EDB Open Source
Learning Day

Running Postgres in Kubernetes

Jaime Silvela
Senior SDE, cloud-native core team

EDB™
POWER TO POSTGRES

About me

- Senior SDE, cloud native core team, EDB
- Previously, looong career
  - In USA: Microsoft, Wall Street
  - In Luxembourg: Amazon
  - In Dublin: catastrophe research
  - In Madrid: e-commerce startup
- Been a lover of Postgres since 2005
- And a lover of Go since 2014

Follow me: **@jsilvela**

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Kelsey Hightower
@kelseyhightower

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Kelsey Hightower ✓
@kelseyhightower

You can run databases on Kubernetes because it's fundamentally the same as running a database on a VM. The biggest challenge is understanding that rubbing Kubernetes on Postgres won't turn it into Cloud SQL. 🧵

Traduci il Tweet

Soham Dasgupta @thesobercoder · 10 feb

@kelseyhightower Bust a myth for us please - running any sort of database on a Kubernetes instance is bad idea. I've heard this enough times to actually start believing it. #kubernetes #mythbuster

Mostra questa discussione

5:21 PM · 10 feb 2023 · **318.944** visualizzazioni


Kelsey Hightower
@kelseyhightower
Kubernetes has made huge improvements in the ability to run stateful workloads including databases and message queues, but I still prefer not to run them on Kubernetes.
Traduci il Tweet
3:04 PM · 13 feb 2018


Kelsey Hightower
@kelseyhightower
Kubernetes supports stateful workloads; I don't.
3:26 PM 13 feb 2018

A majority (83%) attribute over 10% of their revenue to running data on Kubernetes

One-third of organizations saw their productivity increase twofold.

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Timeline and team involvement

- **2014**, June: Google open sources Kubernetes
- **2015**, July: Version 1.0 is released
- **2015**, July: Google and Linux Foundation start the CNCF
- **2016**, November: The **operator pattern** is introduced in a blog post
- **2018**, August: The Community takes the lead
- **2019**, April: Version 1.14 introduces **Local Persistent Volumes**
- **2019**, August: Cloud Native team 2nd Quadrant starts the Kubernetes initiative
- **2020**, June: we publish this blog about benchmarking local PVs on bare metal
- **2020**, June: Data on Kubernetes Community founded
- **2021**, February: EDB Cloud Native Postgres (CNP) 1.0 released
- **2022**, May: EDB donates CNP and open sources it under CloudNativePG

*"The **same** as running a **database** on a **VM**"*

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*I would add: "... provided **you ...**"*

- Know PostgreSQL
- Know Kubernetes
- Have a good **operator** like CloudNativePG

You = You organization, made up of one or more multidisciplinary teams

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#1 - The right architecture for Kubernetes

Kubernetes architectural concepts

- A Kubernetes Cluster (**k-cluster**)
- Availability zones (**AZ**)- also known as failure zones or data centers
  - Connected by redundant, low-latency, private network connectivity
  - At least 3 per k-cluster
- Kubernetes control plane to be distributed across the AZ
- Kubernetes worker nodes in each AZ running applications (workloads)
- Normally:
  - **1 k-cluster = 1 region with 3+ AZ**

1 k-cluster = 1 region with 3+ AZ

- Taken for granted if you know Kubernetes
- All major public cloud providers offering managed K8s services have 3+ AZ
- What about on-premise deployments?
  - You need to plan in advance
  - Stay away from the “2 data center in a region” setup typical of “Lift-and-Shift” exercises
    - Often results in 2 separate Kubernetes clusters
      - Severely impacts the benefits of Kubernetes, particularly self-healing
      - Shifts maintenance and procedural complexity up to the application level

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No!

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Yes!

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#2 - Synchronizing the state

Synchronizing the state of a Postgres database

- Being a DBMS, PostgreSQL is a **stateful workload** in Kubernetes
- Stateless workloads achieve HA and DR mainly through traffic redirection
- Stateful workloads require the state to be replicated in multiple locations:
  - **Storage-level** replication
  - **Application-level** replication (in our case, application = Postgres)
- Postgres has a very robust and powerful native replication system
  - We've built it
  - Founded on the Write Ahead Log
  - Read-only standby servers
  - Supports also synchronous replication controlled at the transaction level
- **We recommend application-level** over storage-level replication for Postgres

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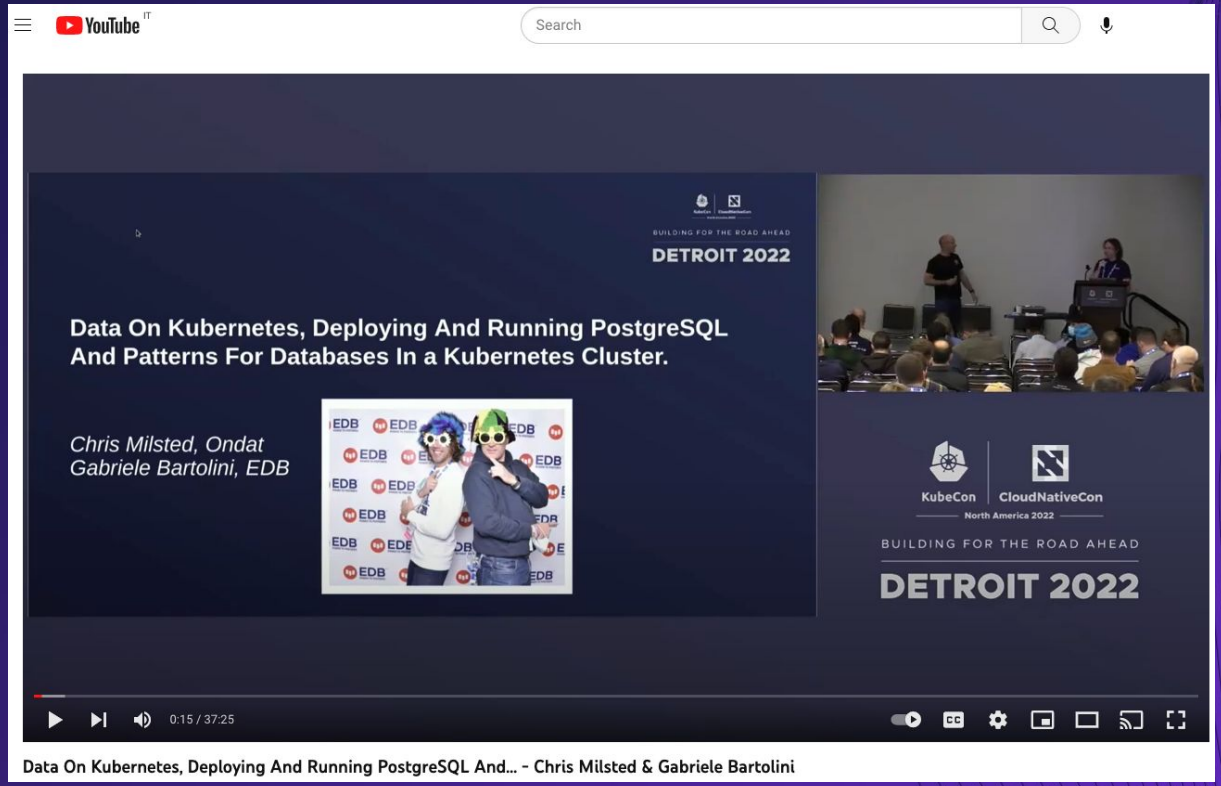
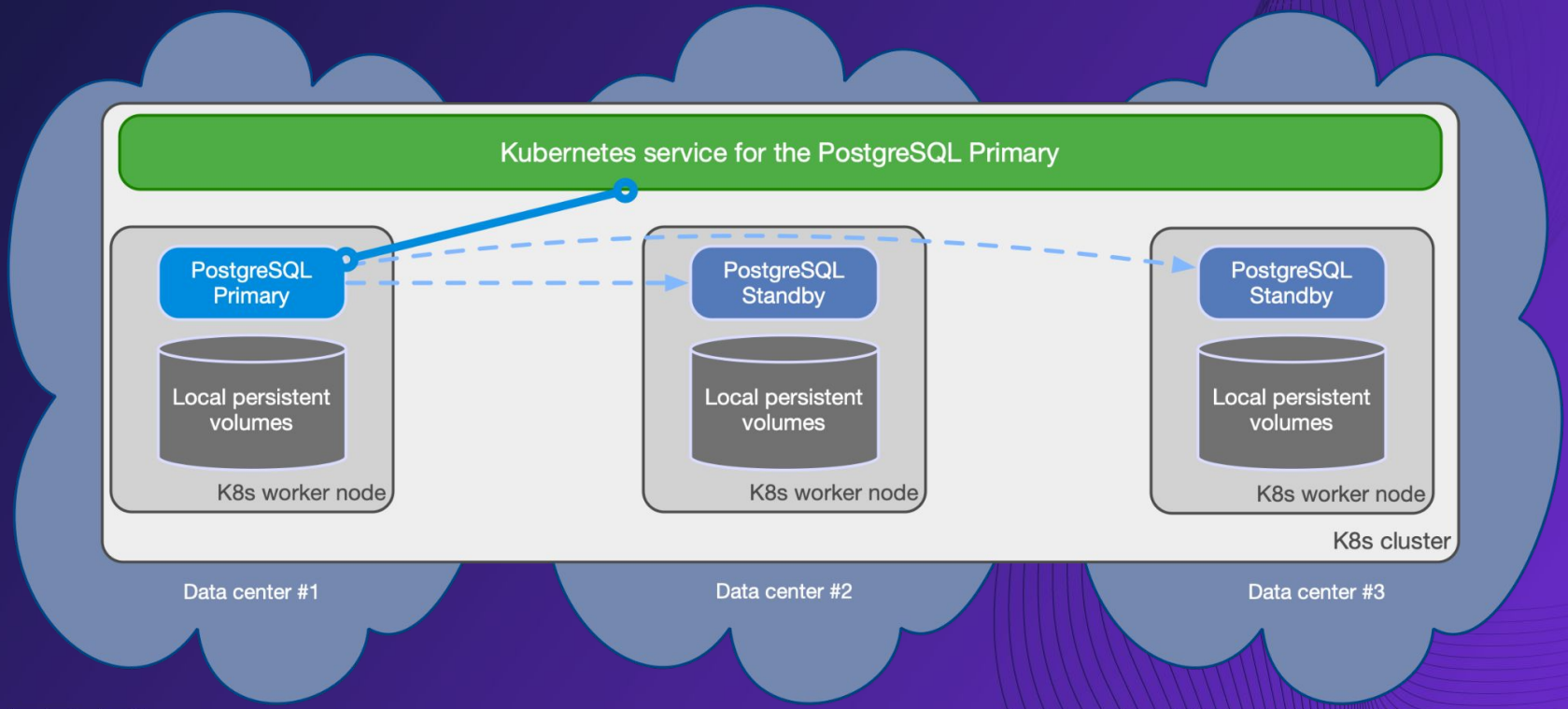
KubeCon NA 2022 - talk with Chris Milsted (Ondat)



