AWS re:Invent

BLC203

Why you need a ledger database: BMW, DVLA, and Sage discuss their use cases

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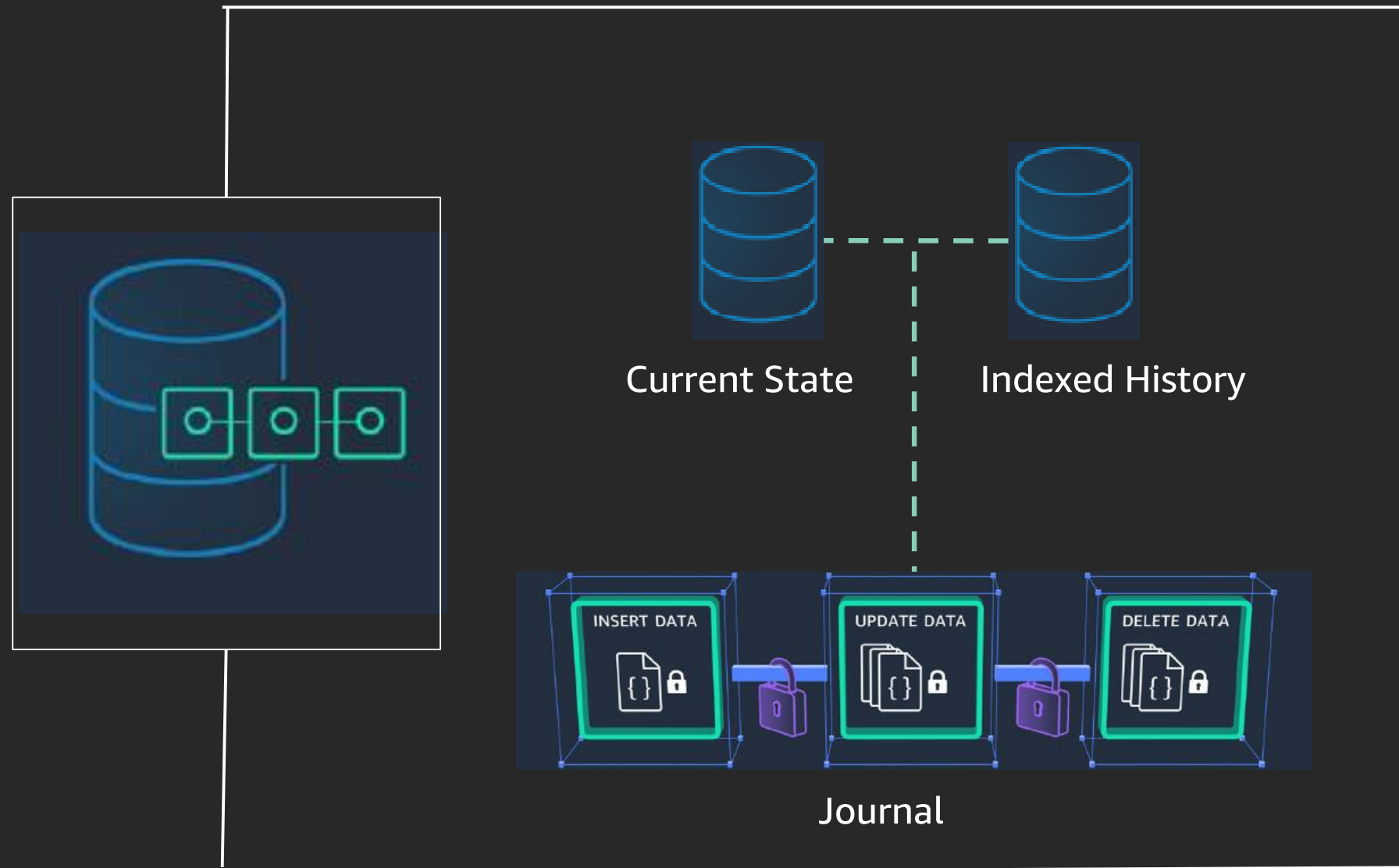Sage Group Plc

AWS re:Invent

aws

Why did we build a ledger database?

Professionals use purpose-built tools
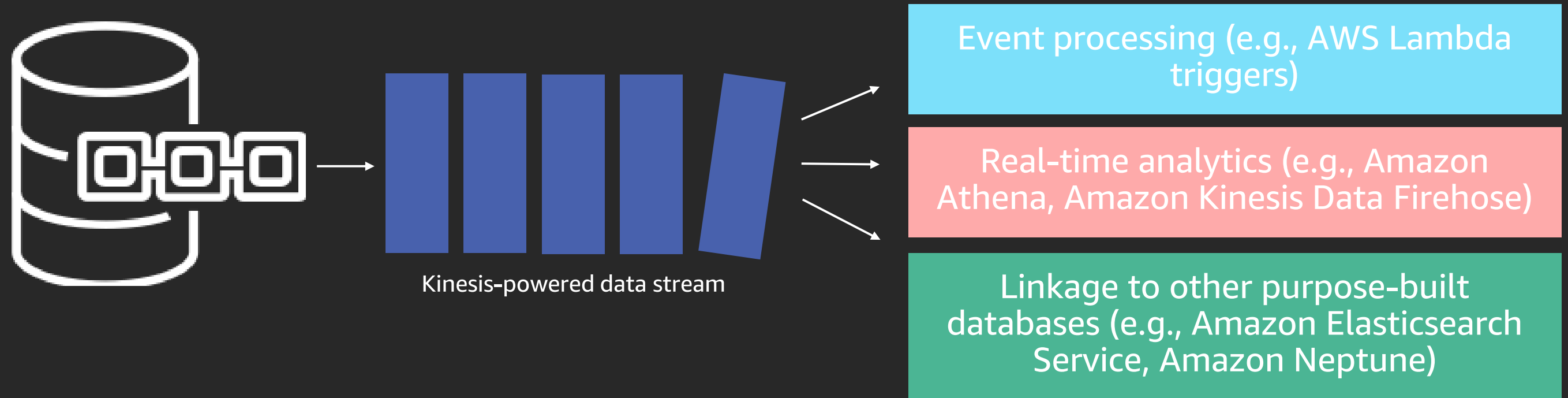
to reduce time, lower total cost, and get better quality

Amazon Quantum Ledger Database (Amazon QLDB)
A first-of-its-kind, purpose-built ledger database

