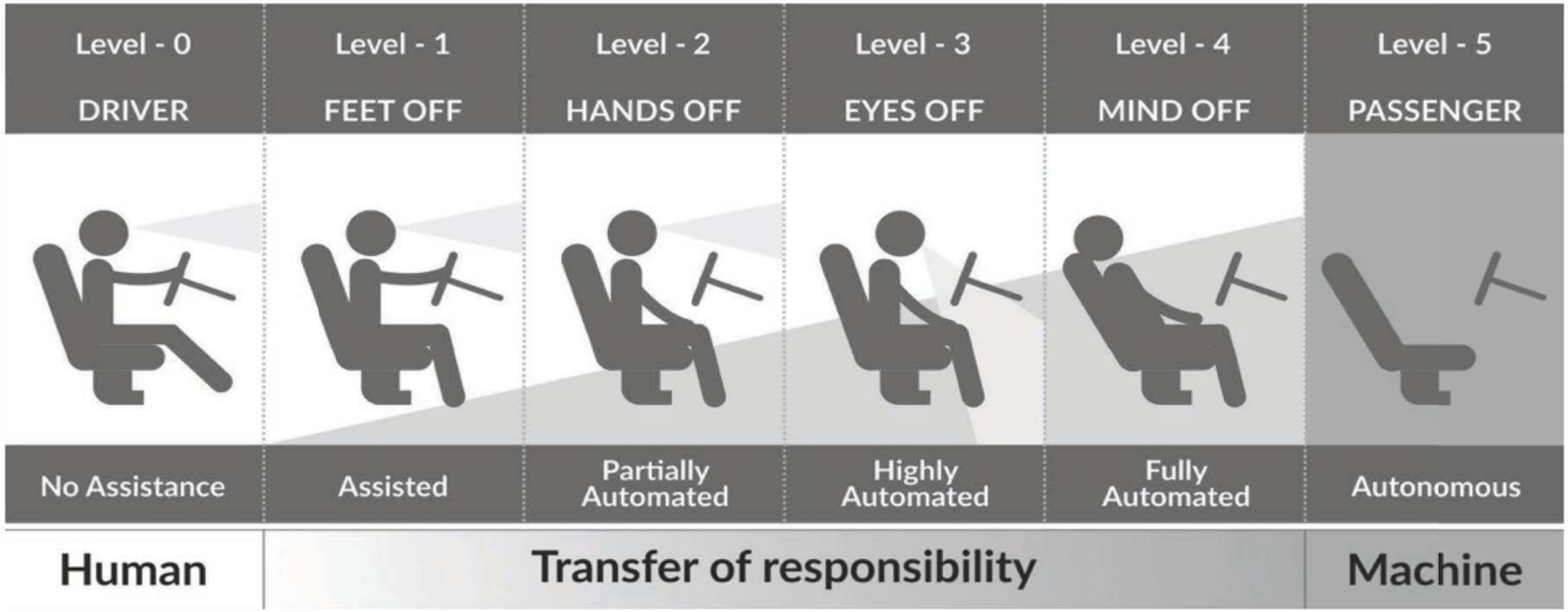
250+ global partners

14 strategic co-investing partners

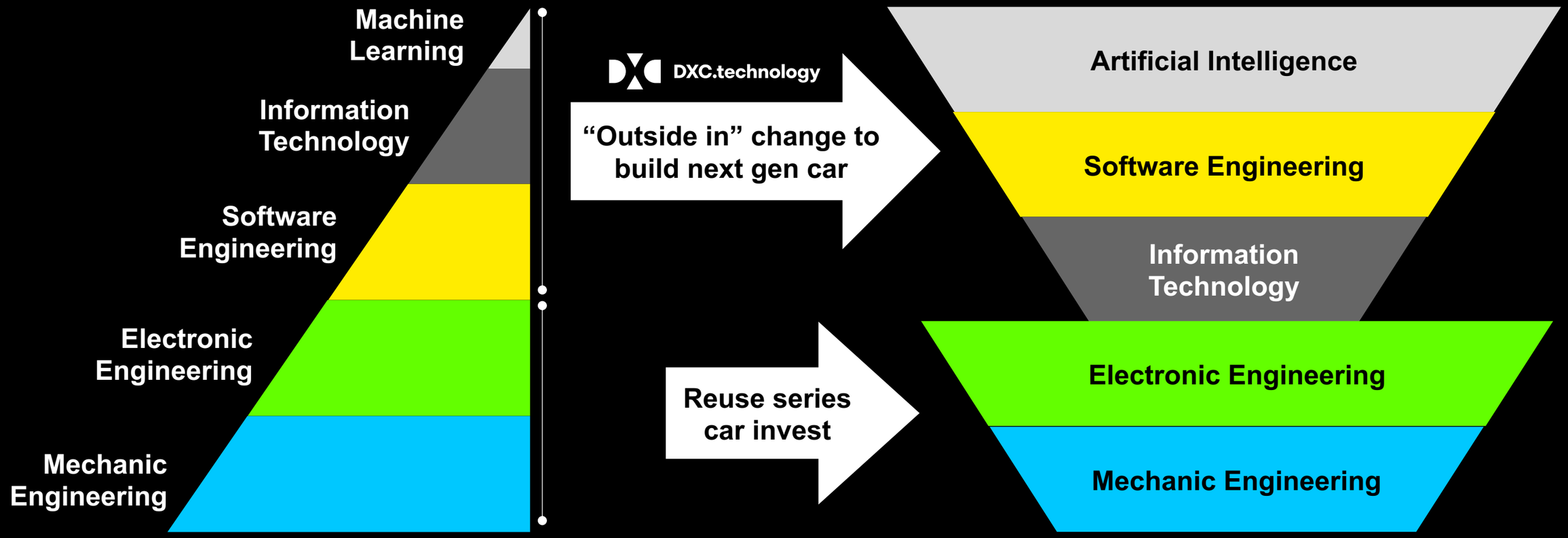
Streamlined offerings



Autonomous Driving