Yes!


Kubernetes service for the PostgreSQL Primary
PostgreSQL Primary
Local persistent volumes
K8s worker node
PostgreSQL Standby
Local persistent volumes
K8s worker node
PostgreSQL Standby
Local persistent volumes
K8s worker node
K8s cluster
Data center #1
Data center #2
Data center #3

#3 - The right storage for you

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Storage management

- Storage is the most critical component for a database
- Direct support for Persistent Volume Claims (PVC)
  - We deliberately do not use Statefulsets
- The PVC storing the PGDATA is central to CloudNativePG
  - Our motto is: “PGDATA is worth a 1000 pods”
- Storage agnostic
- Freedom of choice
  - Local storage
  - Network storage
- Automated generation of PVC
  - Support for PVC templates
  - Storage classes

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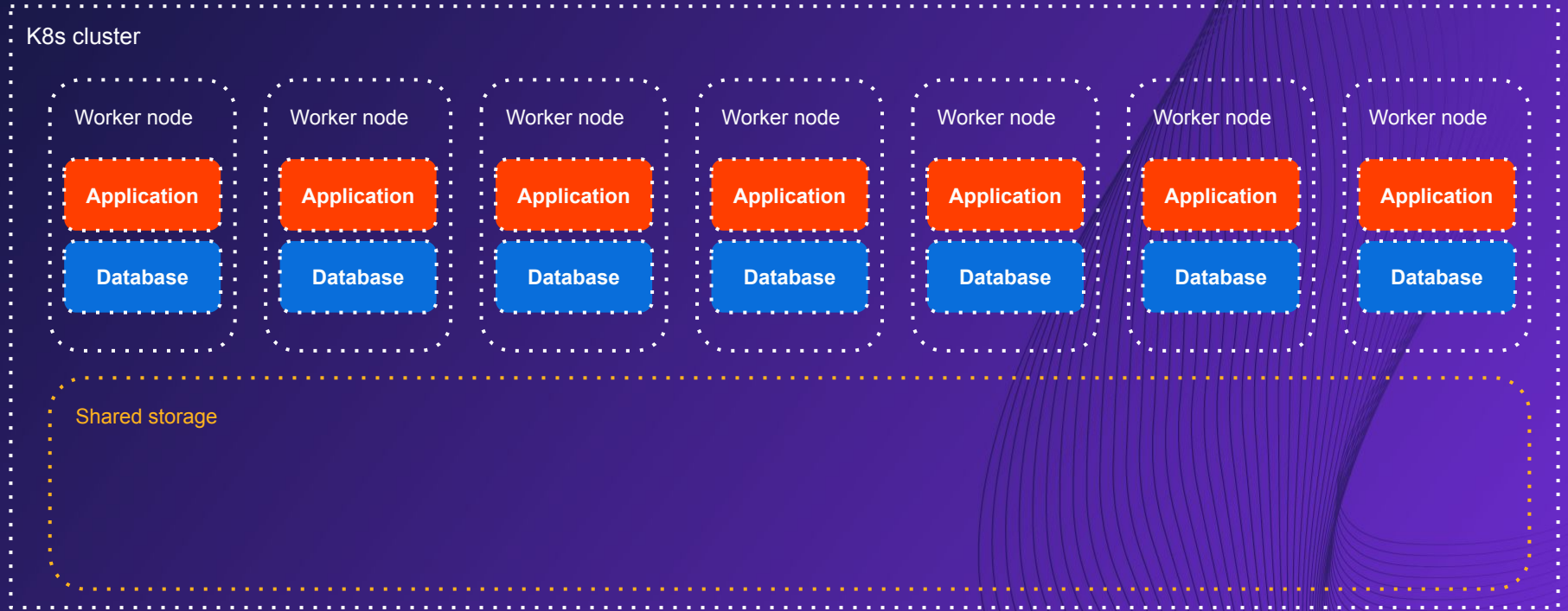
Main components

- Kubernetes cluster
- Availability zone
- Application pod
- Postgres pod
- Kubernetes worker node
- Network storage
- Local storage
    - i.e. dedicated and local to the worker node

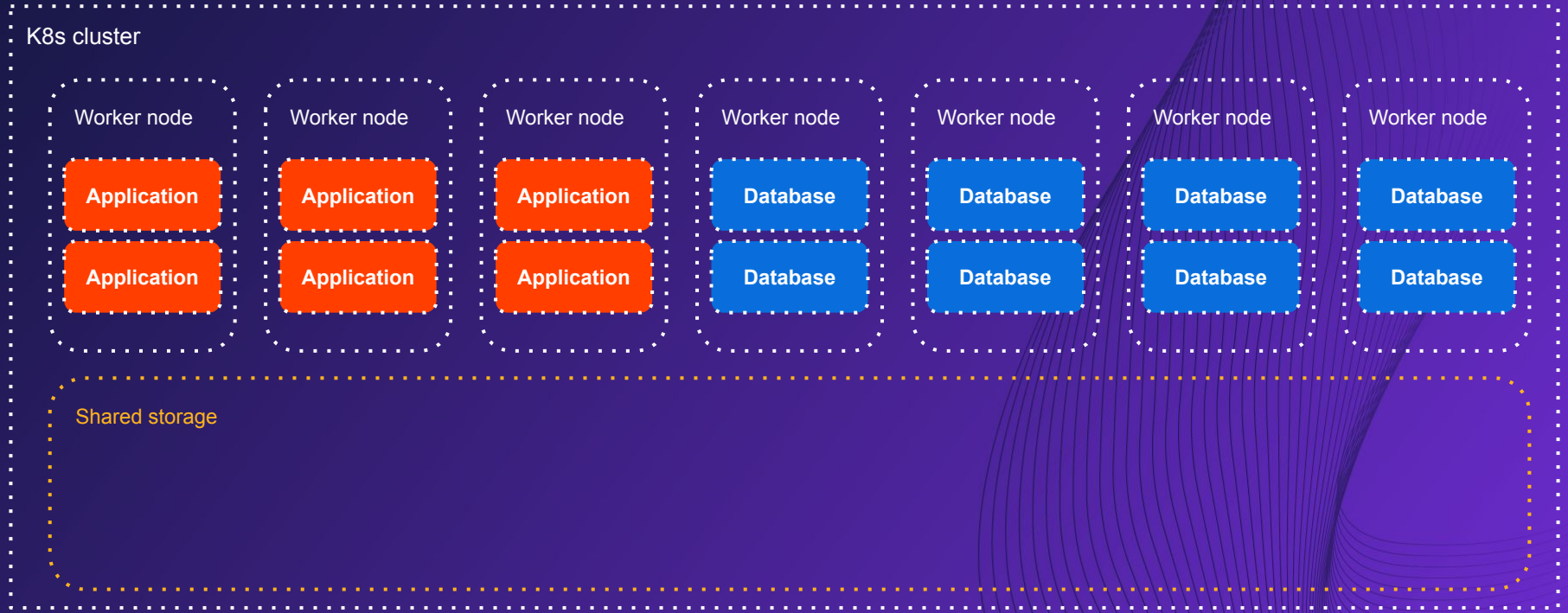
Scheduling Postgres instances with CloudNativePG

- Entirely declarative!
- Affinity section in the `Cluster` specification
  - pod affinity/anti-affinity
  - node selectors
  - tolerations against taints placed on nodes
- Topology spread constraints