Current State

Indexed History

INSERT DATA {}

UPDATE DATA {}

DELETE DATA {}

Journal

- ✓ Journal-first
- ✓ Immutable
- ✓ Serializable ACID txns
- ✓ Verifiable
- ✓ Document data model
- ✓ SQL-like query
- ✓ Serverless and Scalable

Announcing private preview of Amazon QLDB streaming

Kinesis-powered data stream

Event processing (e.g., AWS Lambda triggers)

Real-time analytics (e.g., Amazon Athena, Amazon Kinesis Data Firehose)

Linkage to other purpose-built databases (e.g., Amazon Elasticsearch Service, Amazon Neptune)

To get started, email: qldb-outbound@amazon.com

BMW use case: Leveraging Amazon QLDB as a trusted verifiable ledger for automotive data

ACES: The core elements of future mobility
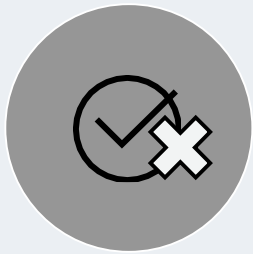

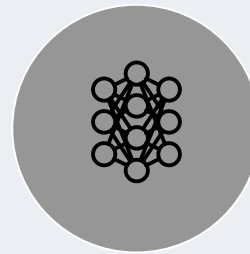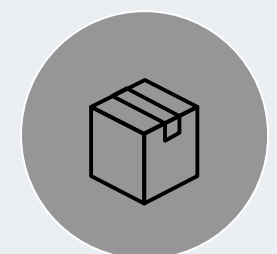A — Autonomous

C — Connected

E — Electrified

S — Services

Challenges in automotive value chain

Data must be verified and auditable

Multiple organizations and partners involved

Ensure customer privacy

Ledger technologies enable end-to-end data management with verification built in at every stage.

Ledger technologies enable great opportunities along the automotive value chain

SUPPLY CHAIN & PRODUCTION

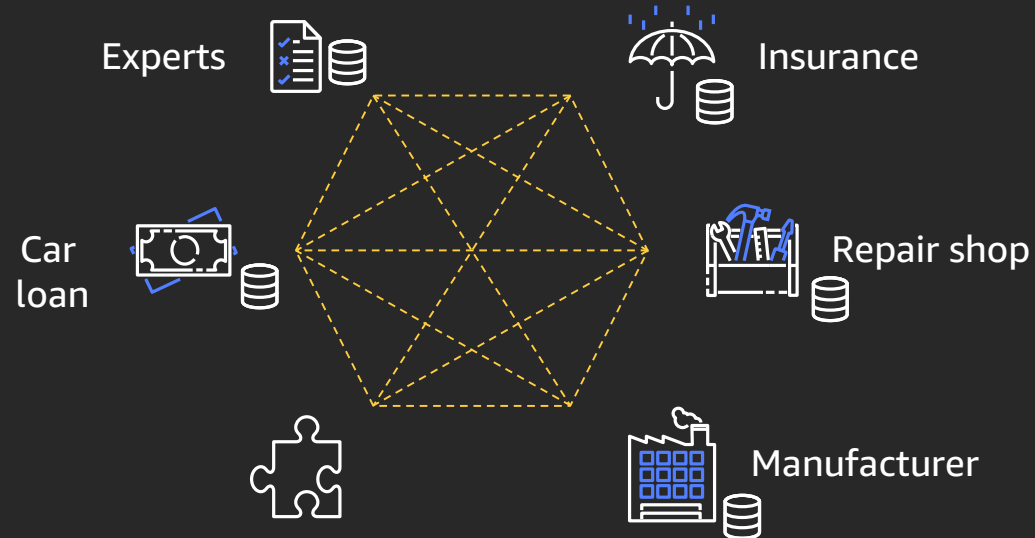**VEHICLE**

ARTIFICIAL INTELLIGENCE

Verifiable data provenance

Vehicle and mobility ecosystems are complex
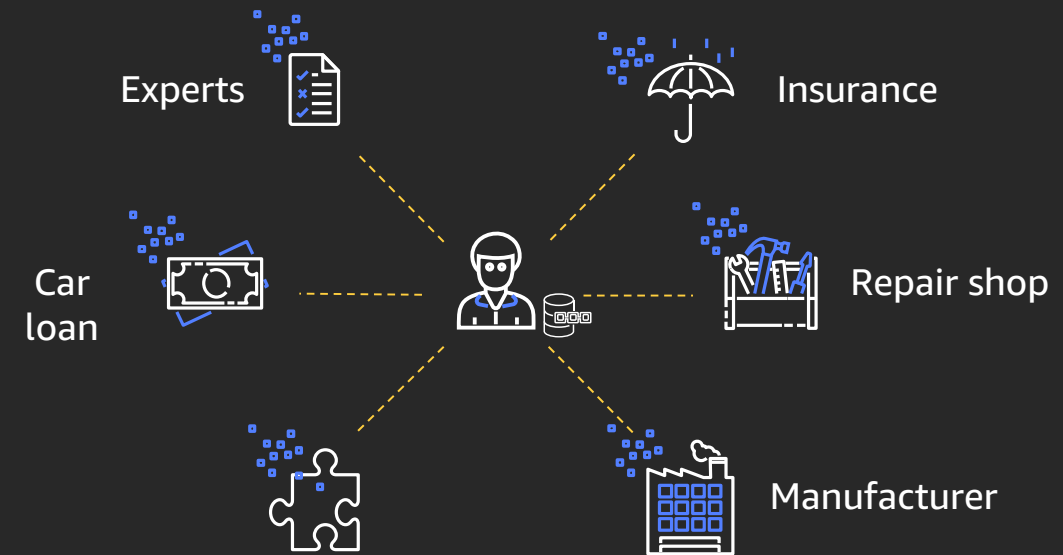## Trusted, verifiable data is the key