R&D in Automotive Industry – Capabilities are Changing



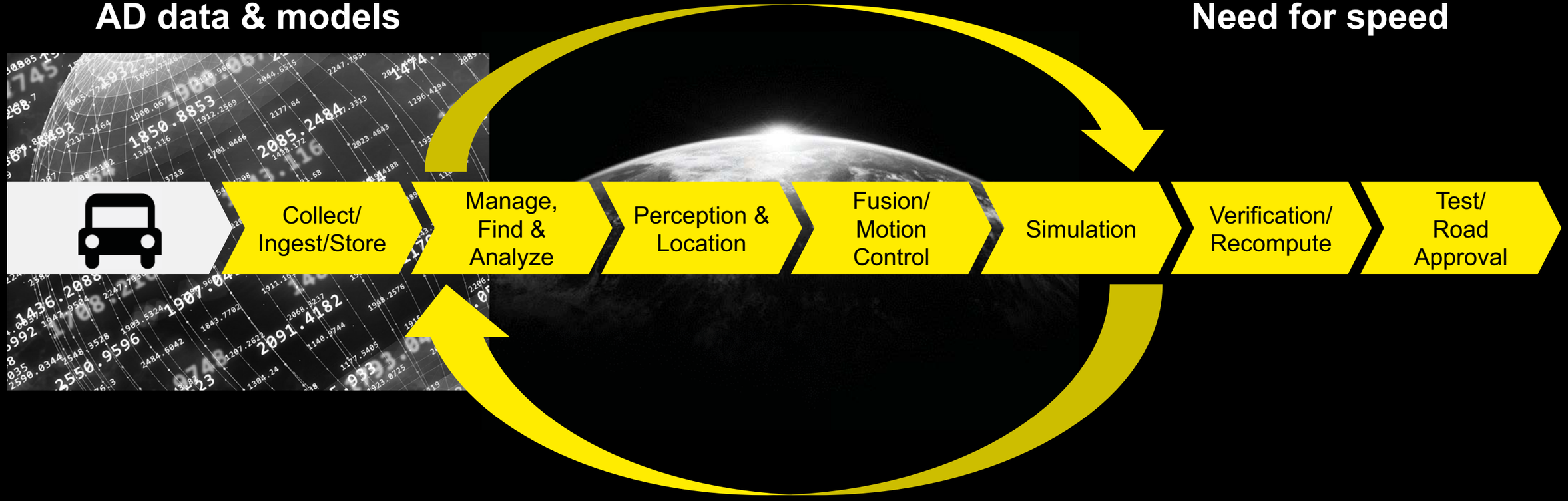
Extend & reuse current mechanic engineering capability combined with artificial intelligence, software building and IT is important to survive

