## Scaling CQRS in Theory, Practice and Reality



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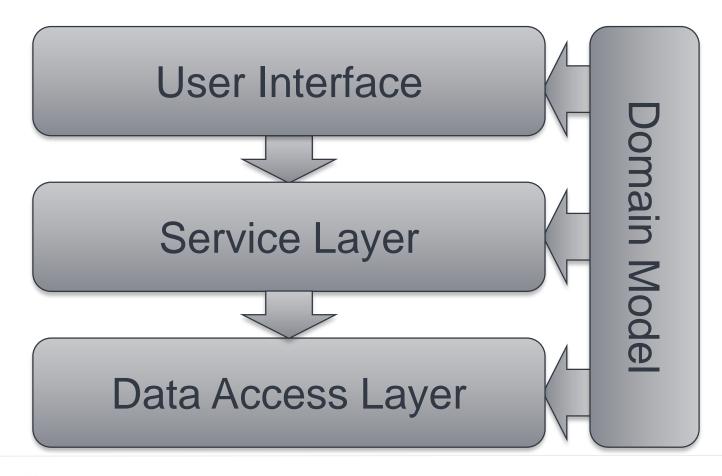








### Layered architecture

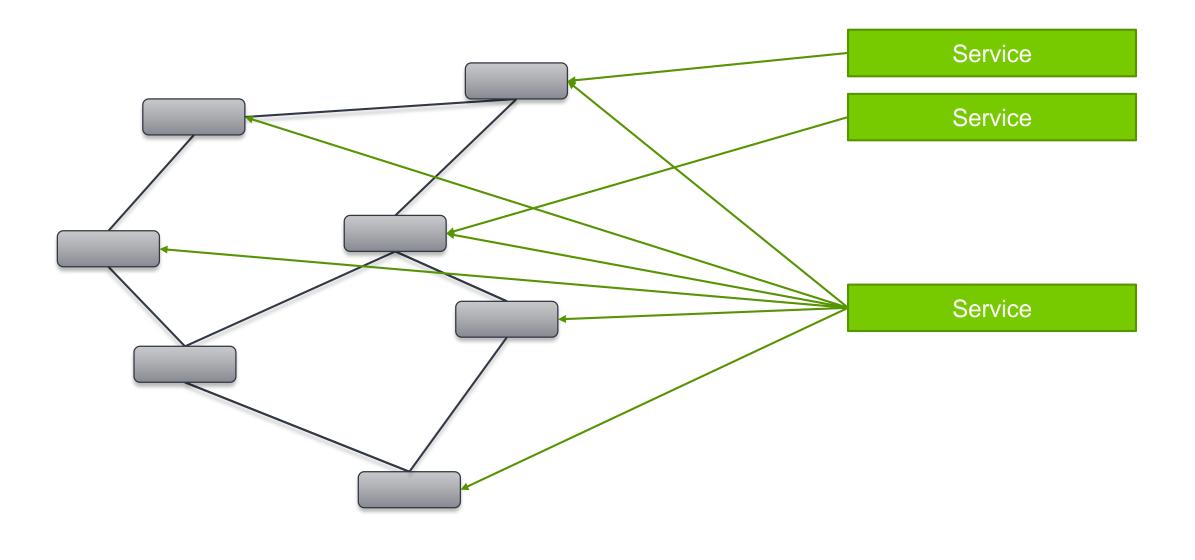




















### 'Normal' SQL QUERY

CREATE ALGORITHM = UNDEFINED DEFINER = 'dbat'@'%' SQL SECURITY DEFINERVIEW 'BUSINESS FROCESS VIEW DISABLED' AS SELECT 'tpo'. NAME' AS 'TRADING PARTNER NAME', 'bt'. NAME' AS 'TRADING PARTNER NAME', 'tb'. NAME', 'tb'. NAME', 'tb'. NAME', 'tb'. NAME' AS 'TRADING PARTNER NAME', 'tb'. NAME', 'tb'. NAME' AS 'TRADING PARTNER NAME', 'tb'. NAME', 'tb 'rtedid'. 'VALUE' AS 'TRADING PARTNER ROOT EID', 'tpot'. 'ORG SUB TYPE NAME' AS 'TRADING PARTNER CUSTOMER TYPE', 'tpot'. 'STATUS' AS 'TRADING PARTNER TYPE', 'tpot'. 'NAME' AS 'TRADING TYPE', 'Tpot'. 'NAME' AS 'TRADING TYPE', 'Tpot'. 'NAME' AS 'TRADING TYPE', 'Tpot'. 'NAME' AS 'TRAD 'TRADING PARTHER\_DUMS', 'bglm'.'VALUE' AS 'TRADING\_PARTHER GLN', 'bp'.'BUSINESS\_PROCESS' AS 'BUSINESS\_PROCESS', (CASE CONCAT(('myo'.'ORGANIZATION\_ID' = 'rel'.'PARTY1\_ID'), ('myo'.'ORGANIZATION\_ID' = 'rel'.'PARTY2\_ID'), 'bp'.'PARTY1\_DIRECTION') WHEN '10TO' THEN 'TO WHEN '10FROM' THEN 'FROM' WHEN '11TO' THEN 'TO' WHEN '01TO' THEN 'FROM' WHEN '01FROM' THEN 'TO' END) AS 'DOCUMENT DIRECTION', 'bp'. STATUS', 'idt'. 'DOC\_TYPE' AS 'INBOUND\_TYPE', 'idt'. 'DOC\_SUB\_TYPE' AS 'INBOUND\_SUB\_TYPE', AS 'INBOUND\_SUB\_TYPE 'idt'.'DOC\_VERSION' AS 'INBOUND\_VERSION', 'iodt'.'DOC\_DIRECTION' AS 'INBOUND\_DIRECTION', 'odt'.'DOC\_DIRECTION', 'odt'.'DOC\_DIRECTION' AS 'OUTBOUND\_TYPE' AS 'OUTBOUND\_SUB\_TYPE', 