Current model

Experts

Insurance

Car loan

Repair shop

Manufacturer

VS

Target model

Experts

Insurance

Car loan

Repair shop

Manufacturer

Challenges
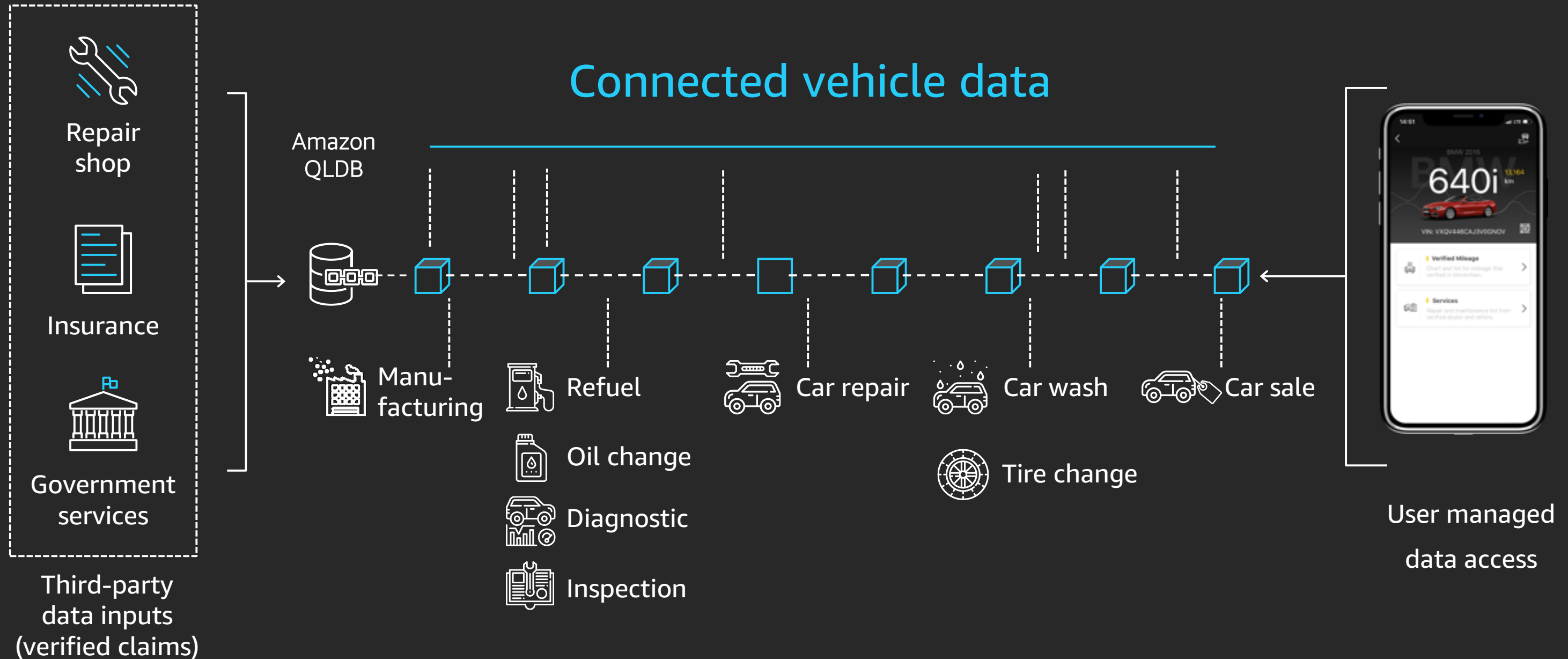
Disparate, closed systems

Non-integrated data/information

Hard to verify data integrity

Solutions

Integrated application

Full transparency on transactions across multiple entities

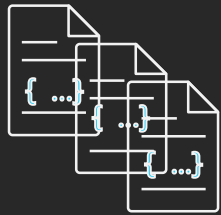Ability to trust, but verify that info was not tampered with

Trusted vehicle data: the foundation of ecosystems
Powered by a centralized ledger, Amazon QLDB

Connected vehicle data

Repair shop

Insurance

Government services

Third-party data inputs (verified claims)

Amazon QLDB

Manu-facturing

Refuel

Oil change

Diagnostic

Inspection

Car repair

Car wash

Tire change

Car sale

User managed data access

Amazon QLDB as enabler for automotive data ecosystems

Historical data

Trusted, verifiable, data

Scalability

Ease of use
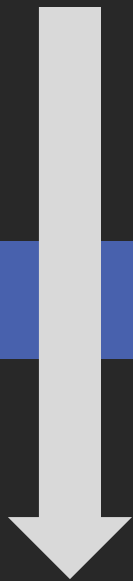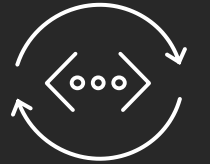
Amazon
QLDB