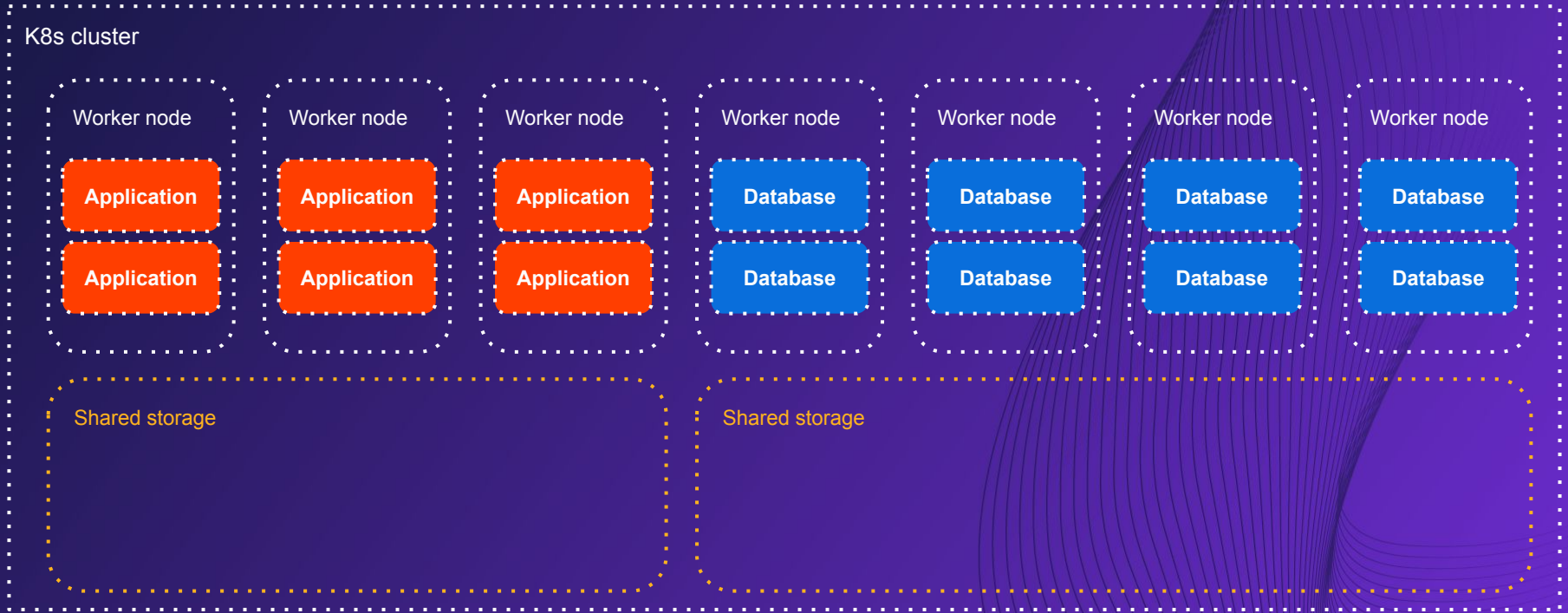
Shared workloads, shared storage #1



Shared workloads, shared storage #2

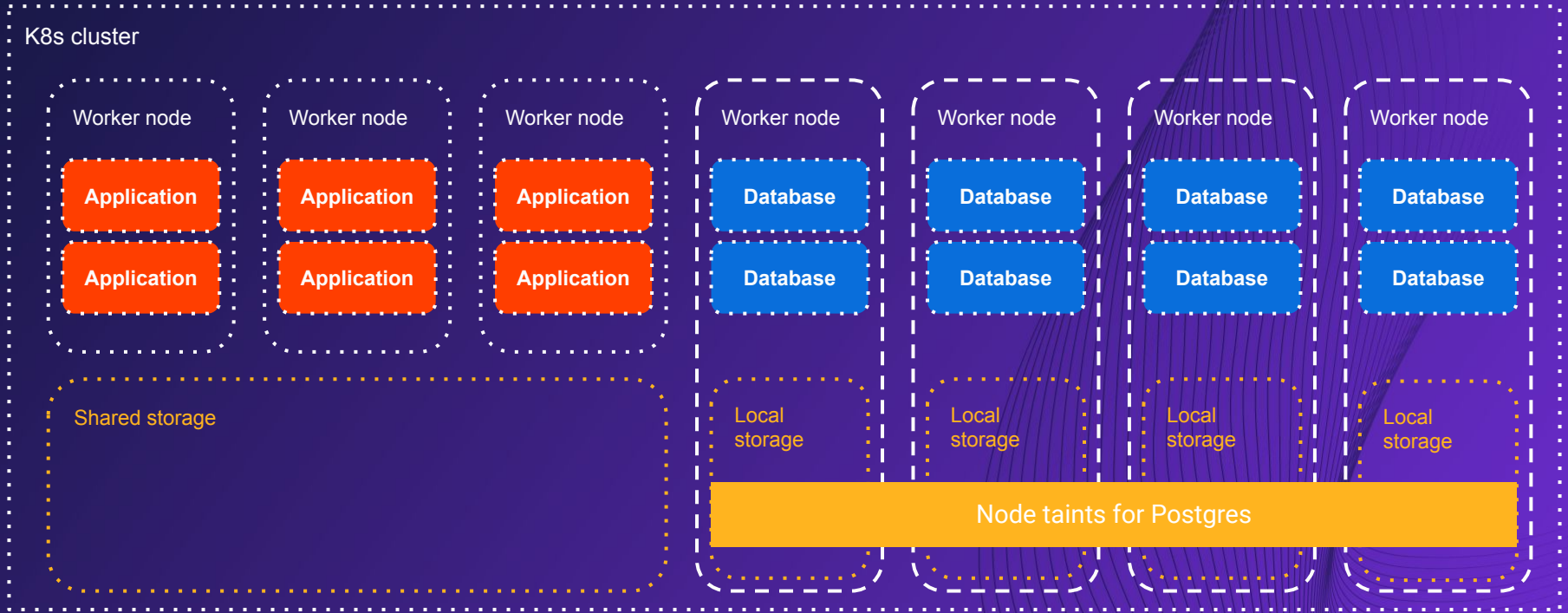


Shared workloads, shared storage #3



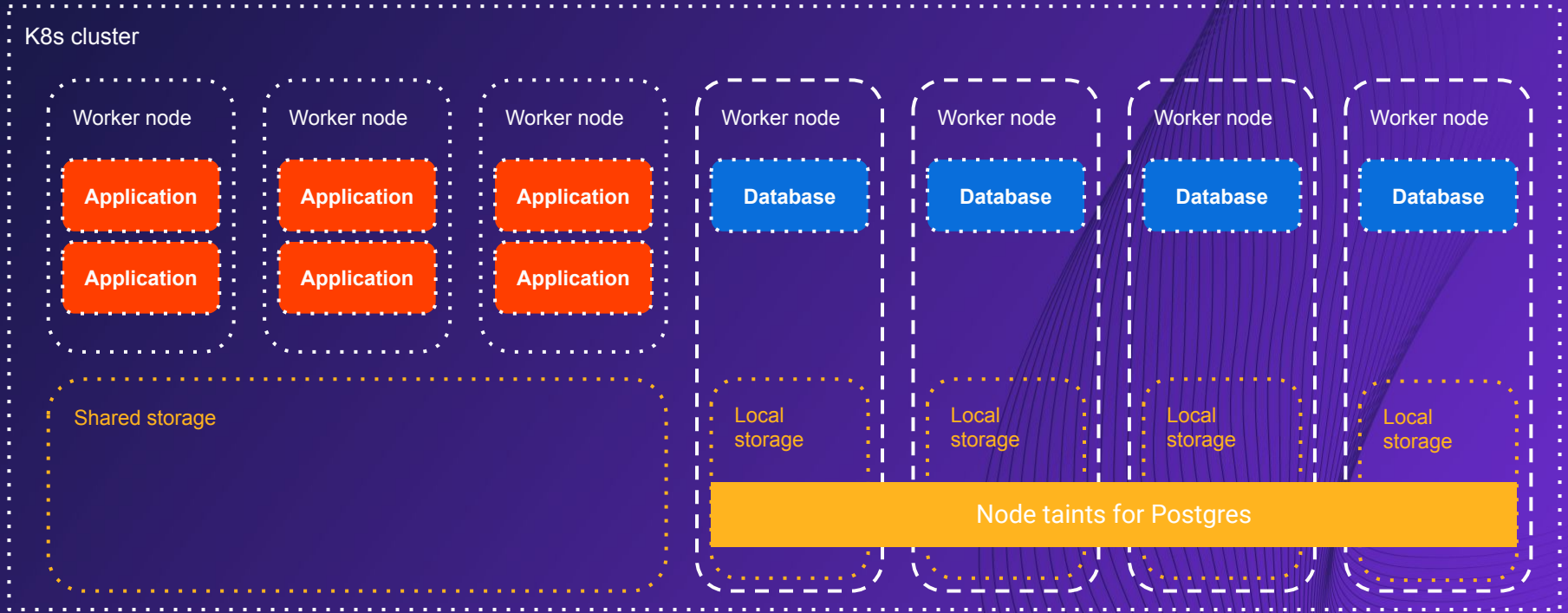
Shared workloads, local storage

Good value for money!