'odt'.'DOC\_VERSION' AS 'OUTBOUND\_VERSION', 'iodt'.'DOC\_DIRECTION' AS 'OUTBOUND\_DIRECTION', 'bp'.'GO\_LIVE\_DT' AS 'GO\_LIVE\_DATE', 'bp'.'SUSINESS\_FROCESS\_ID' AS 'ID', 'myo'.'ORGANIZATION\_ID' AS 'ORG\_ID', 'myo'.'NAME' AS 'ORG\_NAME', 'meid'.'VALUE' AS 'ORG\_EID', 'ro'.'ORGANIZATION\_ID' AS 'ROOT\_ORG\_ID', 'ro'.'NAME' AS 'ORG\_NAME', 'moid'.'VALUE' AS 'ORG\_EID', 'ro'.'ORGANIZATION\_ID' AS 'ROOT\_ORG\_ID', 'ro'.'NAME' AS 'ORG\_NAME', 'moid'.'VALUE' AS 'ORG\_EID', 'ro'.'ORGANIZATION\_ID' AS 'ROOT\_ORG\_ID', 'ro'.'NAME' AS 'ORG\_NAME', 'moid'.'VALUE' AS 'ORG\_EID', 'ro'.'ORGANIZATION\_ID' AS 'ROOT\_ORG\_ID', 'ro'.'NAME' AS 'ORG\_NAME', 'moid'.'VALUE' AS 'ORG\_NAME' 'ROOT\_ORG\_NAME', 'xeid'.'VALUE' AS 'ROOT\_ORG\_EID', 'idt'.'DOC\_TYPE\_ID' AS 'INBOUND\_DOC\_TYPE\_ID', 'odt'.'DOC\_TYPE\_ID', 'xel'.'RELATIONSHIP\_ID' AS 'RELATIONSHIP\_ID', 'oop'.'ISAOS' AS 'OB\_ENV\_SNDR\_QUAL', 'oop'.'ISAOS' AS 'OB\_ENV\_SNDR\_ID', 'oop'.'ISA07' AS 'OB\_ENV\_RCVR\_QUAL', 'oop'.'ISA08' AS 'OB\_ENV\_RCVR\_ID', 'oop'.'GS02' AS 'OB\_IN\_SNDR\_ID', 'oop'.'ISA05' AS 'IB\_ENV\_SNDR\_QUAL', 'iop'.'ISA06' AS 'IB\_ENV\_SNDR\_ID', 'iop'.'ISA07' AS 'IB\_ENV\_RCVR\_QUAL', 'iop'.'ISAO8' AS 'IB\_ENV\_RCVR\_ID', 'iop'.'GSO2' AS 'IB\_IN\_SNDR\_ID', 'iop'.'GSO3' AS 'IB\_IN\_RCVR\_ID', 'bpop'.'IB\_OVR\_ENV\_RCVR\_QUAL' AS 'IB\_OVR\_ENV\_RCVR\_QUAL', 'bpop'.'IB\_OVR\_ENV\_RCVR\_ID', 'AS 'IB\_OVR\_ENV\_RCVR\_ID', 'IOP'.'ISAO8' AS 'IB\_IN\_RCVR\_ID', 'IOP'.'ISAO8' AS 'ISAO8' AS 'ISAO 'bpop'.'IB\_OVR\_ENV\_SNDR\_QUAL' AS 'IB\_OVR\_ENV\_SNDR\_QUAL', 'bpop'.'IB\_OVR\_ENV\_SNDR\_ID' AS 'IB\_OVR\_ENV\_SNDR\_ID' AS 'IB\_OVR\_ENV\_SN