Requires an end-to-end data and AI capability ecosystem for AD development

Geographically distributed R&D teams

AD data & models

Need for speed



HIGH PERFORMANCE DATA DRIVEN DEVELOPMENT PLATFORM

FACTS & FIGURES

- >200 PB superconverged
- >100.000 processor cores
- Setup in only 3 months
- >200 GPUs
- 96 x 100 Gpbs to ADC
- >1.150 m²
- >2.3 MW
- Multi-tenancy

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TECHNOLOGY STACK

Business Organizations

Data Ingest

Data Source

Visualization Collaboration	jupyter, Apache Zeppelin, Confluence, Jira Software
Analytics Deep Learning	TensorFlow, Kubeflow, Spark Streaming, Spark, APACHE DRILL, HIVE, elasticsearch, hadoop
Abstraction Orchestration	Apache Airflow, APACHE HBASE API, kafka API, HDFS API, YAML Azure Pipelines
Storage	ceph, MAPR DATA FABRIC for Kubernetes, MAPR-DB, MAPR-ES, MAPR-XD
Virtualization OS	OPENSHIFT, Red Hat
Infrastructure	Hewlett Packard Enterprise, DELL EMC, NVIDIA, Azure

Security

clair, Active Directory, LDAP, Secure Cluster, MAPR

Monitoring Deployment Automation

Grafana, kibana, Jenkins, Nexus, Azure DevOps, sonarqube, beats, logstash, elasticsearch, Prometheus, OPENTSDB, ANSIBLE

Autonomous Driving with Airflow – In a Nutshell (1/3)

- **Airflow on OpenShift**
  - 1 scheduler instance – big risk
  - Multiple webservers – load balanced (Rest API Calls)
  - Numerous workers – multiple queues

- **Automated deployment via Helm charts**
  - Various configurations for different instances (also different Airflow versions)
  - History tracking via version control

- **On-demand Airflow instances (ex: development purposes, isolated testing – on a service level)**

Autonomous Driving with Airflow – In a Nutshell (2/3)

- **Integration with the Data and Storage Platform – MapR**
  - Loading DAGs from different locations
  - Loading job configurations, used by the different operators

- **Integration with the Compute Platform – OpenShift**
  - KubernetesPodOperator
  - KubernetesExecutor

Autonomous Driving with Airflow – In a Nutshell (3/3)

- **Metrics Collection & Monitoring**
  - StatsD → Prometheus → Grafana
- **Log collection and aggregation: ElasticSearch + Kibana**
- **Large scale orchestration: aiming at orchestrating jobs at the scale of 100,000's / month**
  - Ingestion, simulation, reprocesssing, machine learning, …etc
  - Complex DAG dependencies

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Apache Airflow - Robotic Drive orchestrator

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Platform Orchestration Requirements

- Open Source
- Scalability
- Easy to adapt / extend
- Active community

What do we Orchestrate?