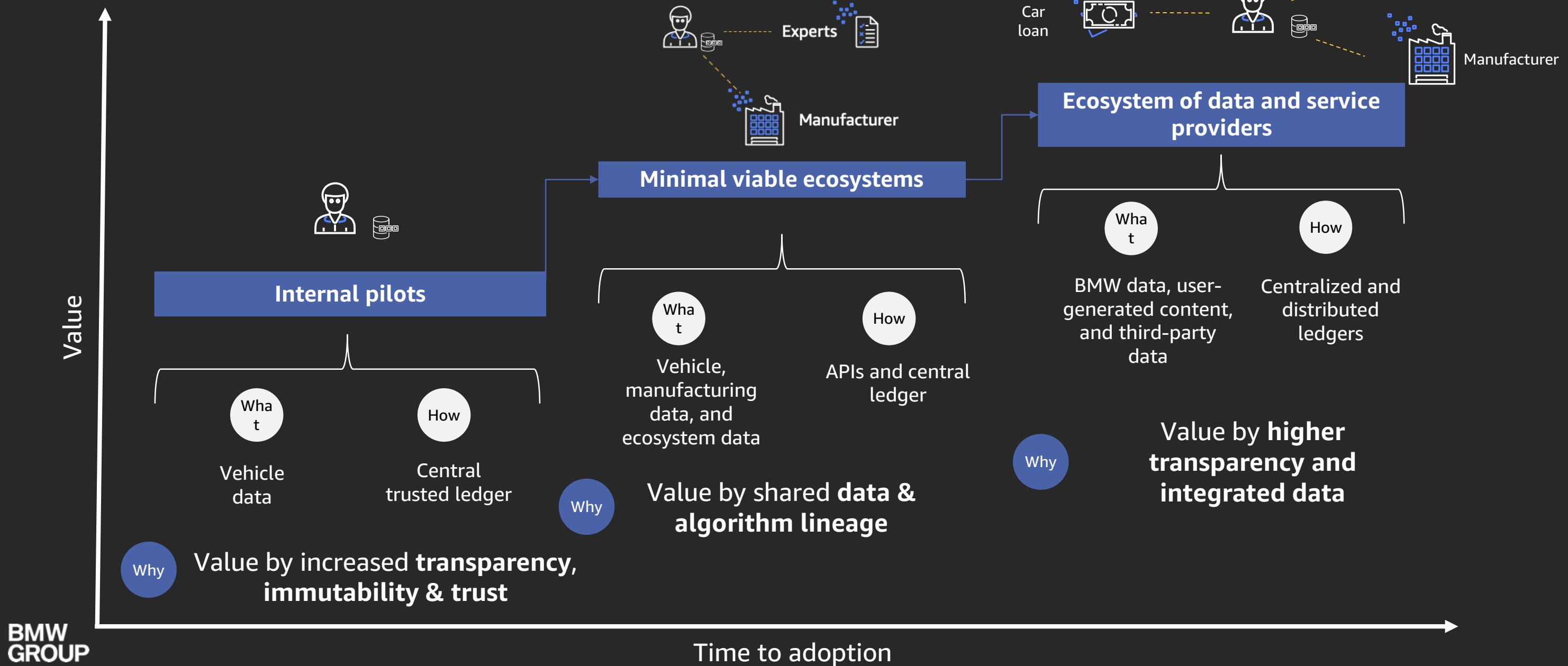**Journaled data revisions**

Cryptographic hashing/ verification

Higher throughput than decentralized ledgers

Serverless, Schema-less design, SQL-like, ACID

Roadmap: automotive ecosystems on ledgers

Value

Time to adoption

Internal pilots

What — Vehicle data

How — Central trusted ledger

Why — Value by increased **transparency, immutability & trust**

Minimal viable ecosystems

What — Vehicle, manufacturing data, and ecosystem data

How — APIs and central ledger

Why — Value by shared **data & algorithm lineage**

Ecosystem of data and service providers

What — BMW data, user-generated content, and third-party data

How — Centralized and distributed ledgers

Why — Value by **higher transparency and integrated data**

Experts

Manufacturer

Car loan

Insurance

Repair shop

BMW GROUP

Sage use case: Resolving the trust crisis in B2B automation through an open Trust Fabric

aws

Sage in numbers

A global market leader for technology that helps small and medium businesses and nonprofits to manage finances, operations, and people.

13,000 colleagues
Presence in 23 countries
Market cap of >$10bn
Revenues of $2.3bn

28M
Over 28M people paid through Sage Payroll worldwide (1 in 3 UK)

2.2M+
Sage ID accounts and 820,000 unique logins per months

3M
Over 3M business customers worldwide

$4.2T
Move annually through Sage software

13B
Invoices sent and received by Sage customers annually

Founded 1981
By a British business entrepreneur working with a team of Newcastle University students and a former NASA scientist

74 TB+
Financial data and > 6B journal entries in Sage Intacct alone

Sage Business Cloud
Digital environment of cloud native apps and services, also supporting connected apps
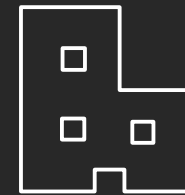
Business requires trust

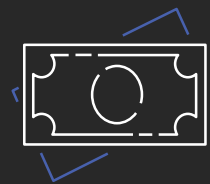## Implied trust is at the heart of Sage's brand promise:
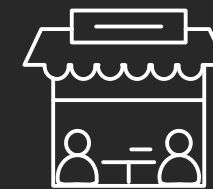
Banks/Payment

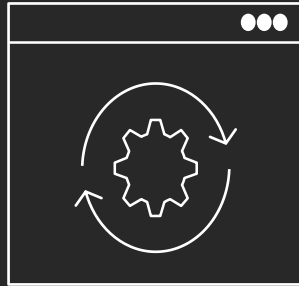**Tax authorities**

Mortgage lenders

HR/Payroll

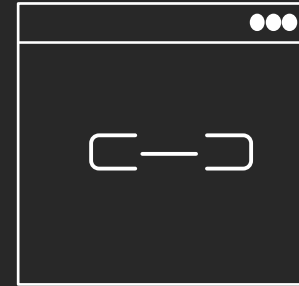**Accountants**

Customers receivable

The trust crisis in ML/AI automation

Many business and accounting processes can be automated especially through machine learning/artificial intelligence:

Automate accounts payable
- **Reduce errors**
- **Save time**
- **Improve internal controls**

Linking accounts receivable

- Frictionless ecommerce
- Optimize cash flow

However, if trust between parties is implicit and dependent on contextual knowledge, how can automation ever become pervasive and universal?

Trust authority vs trust facilitation

Overcoming the trust challenge with conventional trading platforms that act as trust "authorities":

Works for large organizations BUT discriminates against smaller participants

Does NOT embrace networks that already exist, it creates yet another

Requires participants to share trade-confidential information, e.g., who trades with whom, when, and at what price and quantity

Could trust(worthiness) be determined from existing network and facilitated rather than assigned?

Introducing Trust Fabric

A technology to facilitate trust within existing networks:

Mapping relationships with implied trust to a crypto-graphically secure fabric

Allowing businesses to connect, transact, process, and automate with confidence

Tax authorities

Banks

Businesses

Trust fabric

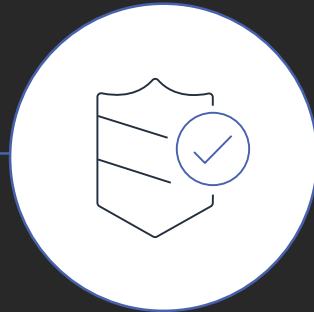Employees

Sage accounting

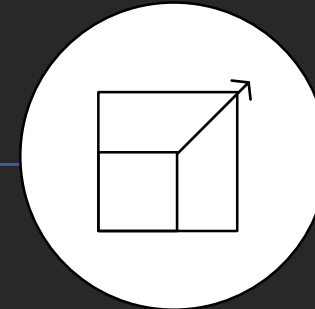Sage payroll
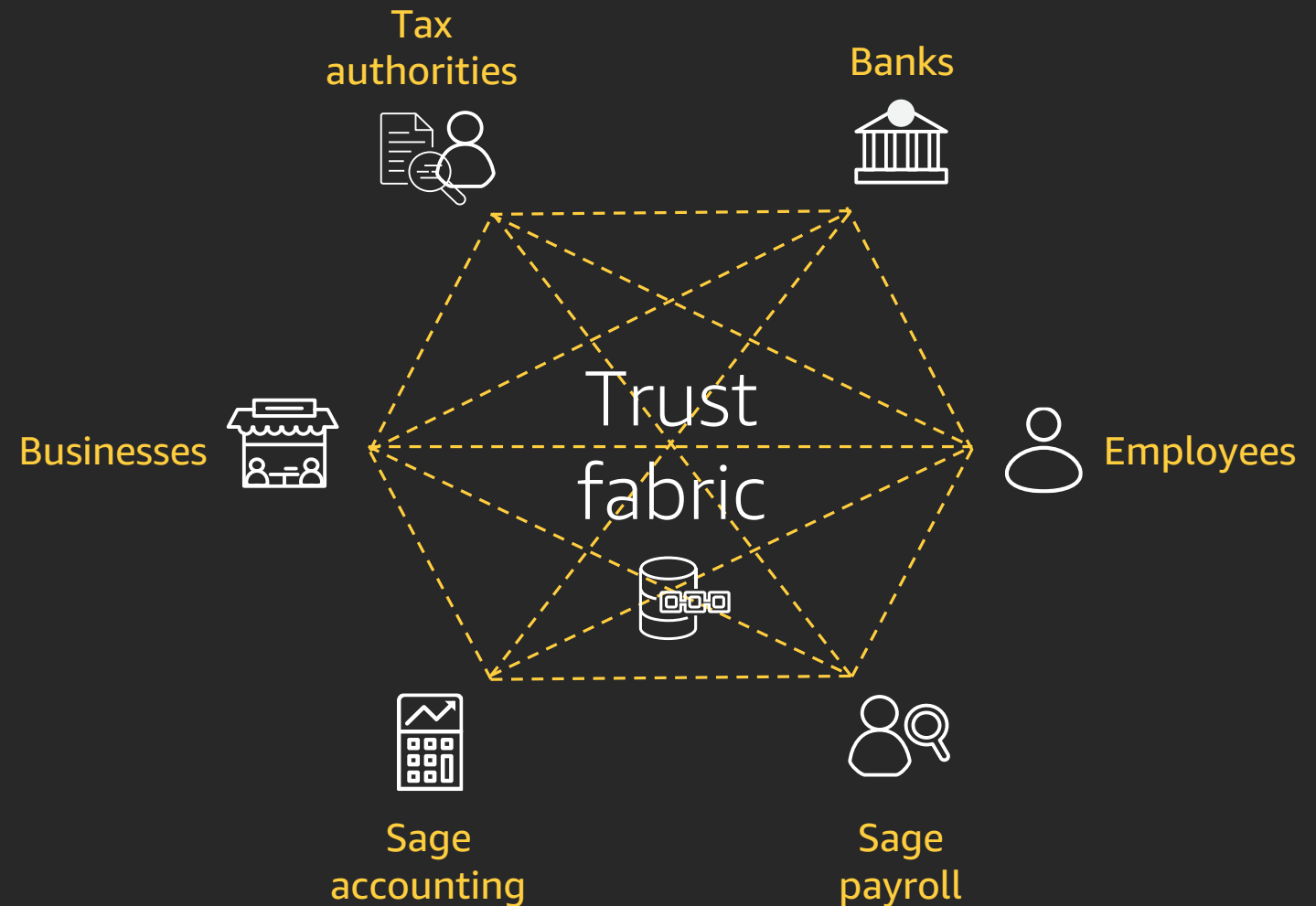
Fundamental purpose

For any given business transaction represented by a JSON document, the Trust Fabric provides:
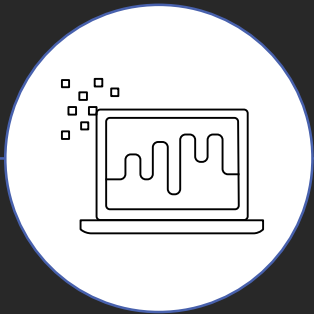
Provenance of the document, i.e., who within the Fabric created it

Actuality of the document, i.e., what point in time it existed

Integrity of the document, i.e., that it wasn't tampered with by a rogue actor

Assertions recorded against the document subsequently

Making trust programmable

✓ Reduce invoice fraud

✓ Automate AP reconciliation and payment process

✓ Automate financial audits

✓ Verify a payslip for a mortgage application

✓ Provide proof when a tax return was filed

✓ Allow a business loan to be registered against an invoice

How the Trust Fabric works

Scenario: Multitenant accounting application (e.g., Sage Business Cloud Accounting) with electronic tax filing, banking, and payment services

The sender's application records in the trust ledger of the Trust Fabric service:

1. Company profile for each tenant plus optional network-based assurances ("has last filed with tax authority on")

2. Hash for business transaction documents, e.g., sales invoices, linked to the originating company profile
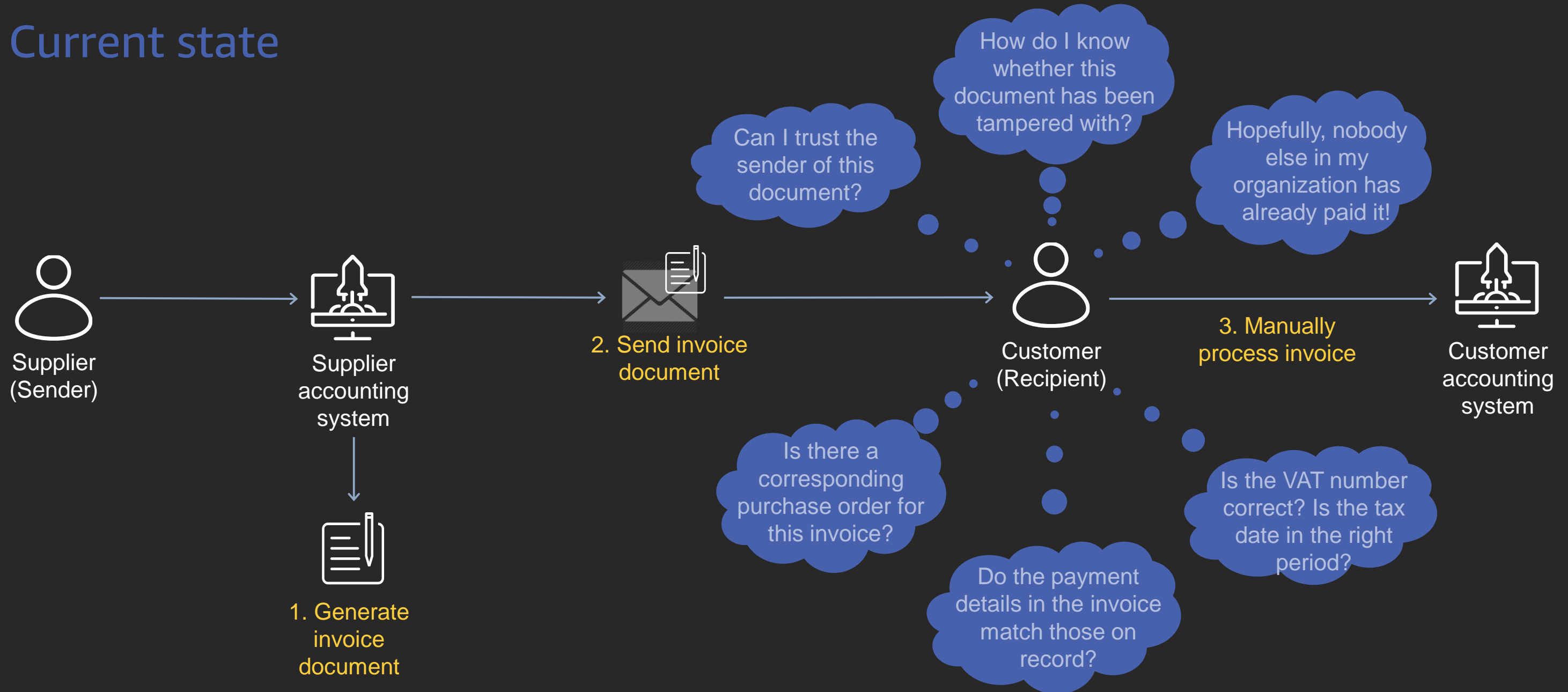
The recipient of a sales invoice:

1. Re-calculates the document hash

2. Presents the hash to a public endpoint of the issuing Trust Fabric, e.g., https://trust.sage.com

3. Gets back timestamp, profile of the issuer, and any subsequent events recorded against the document for a hash previously recorded in the trust ledger

Document confidentiality is maintained throughout the process. The recipient does not need to be a member of the Trust Fabric.
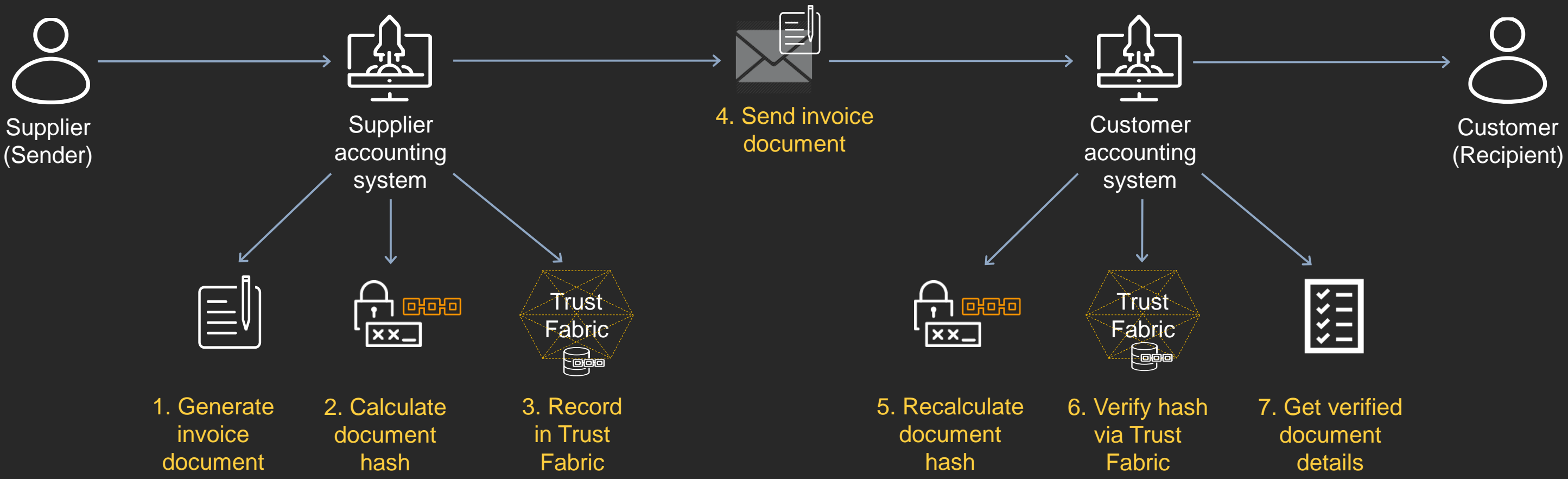
B2B document exchange use case

Current state

B2B document exchange use case

Powered by Trust Fabric/Amazon QLDB

Supplier (Sender)

Supplier accounting system

4. Send invoice document

Customer accounting system

Customer (Recipient)

1. Generate invoice document

2. Calculate document hash

Trust Fabric

3. Record in Trust Fabric

5. Recalculate document hash

Trust Fabric

6. Verify hash via Trust Fabric

7. Get verified document details

Advanced Trust Fabric concepts

Document assertions

- Assertions are entries in the trust ledger against an existing document, for instance to record a simple status (e.g., "paid"), a note (e.g., "goods received damaged"), or a cross-reference to another document in the ledger (e.g., credit note)

- Assertions can be recorded by any application in the Trust Fabric for a member in possession of the document hash

- Assertions are disclosed during document verification

Federation of Trust Fabrics

- To improve interoperability between Trust Fabrics, specifically to support workflows through document assertions across different trust domains

- Secured by mutual authentication at Trust Fabric level

The case for Amazon QLDB

Why is Amazon QLDB preferable to traditional blockchain (classic)?

Amazon
QLDB

➢ The integrity and auditability of a Trust Fabric is predicated on a trust ledger that is cryptographically secure and immutable.

➢ A Trust Fabric adds a trust layer to an existing, managed network. It is from the outset a centralized trusted entity, and does not require decentralized ledger and consensus capabilities.

➢ Amazon QLDB greatly outperforms a private blockchain in terms of performance, cost to serve, and carbon footprint.

➢ SQL querying is a good fit for the trust ledger design.

Call to action

➢ Businesses face a trust crisis that overshadows the progress of ML/AI.

➢ Trust Fabric is a technology to facilitate trust, first and foremost, within the Sage customer community.

➢ No vendor is an island. Sage would love to see wider industry adoption of an open Trust Fabric concept.

➢ In Amazon QLDB, the Trust Fabric has a potent technology partner.

➢ Provided sufficient interest, Sage will contribute relevant code and specifications to open source/creative commons.