'bpop'.'OB\_OVR\_ENV\_RCVR\_QUAL' AS 'OB\_OVR\_ENV\_RCVR\_QUAL', 'bpop'.'OB\_OVR\_ENV\_RCVR\_ID', 'bpop'.'OB\_OVR\_ENV\_SNDR\_QUAL', 'bpop'. AS 'OB\_OVR\_INNER\_RCVR\_ID', 'bpop'.'OB\_OVR\_INNER\_E B\_TRX\_ENV\_SNDR\_QUAL' AS 'IB\_TRX\_ENV\_SNDR\_QUAL', 'bpop'.'IB\_TRX\_ENV\_SNDR\_ID' AS 'IB\_TRX\_ENV\_SNDR\_ "IB TRX INNER E

'bpop'.'OB\_TRX\_ENV\_RCVR\_ID' AS 'OB\_TRX\_ENV\_RCVR 'bpop'.'OB\_TRX\_INNER\_ENV\_SNDR\_ID' AS 'OB\_TRX\_IN = 'bp', 'RELATIONSHIP ID'))) LEFT JOIN 'ORGANIZA' 'ORGANIZATION' 'tpo' ON ((('tpo'.'ORGANIZATION ON (('bta'.'BOARDING\_TYPE\_ID' = 'bt'.'BOARDING ('rteid'.'PRIMARY FLAG' = 1) AND ('rteid'.'ORG (('tpoa'.'ORGANIZATION\_ID' = 'tpo'.'ORGANIZATIO

((('teid'.'ORGANIZATION\_ID' = 'tpo'.'ORGANIZATION\_ID' = 'tpo'.'ORGANIZATION'ID' = 'tpo'.'ORGANIZ

('meid'.'PRIMARY\_FLAG' = 1) AND ('meid'.'ORG\_ID

22 JOINS

TRX ENV SNDR I ORGANIZATION I ORGANIZATION\_ID TYPE ID' FROM 'D oa'.'ORG\_TYPE\_ID DE ID, ENOW , DIW '. 'PRIMARY FLAG'

#### 6 SUBQUERIES

OB\_TRK\_ENV\_RCVR\_QUAL', INNER RCVR ID', LATIONSHIP' 'rel' ON (('rel'.'RELATIONSHIP\_ID' ID' = 'ro'.'ORGANIZATION ID'))) LEFT JOIN NIZATION ID'))) LEFT JOIN 'BOARDING TYPE' 'bt' 'rto'.'ORGANIZATION\_ID') AND

)))) LEFT JOIN 'ORG TYPE ASSOC' 'tpoa' ON myo'.'ORGANIZATION\_ID') AND

)) LEFT JOIN 'ORG\_IDENTIFIER' 'teid' ON R\_TYPE' WHERE ('DIM\_ORG\_IDENTIFIER\_TYPE'.'NAME' R TYPE', 'ORG IDENTIFIER TYPE ID' FROM

= 'EID'))))) LEFT JOIN 'ORG\_IDENTIFIER' 'tduns 'DIM\_ORG\_IDENTIFIER\_TYPE' WHERE ('DIM\_ORG\_IDENTIFIER\_TYPE'. NAME' = 'DUNS'))))) LEFT JOIN 'ORG\_IDENTIFIER\_TYPE\_ID' = (SELECT 'DIM\_ORG\_IDENTIFIER\_TYPE'.'ORG\_IDENTIFIER\_TYPE\_ID' FROM 'DIM\_ORG\_IDENTIFIER\_TYPE' WHERE ('DIM\_ORG\_IDENTIFIER\_TYPE'.'NAME' = "GLN'))}))] LEFT JOIN 'ORG\_IDENTIFIER\_TYPE'.'ORG\_IDENTIFIER\_TYPE\_ID' FROM 'DIM\_ORG\_IDENTIFIER\_TYPE' WHERE ('DIM\_ORG\_IDENTIFIER\_TYPE'.'NAME' = "GLN'))}))] 1) AND ('reid'.'ORG\_IDENTIFIER\_TYPE\_ID' = (SELECT 'DIM\_ORG\_IDENTIFIER\_TYPE\_'.'ORG\_IDENTIFIER\_TYPE\_'.'NAME' = 'EID'))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD')))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD'))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD'))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD'))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD')))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD')))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD')))))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD'))))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD'))))))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD'))))))))) LEFT JOIN 'ORG\_DOC\_TYPE' 'iodt' ON (((('iodt'.'ORG\_DOC\_TYPE\_ID' = IOD')))))))))))))))))))))))))) 'bp'.'IB\_DOC\_TYPE\_ID') AND ((('myo'.'ORGANIZATION\_ID' = 'rel'.'PARTY1\_ID') AND (('bp'.'PARTY1\_ID') OR (('iodt'.'ORG\_DOC\_TYPE\_ID' = 'rel'.'PARTY2\_ID') AND ('bp'.'PARTY1\_DIRECTION' = 'ro')))) OR (('iodt'.'ORG\_DOC\_TYPE\_ID' = 'rel'.'PARTY2\_ID') AND ('iodt'.'ORG\_DOC\_TYPE\_ID' = 'rel'.'PARTY1\_DIRECTION' = 'ro')))) 'bp'.'OB\_DOC\_TYPE\_ID') AND ((('myo'.'ORGANIZATION\_ID' = 'rel'.'PARTY1\_ID') AND ('bp'.'PARTY1\_ID') AND ('bp'.'PARTY1\_ID') AND ('myo'.'ORGANIZATION\_ID' = 'rel'.'PARTY2\_ID') AND ('bp'.'PARTY1\_ID') AND ('bp'.'P (('idt'.'DOC\_TYPE\_ID' = 'iodt'.'DOC\_TYPE\_ID') | LEFT JOIN 'ORG\_DOC\_TYPE\_' 'oodt' ON (((('oodt'.'ORG\_DOC\_TYPE\_ID') AND (('myo'.'ORGANIZATION\_ID' = 'rel'.'PARTY1\_DIRECTION' = 'TO')) OR (('myo'.'ORGANIZATION\_ID' = 'to')) OR (('myo'.'ORGANIZATION\_ID = 'xel'.'FARTY2\_ID') AND ('bp'.'FARTY1\_DIRECTION' = 'FROM'))) OR (('oodt'.'ORG\_DOC\_TYPE\_ID' = 'bp'.'ORGANIZATION\_ID' = 'xel'.'FARTY1\_ID') AND ('bp'.'FARTY1\_DIRECTION' = 'FROM')) OR (('myo'.'ORGANIZATION\_ID' = 'xel'.'FARTY1\_ID') AND ('bp'.'FARTY1\_ID') AND ('bp'.'FARTY1\_ID') OR ('myo'.'ORGANIZATION\_ID' = 'xel'.'FARTY1\_ID') 'rel'.'PARTYZ\_ID') AND ('bp'.'PARTYI\_DIRECTION' = 'TO')))))) LEFT JOIN 'DIM\_DOC\_TYPE' 'odt' ON (('odt'.'DOC\_TYPE\_ID' = 'codt'.'DOC\_TYPE\_ID'))) LEFT JOIN 'BUSINESS\_FROCESS\_OVERRIDE\_FARAM' 'bpop' ON (('bpop'.'BUSINESS\_FROCESS\_OVERRIDE\_FARAM\_ID' = 'TO'))))