- Data Ingestion
- Machine Learning
- Reprocessing
- Simulation Jobs

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Journey from PoC to Production

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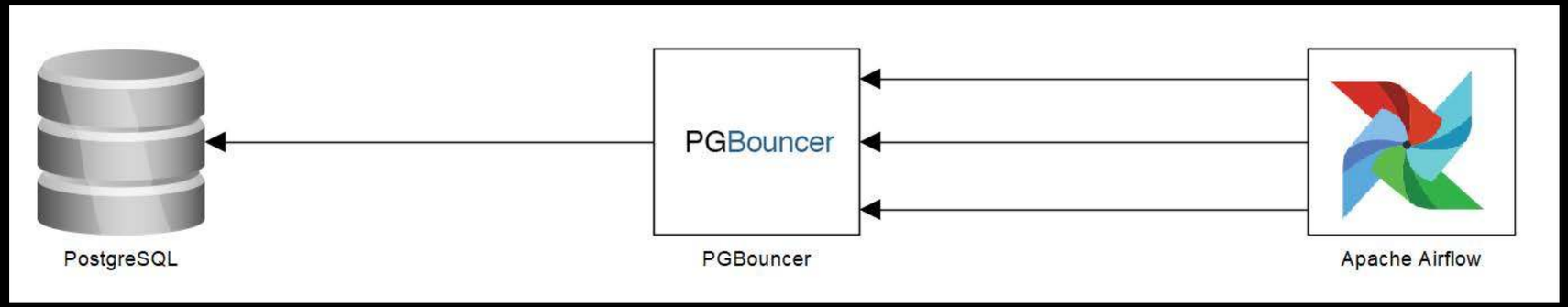
Airflow at Robotic Drive – the beginnings

- Initial work started at Q2 2019
- Airflow 1.10.2 with CeleryExecutor
- PostgreSQL 9.4
- RabbitMQ

Technical Challenges and Lessons Learned

- **Airflow stress and scalability tests**

- **Bottlenecks in the Architecture:**
  - PostgreSQL connection scalability: directly proportional relationship between number of running tasks and database connections
  - Scheduler configuration & performance



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Tailor-made Solutions

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Operators / Hooks Customizations (1/3)

Customization and standardization of SparkSubmitOperator

Included „properties_file” in operator constructor

- Spark application configuration can be provided via separate properties file
- It allows submitting jobs via Airflow, in the same fashion as submitting them standalone from the Hadoop cluster

Extend list of parameters where templating is supported

- Better DAGs reusability
- Reduced code duplication

Operators / Hooks Customizations (2/3)

Enrich Airflow logs by adding YARN application details for Spark jobs

- Correlation between Spark application (triggered by Airflow) and submitted YARN job is challenging to discover when using YARN cluster mode
- Out of the box: YARN Application ID logged in the task logs only when a YARN job fails
- Extension: Extract and log the following for all Spark tasks:

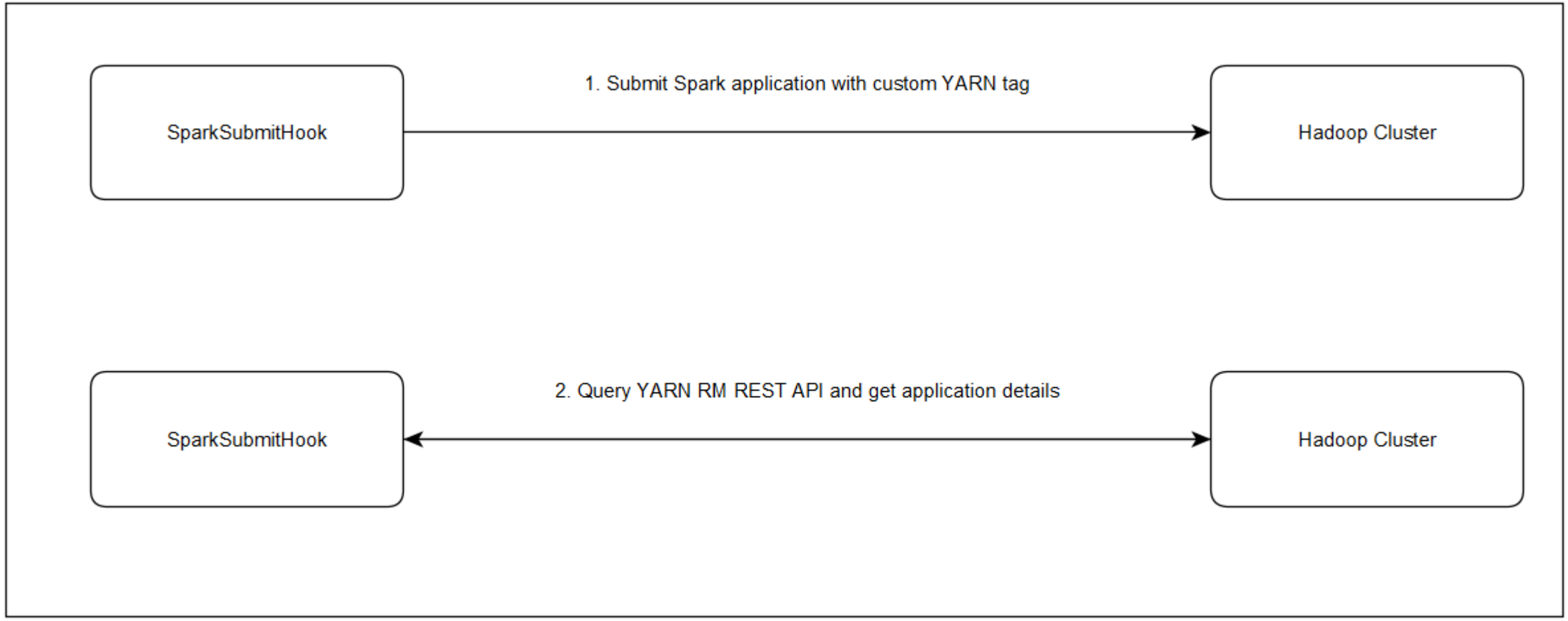
  1) YARN Application ID

  2) YARN Tracking URL

  3) Diagnostics (Failure root cause)

Operators / Hooks Customizations (3/3)

YARN application details visible in Airflow logs for Spark jobs



Custom Authentication Methods

LDAP Secured REST API

- REST API usage allowed only for dedicated AD role
- Complete integration with LDAP
- Only one role specified for REST API – no separation between endpoints so far

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Airflow in Production

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Production-ready Airflow instances

Robotic Drive supports by default 3 main instances used in the platform:

- **Development** (used mostly to test new Airflow deployments / features)
- **Staging** (testing new DAGs)
- **Production** (for full production usage)

Current stable setup is created using **Airflow 1.10.10** and **Celery Executor**

User-based Airflow instances

- Deployment automated via **Helm Charts**
- Airflow created as a Kubernetes project

These 2 points makes it possible to fully parametrize Airflow deployment and create many Airflow instances on-demand. In the Robotic Drive Platform each user is able to create their own, separate Airflow instance.

It helps to eliminate problems related to testing new DAGs, Operators and other features and changes that might impact other users, especially when multiple developers are working on the same component.