DVLA ledger use case

aws

Driver and Vehicle Licensing Agency

Driver & Vehicle
Licensing
Agency

- Register drivers and vehicles

- Issue driver and vehicle documentation

- Collect Vehicle Excise Duty

Our goal is to get the right drivers and vehicles taxed and on the road, as simply, safely, and efficiently as possible

Central authority for canonical registers

Driver & Vehicle Licensing Agency

- Responsible for integrity and accuracy of record

Trailer
14,000
active records

Tachograph
~785K
Driver tachograph cards

VRN
~65M
unallocated

Sold > 5.7m

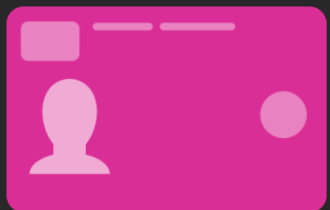Raised > £2.7bn

Vehicle
42.7M
active records

47.1M
licensing tx in 2018/19

~£6B
collected in VED

Driver
49.0M
active records

10.6M
driving licenses issued 2018/19

Business challenges

Growing demand for data

Clean air zones, parking permit, car sharing schemes, identity verification

Evolving dataset

Electric vehicles, connected vehicles, and smarter transport bring new data attributes

Data provenance

Need to uphold and prove accuracy of data through custom audit tables

Architectural principles and techniques
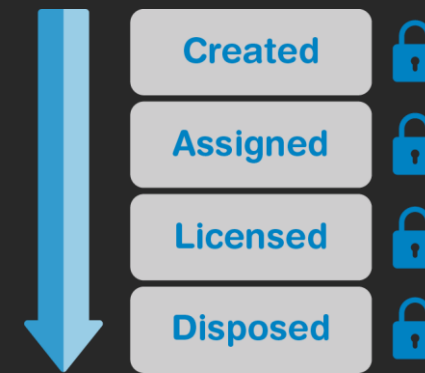
Driver & Vehicle Licensing Agency