'bp'.'BUSINESS PROCESS ID'))) LEFT JOIN 'ORG DOC TYPE PARAMETER BUSINESS PROCESS VIEW' 'iop' ON (('iop'.'ID' = 'bp'.'B DOC TYPE ID'))) LEFT JOIN 'ORG DOC TYPE PARAMETER BUSINESS PROCESS VIEW' 'oop' ON (('oop'.'ID' = 'bp'.'OB DOC TYPE ID'))) WHERE ((((\"myo'.'ORGANIZATION\_ID' = 'rel'.'PARTY1\_ID')) AND ('tpo'.'ORGANIZATION\_ID' = 'rel'.'PARTY2\_ID')) OR ((\"myo'.'ORGANIZATION\_ID' = 'rel'.'PARTY1\_ID'))) AND ISNULL('bp'.'ORGANIZATION\_ID' = 'rel'.'PARTY1\_ID')))



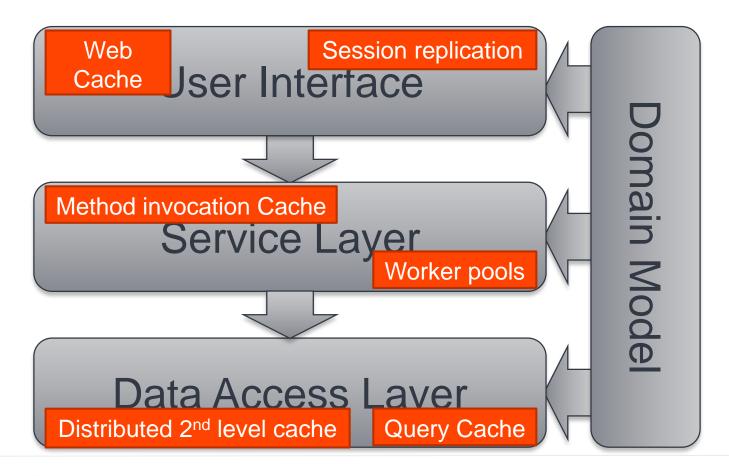






### Layered architecture

Ponder and deliberate before you make a move. —Sun Tzu













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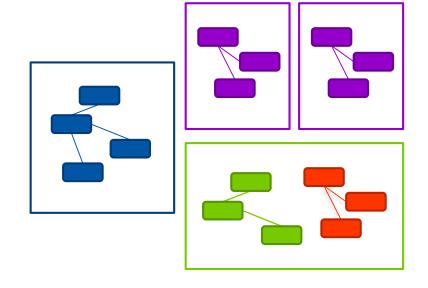






### Microservices systems

- Splitting up systems into smaller, simpler components
  - Agility
  - Scalability