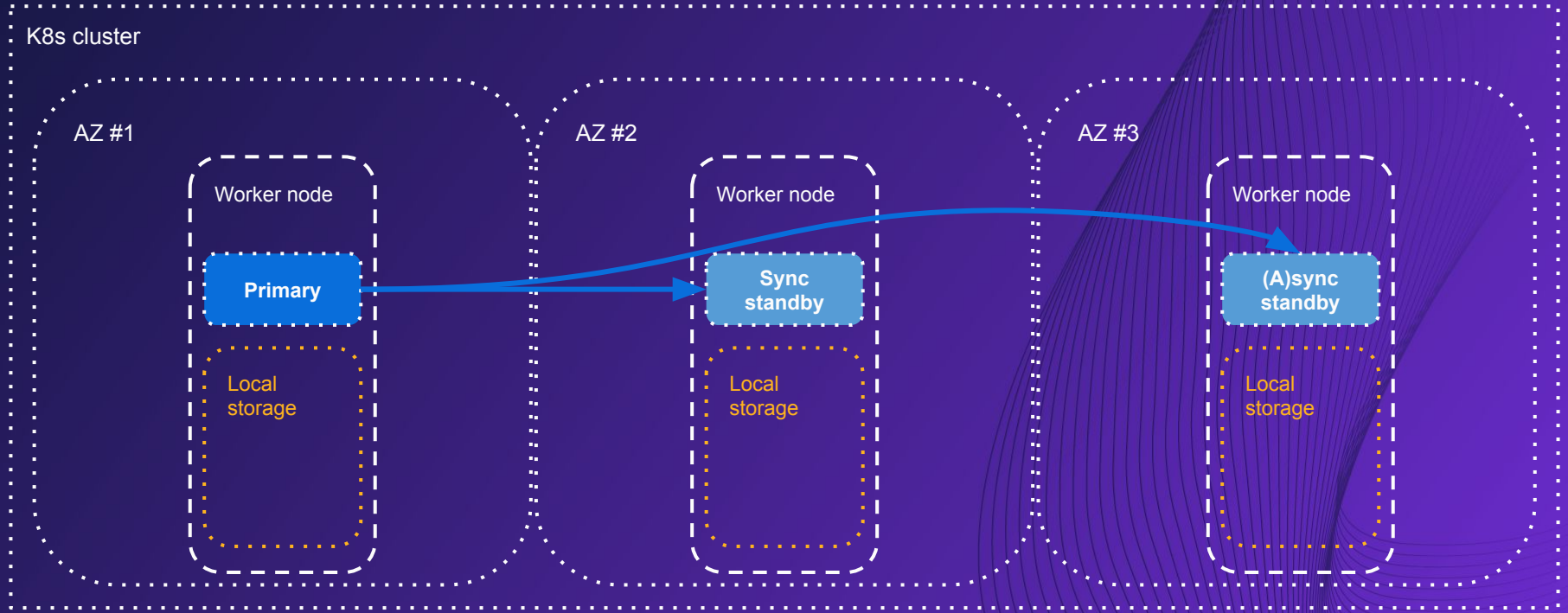


Dedicated workloads, local storage

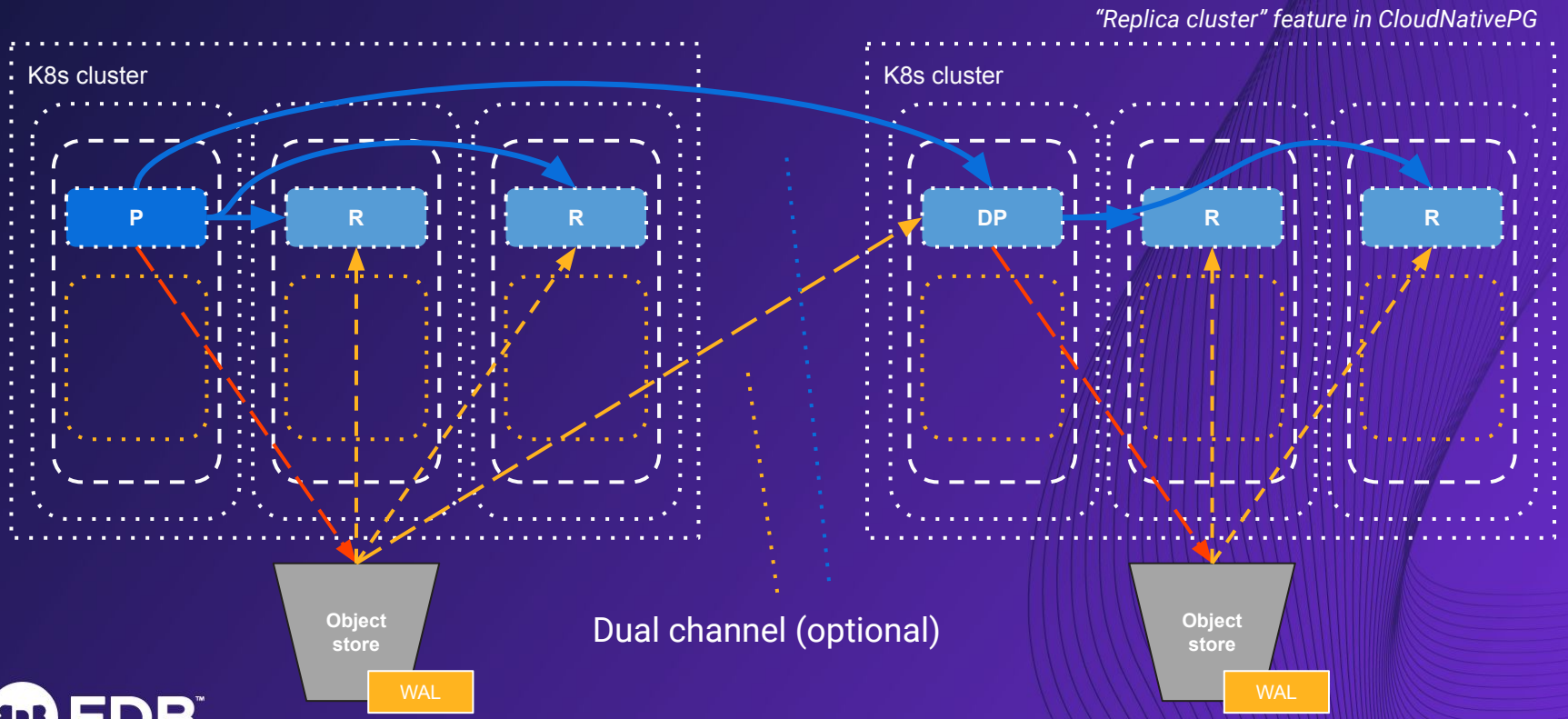
Best Postgres results!