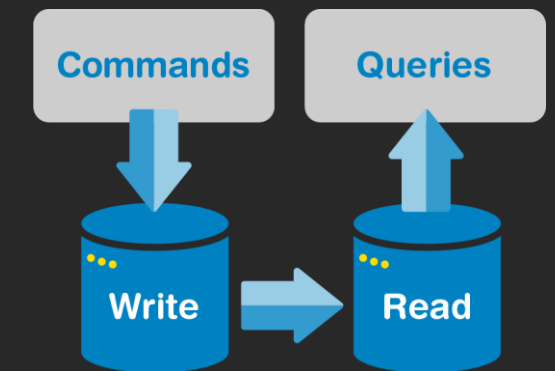## Domain-driven design

Focus on domain model

Immutable data

Accurate and irrefutable

Event sourcing

Created

Assigned

Licensed

Disposed

Append only immutable events

CQRS

Commands

Queries

Write

Read

Separate writes from reads

Event sourcing and CQRS

Citizens

Corporate

OGD

Systems

AssignKeeper

Business Domain

Enquiry Domain

Command Handler

Query Handler

Query Handler

KeeperAssigned

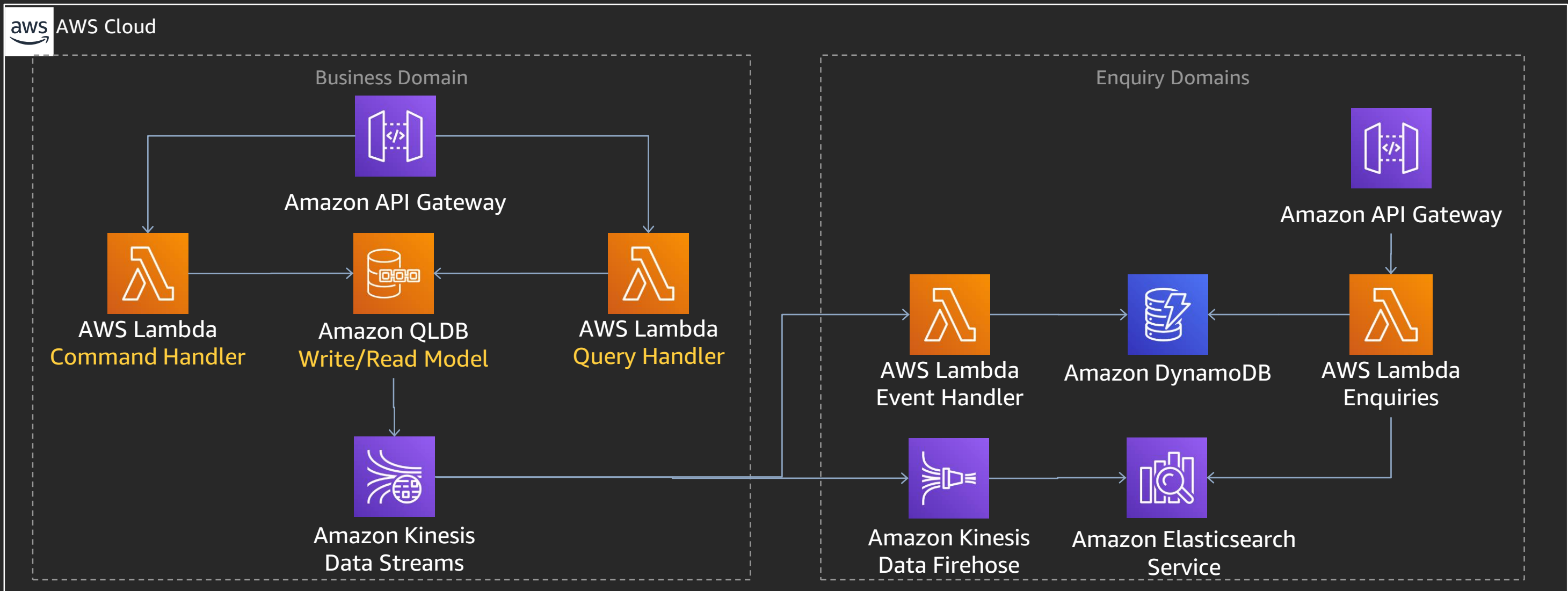Write Model

Read Model

Read Model

Event Handler
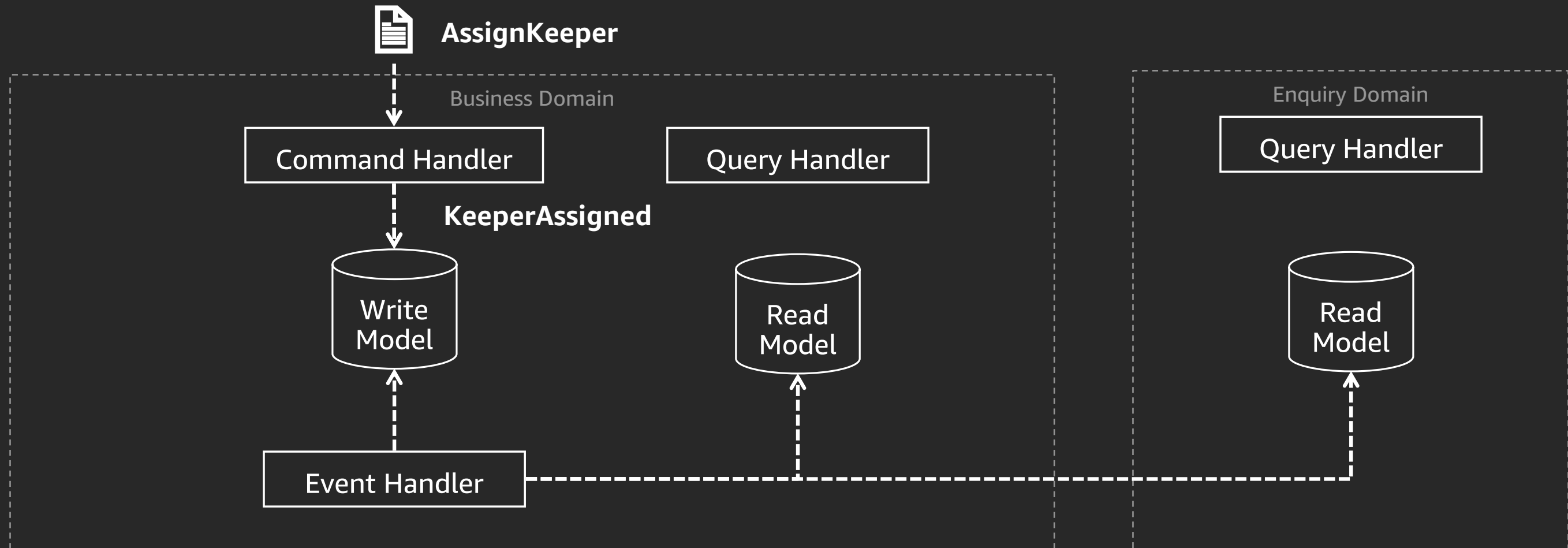
Current state architecture
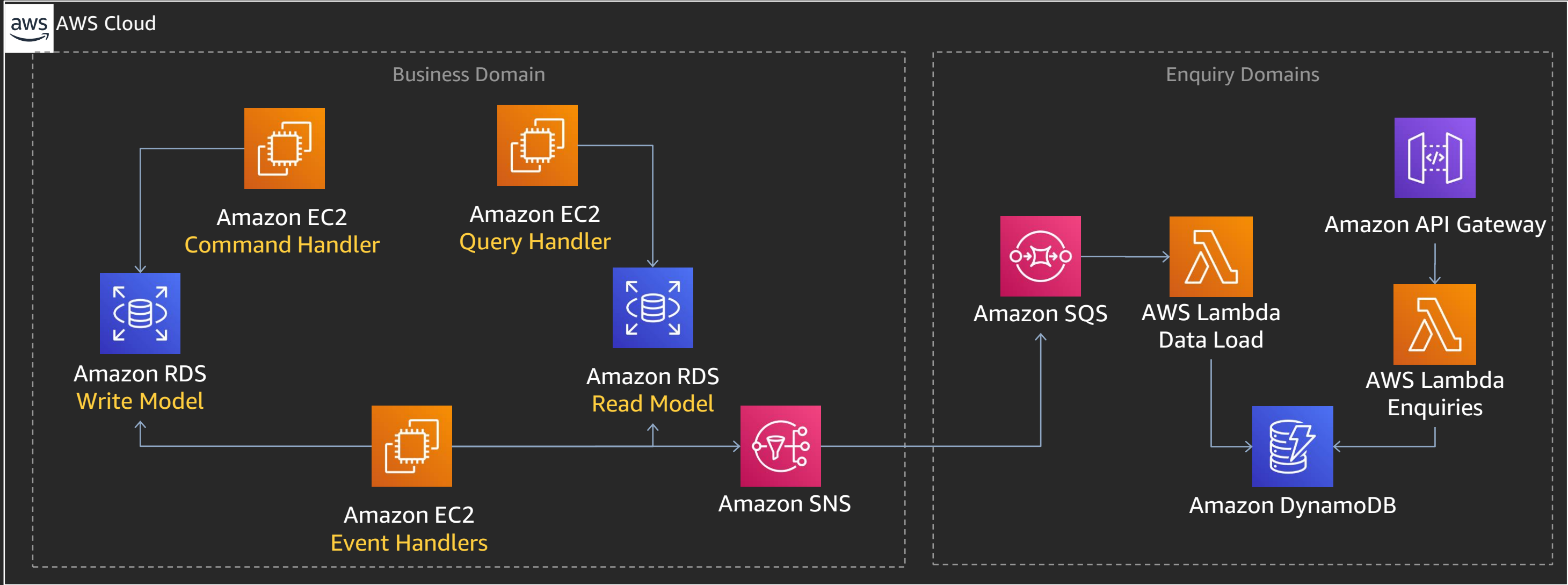
Future state architecture

Key benefits of Amazon QLDB

- Immutable

- Journal, current state, history

- Cryptographically verified

- Familiar interaction model

- Streaming event trigger

- Serverless

Driver & Vehicle
Licensing
Agency

Q&A

Attend other QLDB sessions

DAT380 – Amazon QLDB: An engineer's deep dive on why this is a game changer (Breakout)
Wednesday, Dec 4, 2:30 PM - 3:30 PM – Venetian, Level 4, Delfino 4005

DAT352 – Building applications on Amazon QLDB (Workshop)
Thursday, Dec 5, 12:15 PM - 2:30 PM – Venetian, Level 4, Delfino 4003

BLC209 – Asset provenance ledger system based on Amazon QLDB: BMW's use case (Chalk talk)
Thursday, Dec 5, 1:00 PM - 2:00 PM – Venetian, Level 3, Murano 3301B

Meet us at our booth

- Come talk to our engineering and product teams and get answers to your questions

- Answer some trivia, and win an Amazon QLDB shirt!

- Venetian Expo Hall, AWS Village, Blockchain and Ledger Booth

Thank you!

aws

Please complete the session survey in the mobile app.