# CQRS

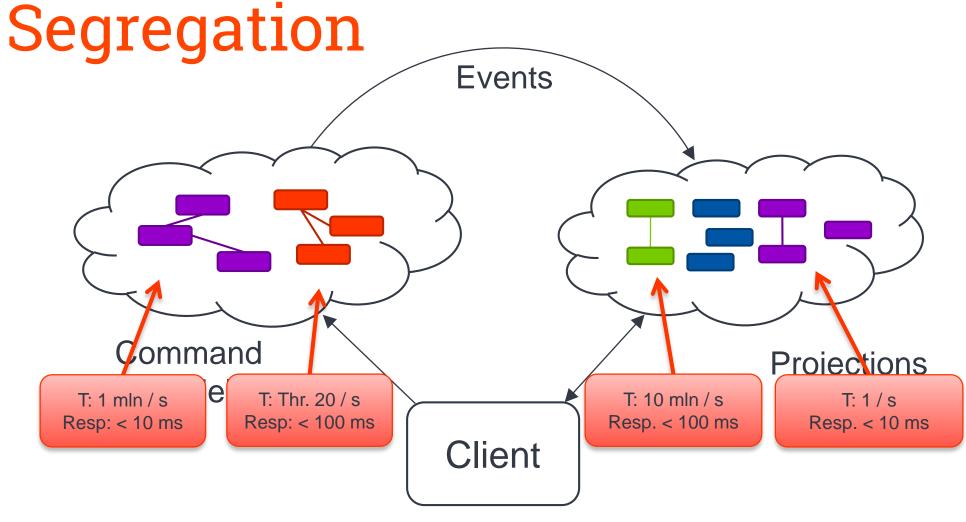








Command Query Responsibility

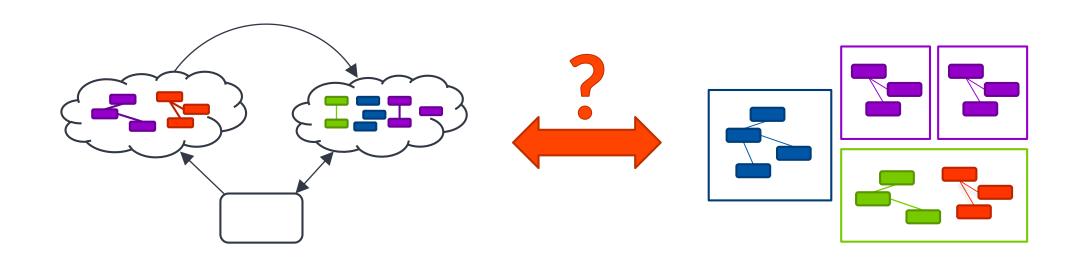












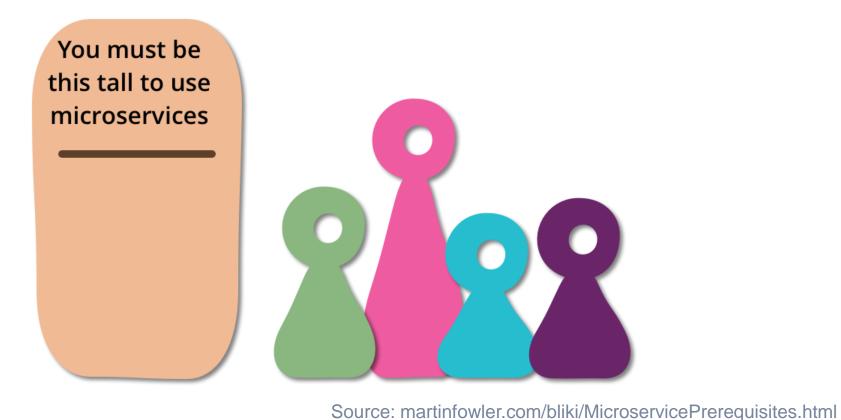








### Are you tall enough?











### "Noun Driven Design"





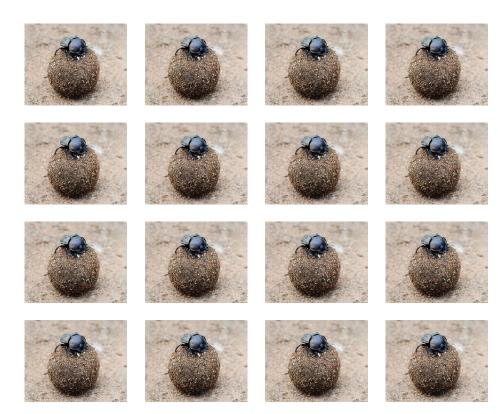




### "Entity Services"















### Monoliths







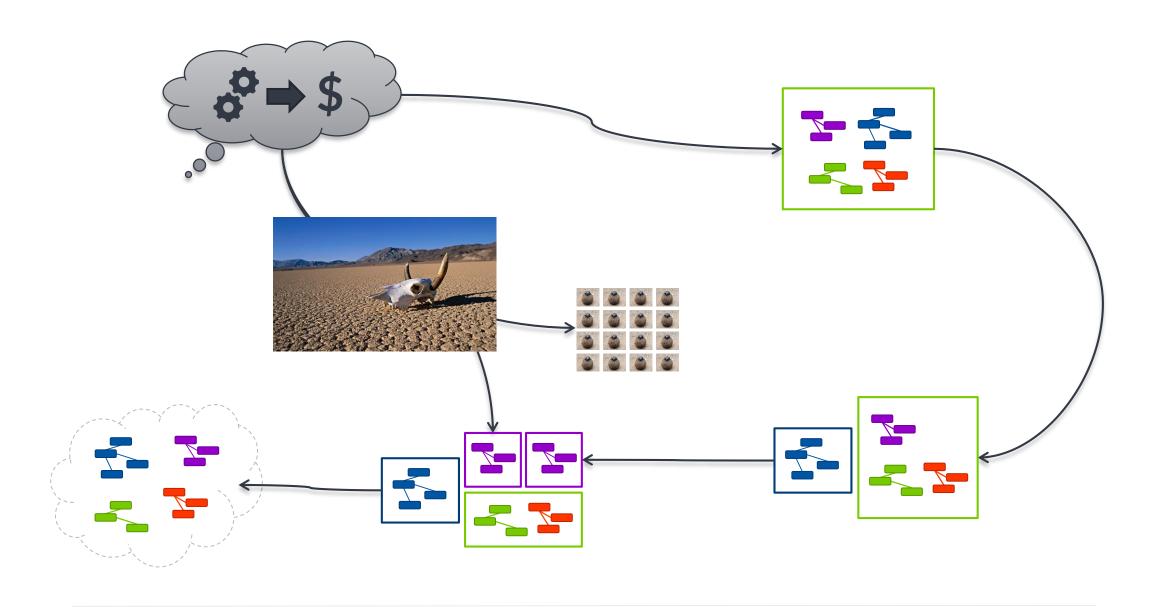
St Breock Downs Monolith - www.cornwalls.co.uk









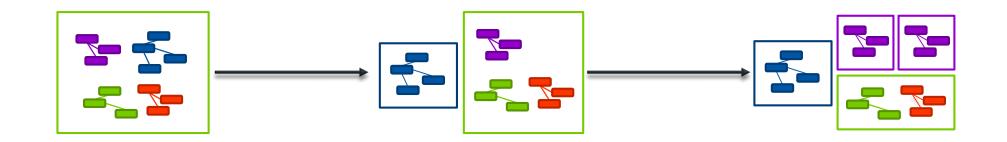








### Location transparency



A component should neither be aware of nor make any assumptions about the location of components it interacts with.

Location transparency starts with good API design (but doesn't end there)