Shared nothing architecture

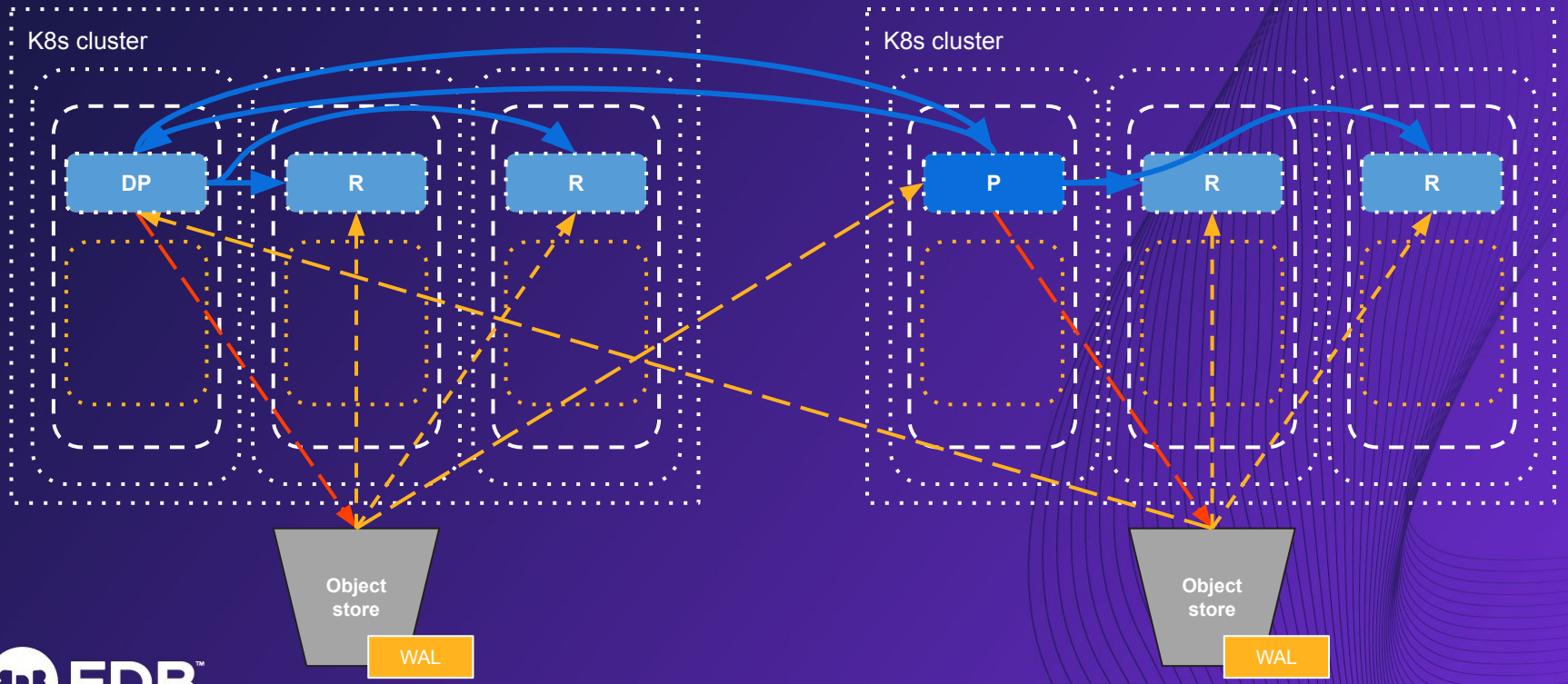


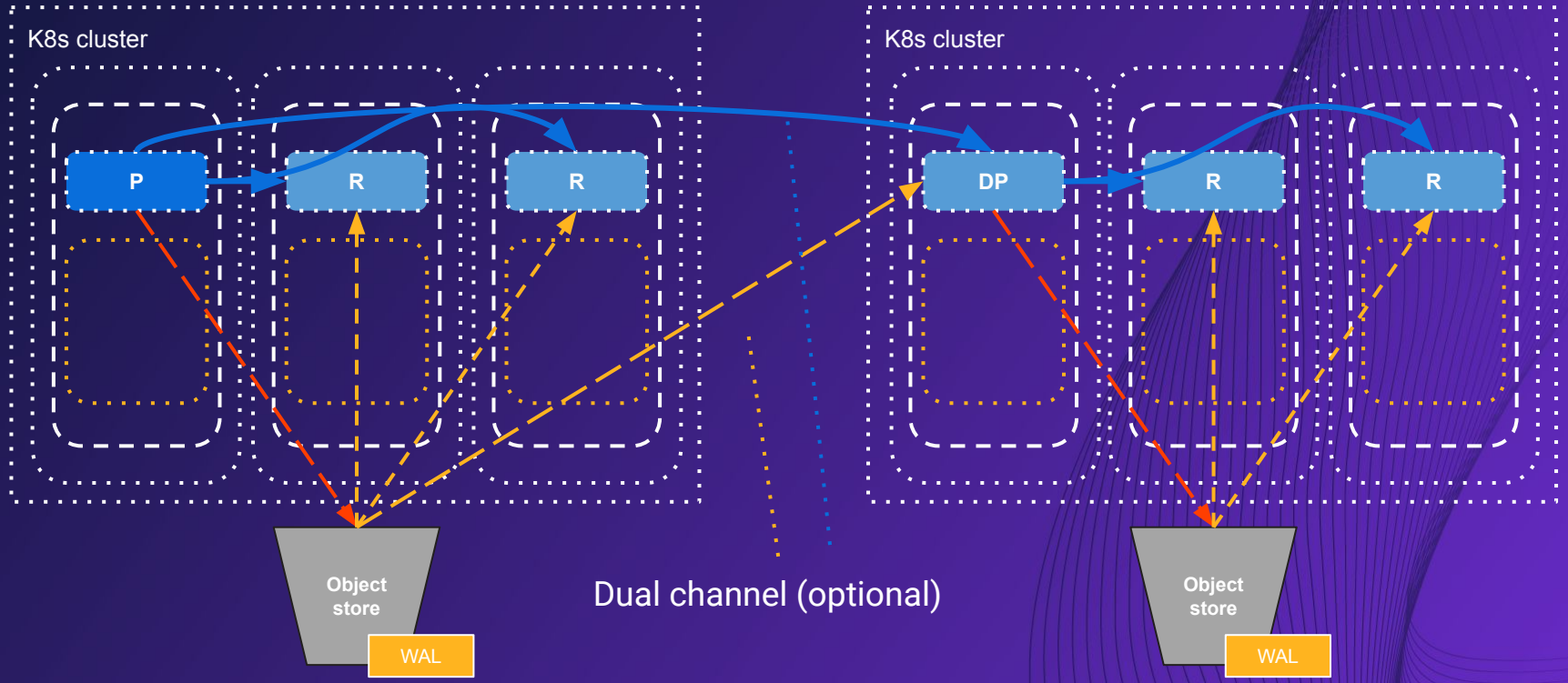
Shared nothing architecture (hybrid/multi)



Shared nothing architecture (hybrid/multi)

"Replica cluster" feature in CloudNativePG

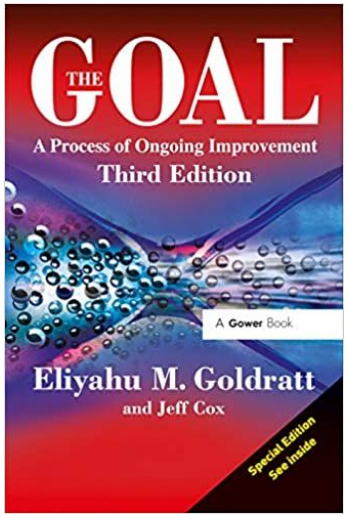



K8s cluster
K8s cluster
P
R
R
DP
R
R
Object store
WAL
Object store
WAL
Dual channel (optional)

DEMO TIME

#4 - The “Goal”

(“Your goal”)



Identify your business continuity goals

- Recovery Point Objective (RPO)
  - Time it takes for you to safely store each WAL file in separate locations
- Recovery Time Objective (RTO)
  - Time it takes for you to promote a standby as primary after a failure
    - Single k-cluster (region)
    - To a different k-cluster (region)
  - Time it takes for you to issue a PITR operation from a backup
- Identify your SPOFs!
- Practice! Measure! Improve!

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RPO with CloudNativePG

- Recovery Point Objective (RPO)
  - WAL files are archived to object stores at least every 5 minutes, depending on the workload
  - RPO <= 5 minutes
- Recovery Time Objective (RTO)
  - Same k-cluster:
    - Automated failover
    - Recommended setup: 3 instances with 1 sync standby
    - Instantaneous detection by Kubernetes
      - (we had to introduce delayed failover configuration)
    - RTO = time taken by a standby to exit recovery and become primary
      - Normally between 5 seconds and a minute
      - Depends on the workload and lag of a standby
  - Different k-cluster:
    - Use replica clusters with WAL shipping and/or streaming
    - Current: manual detection and triggering of the promotion

RPO with CloudNativePG

- HA replicas:
  - Asynchronous replicas: RPO ~ 0
  - Synchronous replicas RPO = 0
- Local object store:
  - WAL files are archived to object stores at least every 5 minutes
    - Depending on the workload
  - RPO <= 5 minutes
- Global object store:
  - (Stored in another region)
  - Local object store RPO + relay of WAL file to another region
  - RPO <= 10 minutes

RTO with CloudNativePG

- Same k-cluster:
  - Automated failover
  - Recommended setup: 3 instances with 1 sync standby
  - Instantaneous detection by Kubernetes
    - (we had to introduce delayed failover configuration)
  - RTO = time taken by a standby to exit recovery and become primary
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    - Depends on the workload and lag of a standby
- Different k-cluster:
  - Use replica clusters with WAL shipping and/or streaming
  - Current: manual detection and triggering of the promotion
- PITR varies on the database size and the amount of WAL to replay