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Monitoring Airflow

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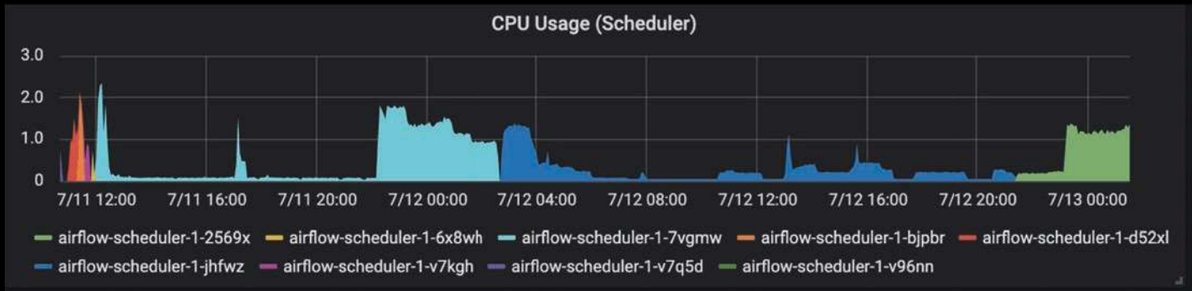
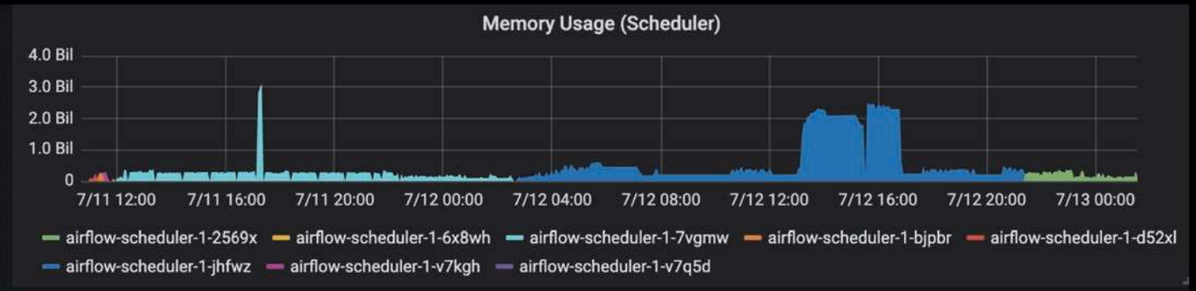
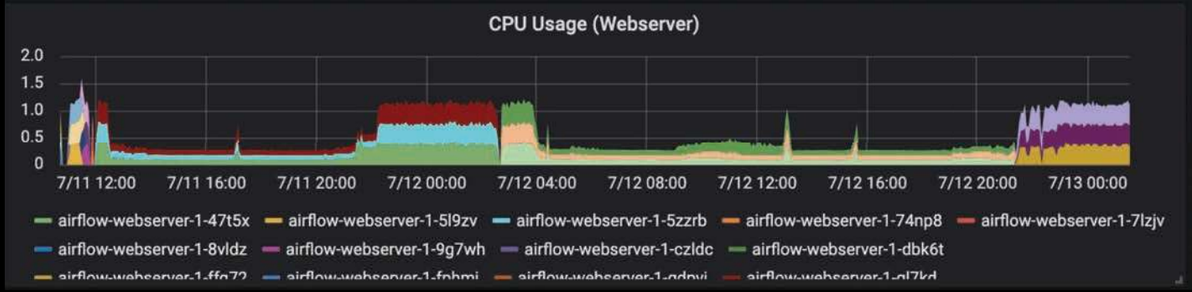
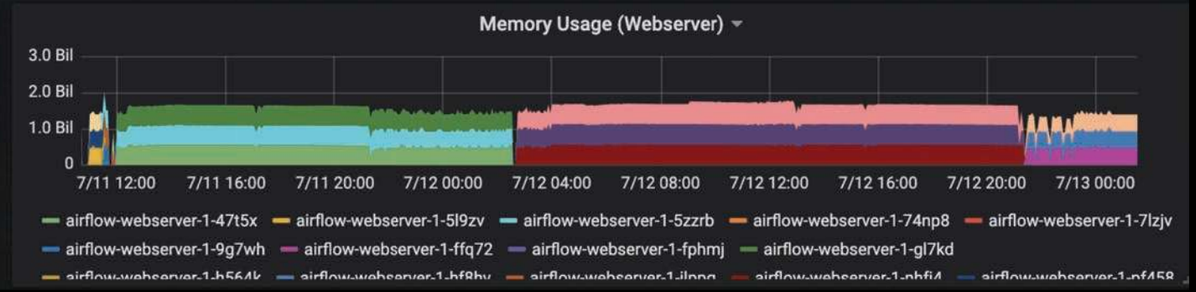
Monitoring Airflow