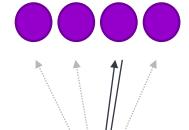






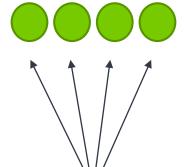
### Microservices Messaging

#### Commands



Route to single handler Use consistent hashing Provide result

#### **Events**



Distribute to all logical handlers Consumers express ordering req's No results

#### Queries





Route with load balancing Sometimes scatter/gather Provide result

"Event" and "Message" is not the same thing



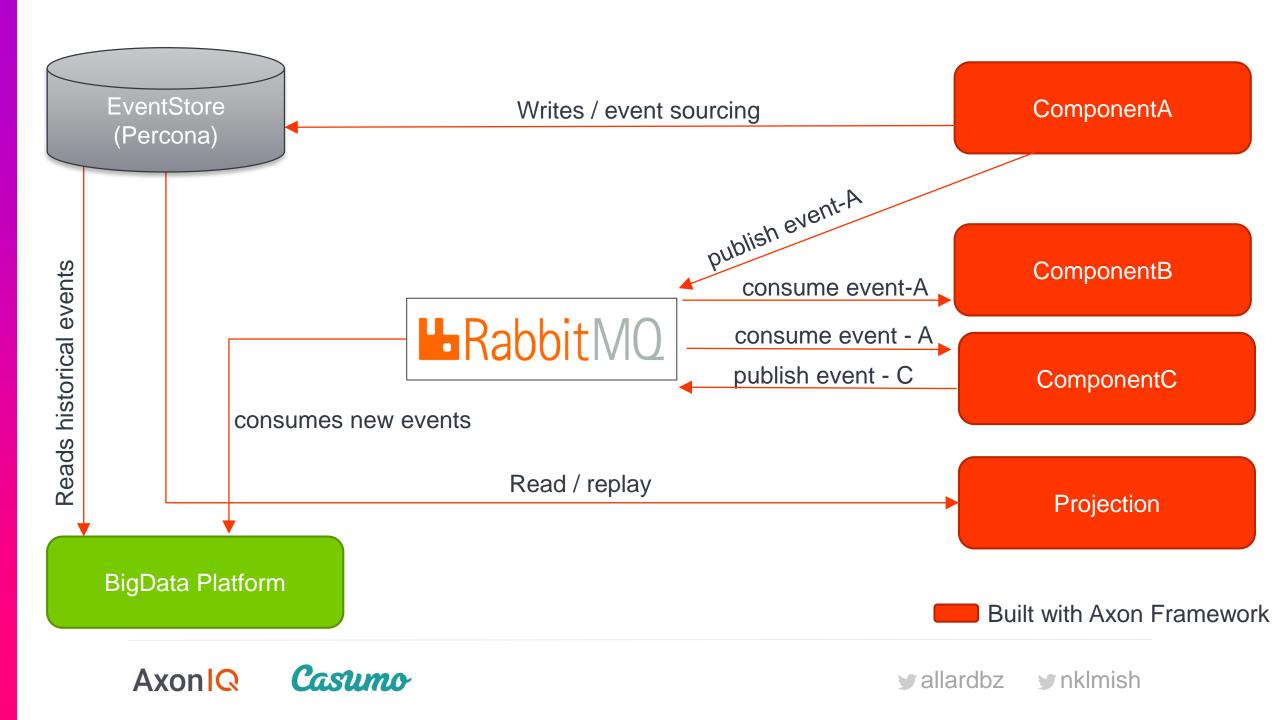












### Casumo

- Event store with >30 billion events
- Hundreds of millions of events, every day
- Every event is EQUALLY important

"I was thinking I might win 50 pounds but when it went all the way to the jackpot I was shocked." - Mega Fortune £2,700,000 jackpot won on the 3rd spin.







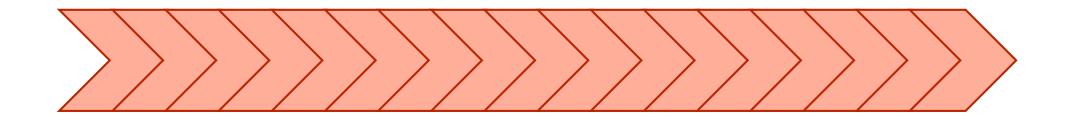






### **Event Store operations**

- Append
- Validate 'sequence'





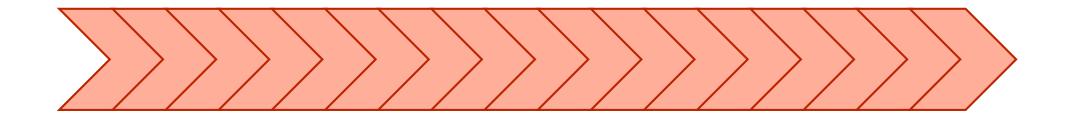






### **Event Store operations**

Full sequential read





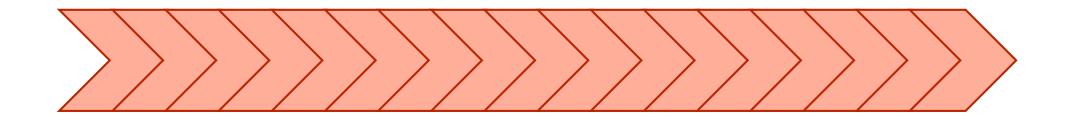






### **Event Store operations**

Read aggregate's events











### Serialized form

Keep it small

Use aliases & abbreviations

Carefully select serializer

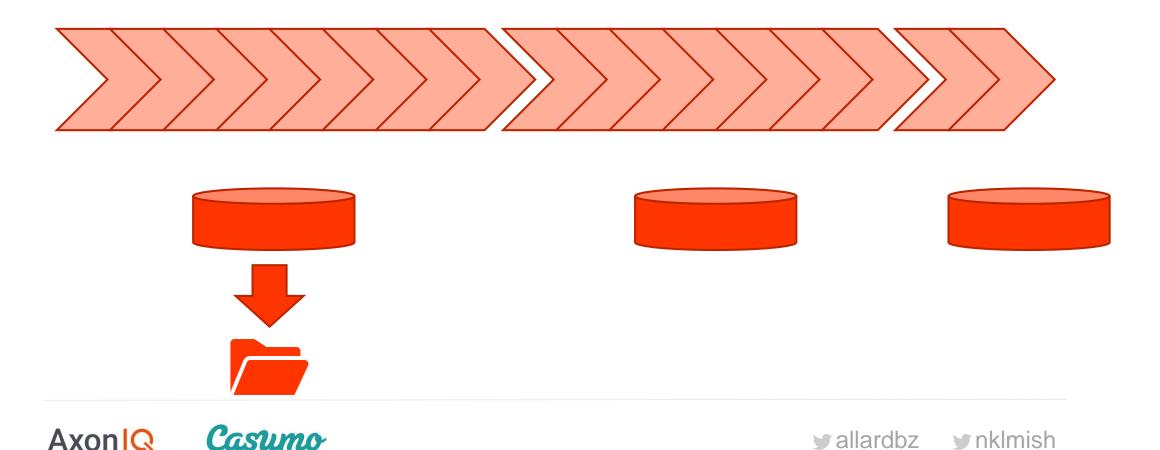








### Partitioning and archiving



### Loading aggregates - snapshots

€ 996 in wallet @ 7 € 7 in wallet @ 3

€ 1M jackpot won!! € 10 wagered € 1000 withdrawn € 2000 won 4: € 1 wagered € 2 wagered € 1 wagered € 10 deposited Wallet created