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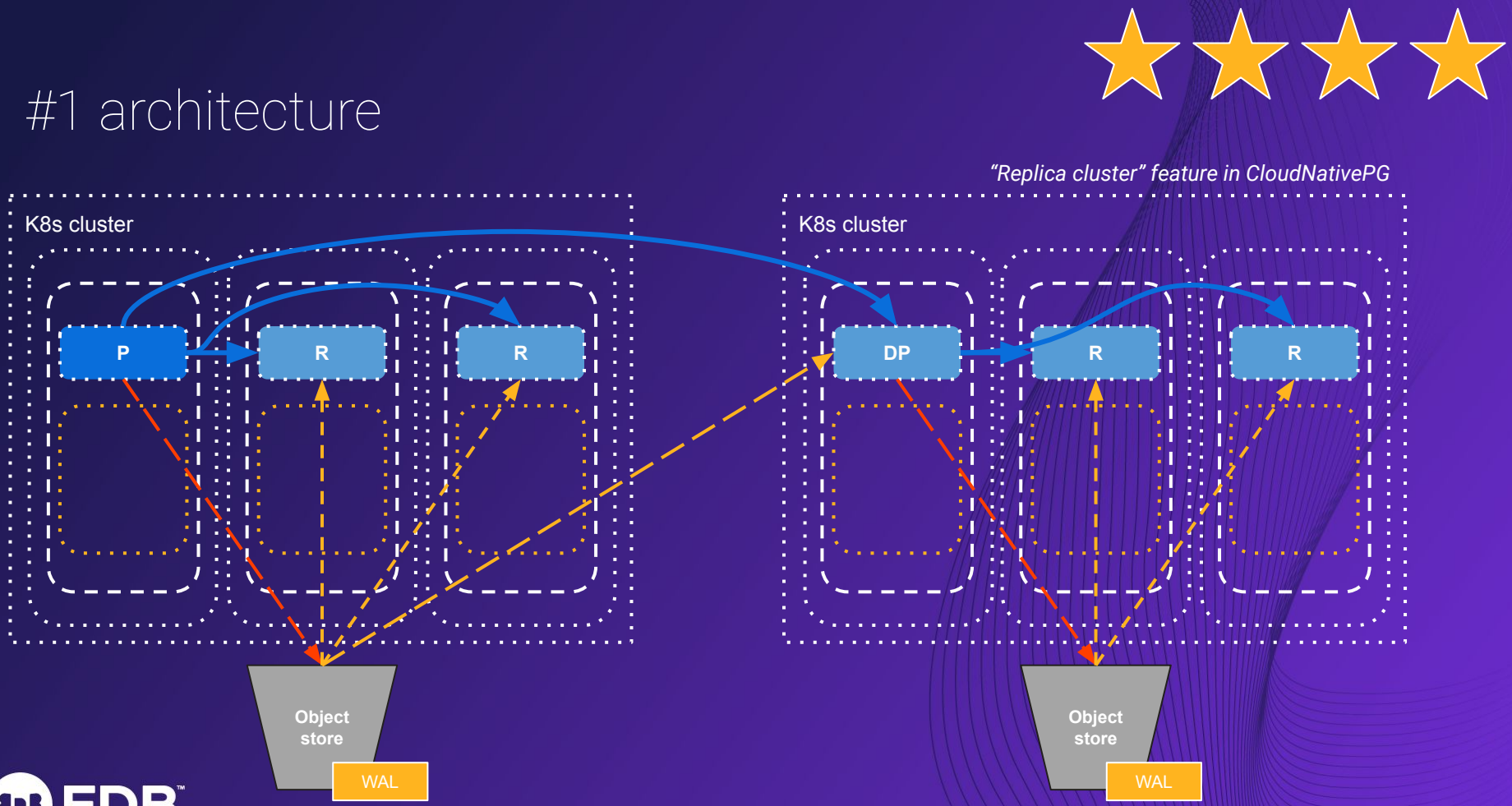
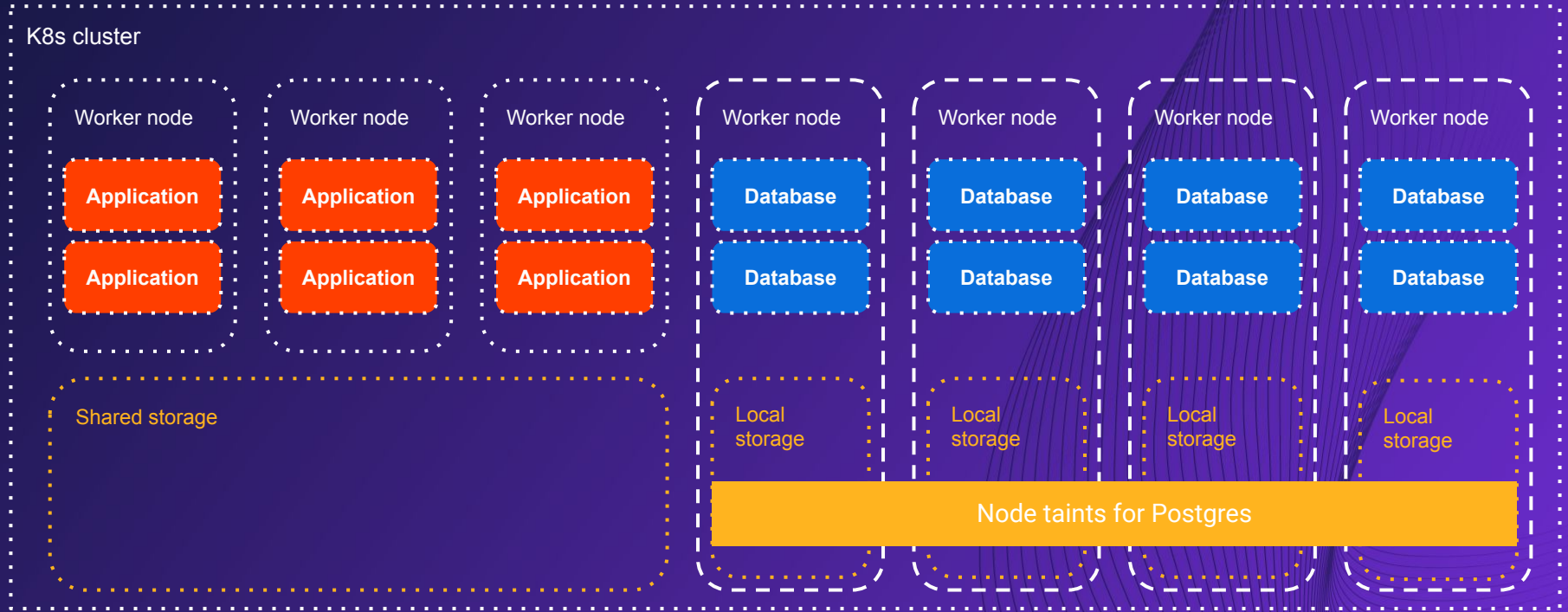
Key takeaways

1. Take advantage of 3+ AZ K-Clusters
2. Rely on PostgreSQL Primary/Standby clusters - like you did on VMs
3. Choose your storage carefully - like you did on VMs
4. Plan your infrastructure around your goals
    - RPO
    - RTO
    - Benchmarks
5. Shared nothing architecture, if you can
    - Otherwise, at least separate PostgreSQL workloads from the rest of your cluster
6. Application and database must be in the same K-Cluster
    - Applications are automatically rerouted to the primary via the updated service

#1 architecture



Shared workloads, local storage



CHAPTERS

UNLOCK THE POWER OF POSSIBILITY

1. The Power of Postgres
2. Enter EDB
3. Why Now?
4. Value Drivers
5. Why EDB?
6. Customer Success Stories
7. History of Postgres Contributions
8. EDB Plans

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UNLOCK THE POWER OF POSSIBILITY

THE POWER OF POSTGRES

Companies must shift to new **digital** operating models to compete and **stay relevant**

A NEW WORLD HAS EMERGED

- Data is the currency
- Data ownership is an economic advantage
- Databases are a strategic asset

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THE DIGITAL TRANSFORMATION IS UNDERWAY

The modern stack is defined by **open source**

Re-platforming of CORE DATABASE PLATFORMS is central to this shift

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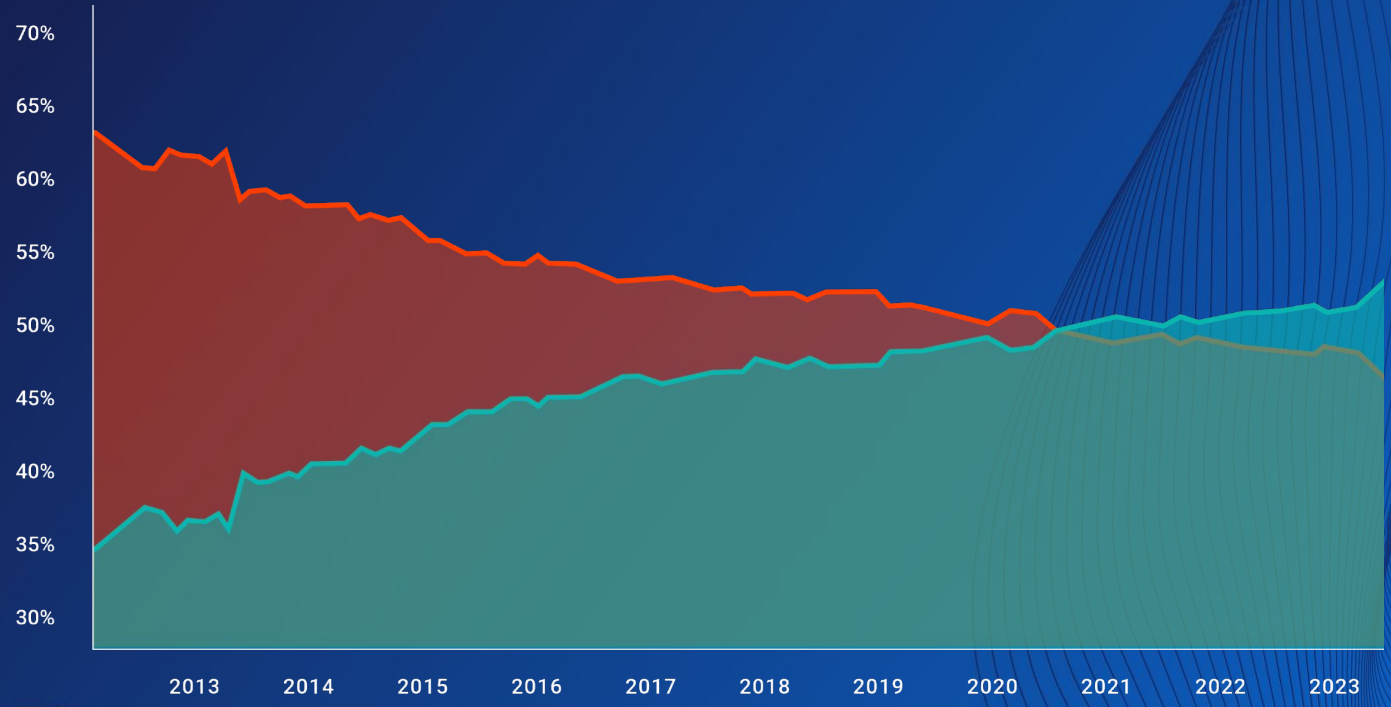
THE TIPPING POINT

Open source database licenses now outpace legacy



source: db-engines, IDC

INDUSTRY LEADERS ARE ADOPTING POSTGRES

Financial Services & Insurance

Technology

Telecom

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PUBLIC SECTOR LEADERS ADOPTING POSTGRES

TO ACHIEVE REAL-WORLD ROI

Multinational risk management software corporation working with BFSI companies

77%

Reduction in report generation time

Energy utility company located in the Midwestern United States

80%

Reduction in costs compared to Oracle

UK Tunnel Monitoring Organization

92%

Reduction in transition time between systems

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HOWEVER, MOST ORGANIZATIONS ARE:

UNDER EQUIPPED

to run applications on Postgres enterprise-wide

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WHERE ARE YOU?

- Does your organization have the skills/expertise to deploy enterprise-wide?
- Are you prepared to build new applications on an open source platform?
- How confident do you feel about your cloud database strategy?