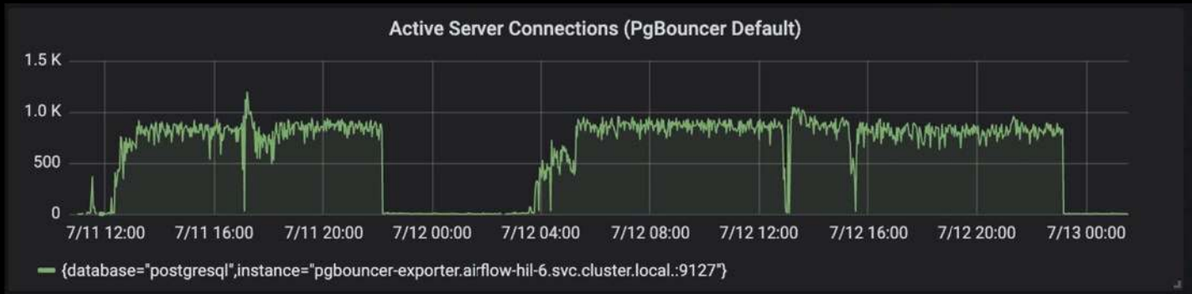


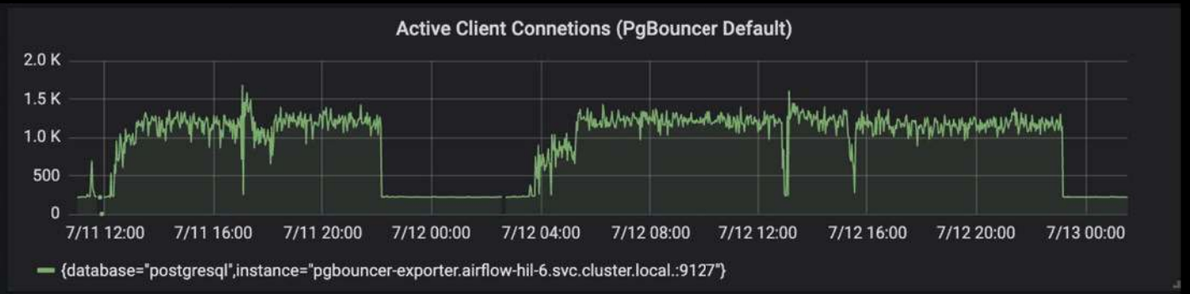


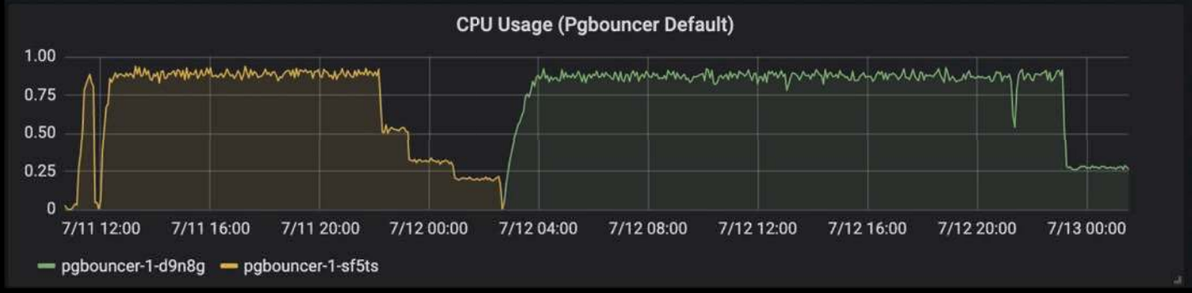


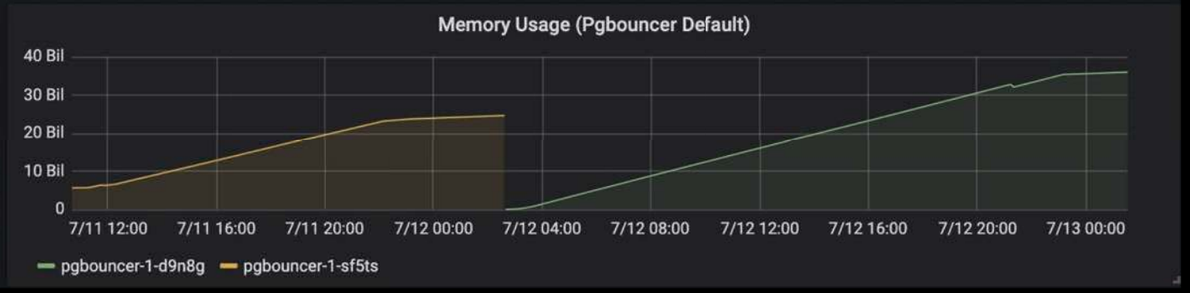


Monitoring Airflow

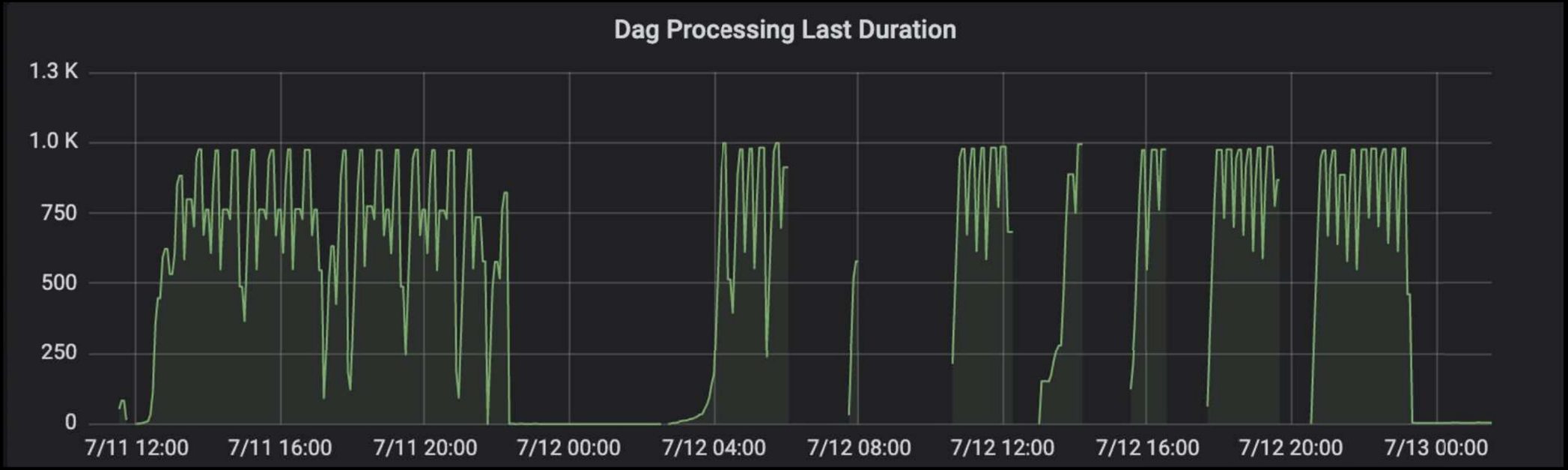








Monitoring Airflow



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What’s next?

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Looking forward to…

- Airflow 2.0: HA Scheduler + Performance Optimizations
- Advanced Authentication + Authorization
- Extend and stabilize monitoring metrics
- Stable API vs Experimental API

Q&A

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