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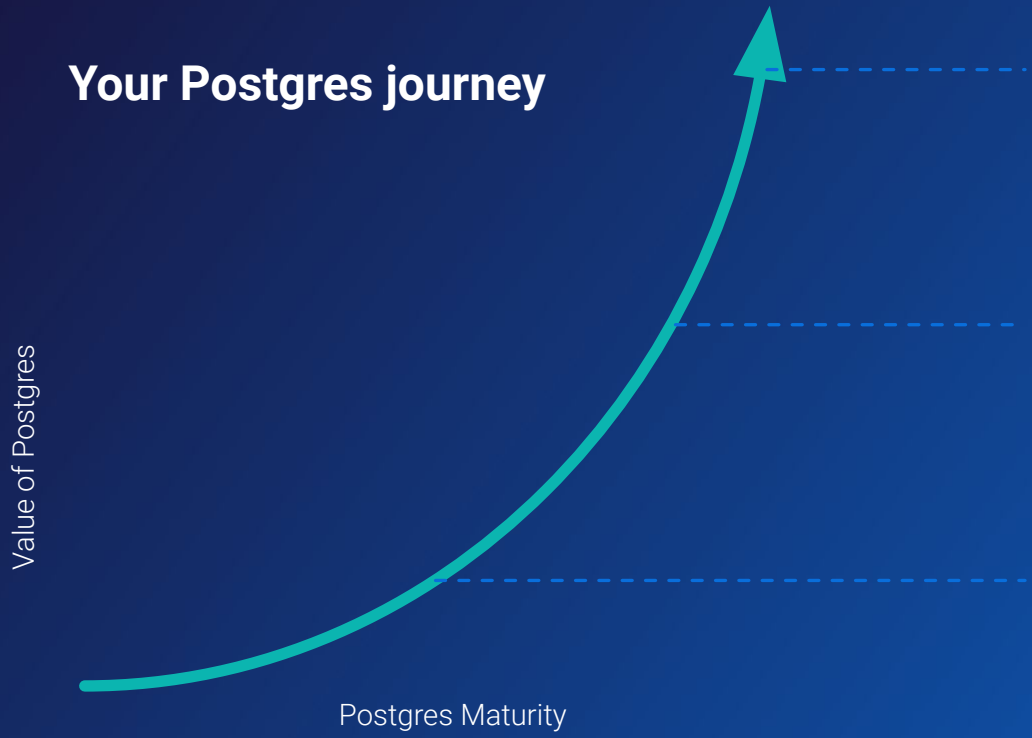
READY TO ACCELERATE?

Your Postgres journey



Strategic

- Postgres considered a “standard”
- Many production apps incl. tier 1
- Concerns for scalability, HA, and automation

Expanding

- Increasingly for production apps
- Tools and automation important
- Worries about database security

Emerging

- Getting started with Postgres
- Often for a single project
- For non mission-critical apps

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ENTER EDB

THE LEADER IN ENTERPRISE-GRADE POSTGRES

1500+ Enterprises and Growing

EDB deeply understands Enterprise Postgres needs.

79 Countries around the World

Global footprint and employee base.

18 Years of Driving Postgres in the Cloud

Long-term customers and deep Postgres capabilities.

3 of 7 Postgres Core Team Members, 7 Committers, 40+ Contributors

EDB is the leading Postgres community contributor.

30% of Postgres Code Contributed in 2021

Driving the innovation and foundation of Postgres.

>300 Dedicated Postgres engineers

Unparalleled expertise in Postgres.

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EDB **builds Postgres,**
alongside a vibrant,
independent community.

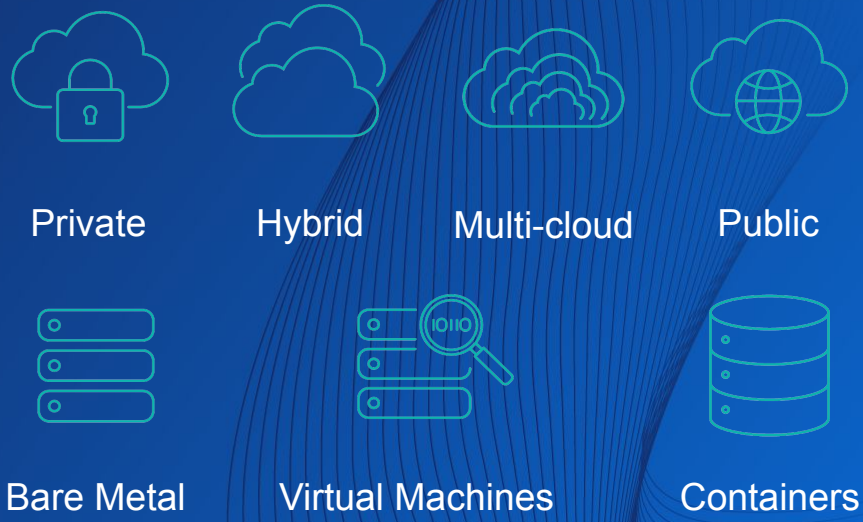
You have direct access to the experts
shaping the direction of the technology.

EDB™

ENABLING THE SAME POSTGRES EVERYWHERE

From self-managed to fully managed DBaaS in the cloud

- Same applications
- Faster innovation
- Performance and scalability
- Stability, security and control
- Seamless integration



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MORE THAN COMMUNITY POSTGRES

- Enterprise-grade solutions
- Hardened security, including TDE
- Extreme high availability
- Oracle compatibility
- World class, 24x7 support
- Better performance
- Reduced costs
- Scalability
- Deployment flexibility

EDB™

WE ACCELERATE YOUR STRATEGY

Considering Postgres

Getting enterprise support

Mapping to goals & outcomes

Migrating from other vendors

Upskilling staff and reducing overhead

Harnessing the full power of Postgres

EDB Guides You Through Every Phase

EDB

WITH GUIDANCE TO MAXIMIZE YOUR BENEFITS

AND COMMITMENT TO YOUR SATISFACTION

>92% EDB Customer Satisfaction

97% Initial Response & Remedy

Always-On and available 24x7 globally for all offerings

"The team behind EDB is strong technically and also extremely responsive. "

SVP of Software Engineering, ACI Worldwide

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WHY NOW?

IN AN UNCERTAIN ECONOMY

Postgres is the economic game changer

EDB helps you:

- Safely, reliably and efficiently adopt open source technology for all criticality levels
- Build new, modern applications in the cloud, and reduce on-premises capacity
- Attract, easily train, and retain top talent
- Permanently reduce the cost of doing business

EDB™

VALUE DRIVERS

WE SUPPORT YOUR STRATEGIC PRIORITIES

- Enabling Faster Business Innovation
- Lowering costs
- Reducing risk
- Aligning tech and talent
- Improving customer satisfaction
- Supporting and building modern apps
- Migrating to the Cloud

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EDB Value Drivers

ENABLING FASTER BUSINESS INNOVATION

Customer Challenges

- Time to market / Win business
- Enable innovation
- Reduce hiring and training costs
- Retain core knowledge

EDB Solutions

- App stack modernization, Oracle compatibility and easy migration tools
- Top enterprise -grade support
- Ability to deploy PostgreSQL on Azure and AWS
- Vast, vibrant independent community of developers who want, use and love Postgres

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EDB Value Drivers

LOWERING COSTS

Customer Challenges

- Reduced cost of doing business
- IT management efficiency
- Knowledge diversification

EDB Solutions

- Reduce TCO by expanding your open source usage
- Inexpensive relative to legacy vendors
- EDB tools can materially reduce cost of migration to Postgres
- IAC capabilities enable shift-left
- Postgres' native extensibility system
- PostgreSQL global development group leadership
- CloudNativePG to provision, operate and maintain, and free up staff to deliver more business value

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EDB Value Drivers

REDUCING RISK

Customer Challenges

- Protecting organization reputation
- Recovering from downtime / data breach
- Performance of mission-critical applications
- Privacy and security
- Predictable costs

EDB Solutions

- EDB Extreme High Availability
- Transparent Data Encryption (TDE)
- Automatic patching for BigAnimal managed offering
- Online maintenance to protect against downtime
- Range of solutions to protect data integrity
- EPAS security features
- Professional services

EDB Value Drivers

ALIGNING TECH & TALENT

Customer Challenges

- Time to market / Win business
- Enable innovation
- Reduce hiring and training costs
- Retain core knowledge

EDB Solutions

- App stack modernization, Oracle compatibility and easy migration tools
- Top enterprise -grade support
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EDB Value Drivers

IMPROVING CUSTOMER SATISFACTION

Customer Challenges

- Products/solutions that work how they should
- Available, reliable and secure databases
- Customers get the experience they deserve
- Strong customer retention

EDB Solutions

- EDB Postgres Distributed for extreme high availability
- Maintenance and upgrades during the online day, without impacting customers
- Expert support with industry leading SLOs
- Enterprise level contracts
- Rolling upgrade capacities
- Seamless upgrade to Azure Ultra Disks

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EDB Value Drivers

SUPPORTING AND BUILDING MODERN APPS

Customer Challenges

- Reducing complexity and proliferation of applications
- Breaking down data silos
- Ensuring data privacy and security efforts
- Best practices in data management and governance

EDB Solutions

- Postgres Database
- Postgres High Availability Clusters
- Postgres Migration
- Postgres Replication
- Postgres Monitoring & Management
- Postgres Backup and Recovery

EDB Value Drivers

MIGRATING TO THE CLOUD

Customer Challenges

- Decreasing complexity of existing architecture
- Shortening migration process
- Reducing costs of cloud migration
- Ensuring data security and compliance

EDB Solutions

- EDB BigAnimal DBaaS
- Oracle compatibility
- Flexible deployment options
- EDB Postgres Advanced Server
- EDB Postgres for Kubernetes

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WHY EDB?

BUILT FOR YOUR ENTERPRISE FUTURE

EDB Ensures:

- **Performance -** The ability to do anything that proprietary, legacy databases can do.
- **Flexibility -** Both self-managed and fully managed.
- **Scalability -** Tools and services to meet the demands of your growing enterprise.
- **Availability** - Tools to deliver more than 99.999% high availability.
- **Portability** - Technology that can be deployed anywhere

EDB

WE DELIVER THE POSTGRES YOU NEED

Your use cases

- New applications
- Database migrations
- Replatform to the cloud

Your requirements

- Availability
- Scalability
- Flexibility
- Expertise

The database you need

- Postgres
- EDB Postgres Advanced
- EDB Postgres Extended

The tools you need

- EDB tools
- Open source tools

Where you want it

- On-premises | hybrid cloud | multi cloud
- Virtual machines
- Kubernetes
- Cloud managed service

The help you need

- Expert 24/7 technical support
- Remote DBAs
- Technical Account Managers
- Professional Services

MAKE THE MOVE WITH EDB

- Faster innovation
- Immensely better economics
- Enterprise-Grade DBMS Capabilities
- Superior to proprietary databases
- Flexible Deployment Choice
- The full power of Postgres

EDB™

WE MAKE IT EASY TO MAKE THE MOVE

- Oracle-compatibility
- Enhanced migration tools
- Industry-leading services and support
- Transparent pricing
- Reduced data management costs
- Flexible deployment
- Options for management (self or EBD-managed)
- Community or Enterprise-grade EPAS
- Unmatched Postgres Expertise

95%

or more of Oracle schema translations

80%

savings on software licensing and support

60%

savings of Oracle data and schema migrations

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THIS IS **YOUR**
MOMENT TO LEAD,
BUILD, CHALLENGE
AND DO MORE

And we are by your side every step of the way.

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CUSTOMER SUCCESS STORIES

ENTERPRISES ARE MOVING TO POSTGRES

Providing clinical trial solutions to healthcare

Shifted mission critical application off oracle to the cloud

Delivering logistics and systems to dairy industry

Transitioned multiple applications to cloud and off oracle

Empowering insurance industry with software platforms

Achieved flexibility and high availability in the cloud

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STC PAY
BUILDS LEADING FINTECH APP WITH POSTGRES AND EDB

Use Case: EHA, Migration, Backup & Recovery

The Challenge: Secure database that could rapidly scale with their growth.

EDB Solution: Migrated complex payment apps and helped achieve high availability for “Always On” customer experience.

“From a database perspective, we’ve seen great performance and stability. We’re the first in the region to be using the platform, and we’re proud to announce to everyone that we’re using Postgres.”

- *Database Team Lead, stc pay*

ACI WORLDWIDE MODERNIZES SOFTWARE, REDUCES RISK AND LOWERS COST WITH EDB

Use Case: EHA

The Challenge: Improve ROI over legacy databases.

EDB Solution: ACI selected EDB as its long-term partner based on responsiveness, resilience and flexibility in architecture.

ACI UNIVERSAL PAYMENTS

"While other databases offered the functionality we were looking for, EDB provided what we needed in a single lower-cost solution. Postgres is a workhorse…the team behind EDB is strong technically and also extremely responsive. "

- *SVP of Software Engineering, ACI Worldwide*

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METASPHERE
IMPROVES BUSINESS CONTINUITY IN THE CLOUD WITH EDB

Use Case: Migration

The Challenge: Improve response times, access to data, and expand its global footprint with a cloud-based platform.

EDB Solution: Cost-effective, cloud-friendly foundation without sacrificing scalability and performance with data-intensive application.

"Oracle's core-based licensing dramatically increased the cost of our solution...We were able to migrate all our hosted customers to Postgres without them even knowing while saving customers from out of control licensing fees. "

- *Director of Product Management, Metasphere*

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LONDON & PARTNERS
EXECUTES MULTI-VERSION POSTGRES WHILE MIGRATING TO THE CLOUD

Use Case: Remote DBA, Cloud Migration, Tech Support and C360

The Challenge: Mix of private and a semi-private cloud environment that led to unplanned outages, limited scalability and performance.

EDB Solution: Cloud migration and 24/7 technical expertise freed up internal teams to drive 30% increase in web traffic.

LONDON & PARTNERS

"Not only did EDB support the upgrade work in the midst of the cloud migration, they really pushed us to be more ambitious and comprehensive in our disaster recovery planning… It's a great example of not only the expertise that EDB brings to the table, but also the fearlessness to challenge our assumptions of what is good enough without being condescending or patronizing. **It's exactly what you want from an expert**."

- *Head of Channels and Innovations, London & Partners*

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Wharton Research Data Services

Leverages EDB for Scalability and Postgres Expertise

Use Case: Services and Support

The Challenge: Scalable solution to provide access to key research data with both high availability and scalability.

EDB Solution: IncreaseD technical depth and provide 24/7 support to users.

wrds
The Global Standard for Business Research

"[Our Postgres environment] doesn't fit any typical usage profile. There aren't many places that give 75,000 active users direct access to a database. With a lot of what we do pushing the limits of Postgres, it is crucial that we can talk to the people who eat, live and breathe this stuff."

- *Sr Database Administrator, Wharton Research Data Services*

EDB

HISTORY OF POSTGRES CONTRIBUTIONS

EDB HAS, AND WILL SHAPE POSTGRES

To be enterprise-grade and business-critical, based on your needs

Heap Only Tuples:
Dramatically reducing the cost of updating rows, massive performance improvements for update-heavy workloads.

pglogical:
Significantly improving replication performance.

MERGE SQL command:
Makes it easier for enterprises to migrate from expensive, legacy databases to open source.

Barman:
Enabling reliability and Always On performance for mission-critical enterprise applications.

Autoindex on Partitioned Tables:
Makes it much easier for developers and DBAs to add new search indexes.

EDB

EDB PLANS

SELF MANAGED PLANS - PRIVATE CLOUD

All plans are licensed as annual subscriptions

SOFTWARE, TOOLS AND OPERATORS	EDB Enterprise	EDB Standard	EDB Community 360
EDB Postgres Advanced Server	✔		
PostgreSQL	✔	✔	✔
EDB Postgres for Kubernetes	✔	✔	
EDB Tools	✔	✔	
Open Source Tools	✔	✔	✔
Expert Support	✔	✔	✔
EDB Extreme High Availability			
Add On - EDB Postgres Distributed			

SELF MANAGED PLANS - BUNDLED SUPPORT

All plans are licensed as annual subscriptions

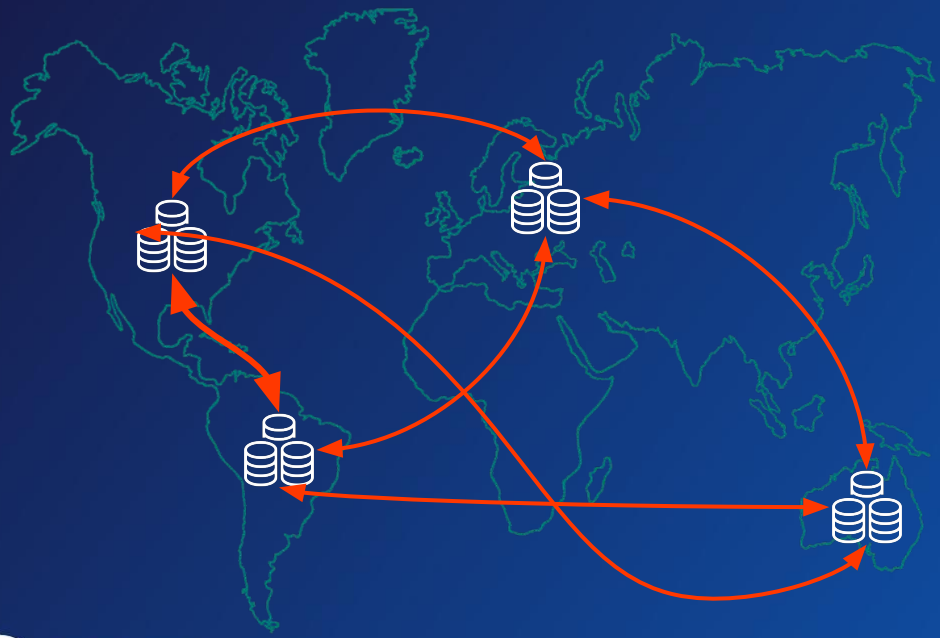
SUPPORT OPTIONS	EDB Enterprise	EDB Standard	EDB Community 360
Basic - for development and test environments	✔	✔	
Production - dedicated 24x 7 support	✔	✔	✔
Premium	✔	✔	✔

FULLY MANAGED PLAN - BigAnimal DBaaS

All plans are licensed as annual subscriptions

Software, tools and operators	EDB Enterprise	EDB Standard	EDB Community 360
EDB Postgres Advanced Server	✔		
PostgreSQL	✔	✔	✔
CloudNative PG	✔	✔	✔
EDB Tools	✔	✔	
Open Source Tools	✔	✔	✔
Expert Support	✔	✔	✔
	EDB Extreme High Availability		
	Add On - EDB Postgres Distributed Beta (single region) Multi-Region in 2023		

HIGHLY AVAILABLE AND GEOGRAPHICALLY DISTRIBUTED



MULTI-MASTER REPLICATION ENABLES

- Logical replication of data and schema enabled via standard Postgres extension
- Data consistency options that span from immediate to eventual consistency
- Robust tooling to manage conflicts, monitor performance, and validate consistency
- Deploy natively to cloud, virtual, or bare metal environments
- Geo-fencing, allowing selectively replicate data for security compliance and jurisdiction control.

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THANK YOU!
EDB