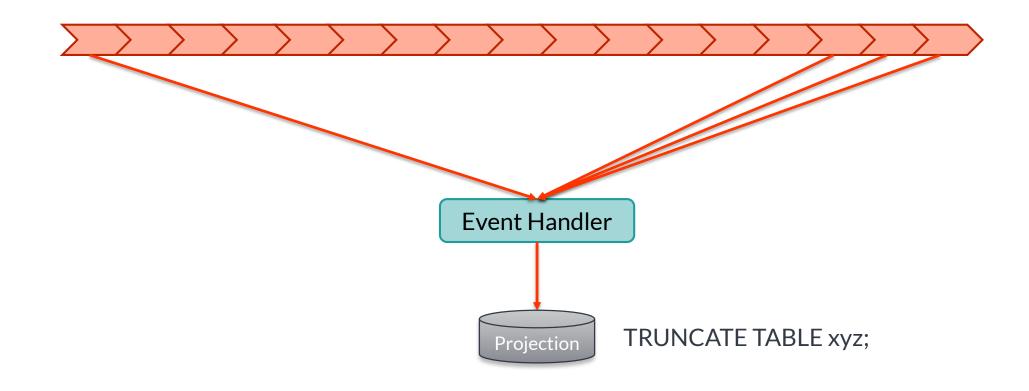








### Replays



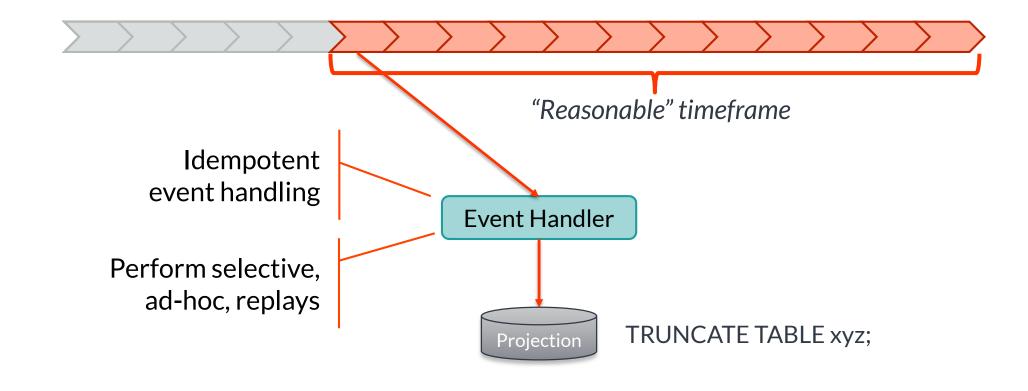








### Partial replays



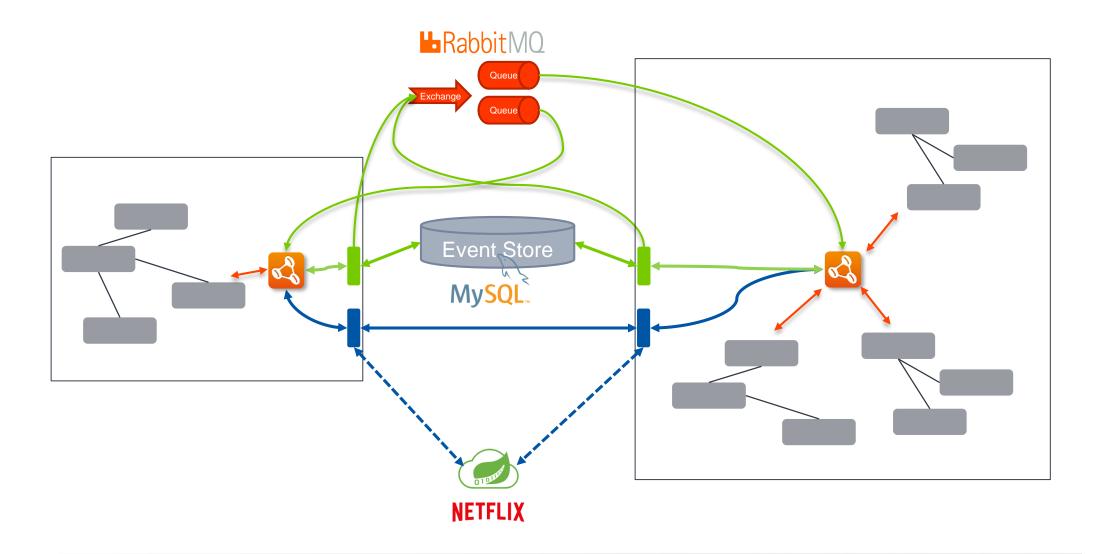










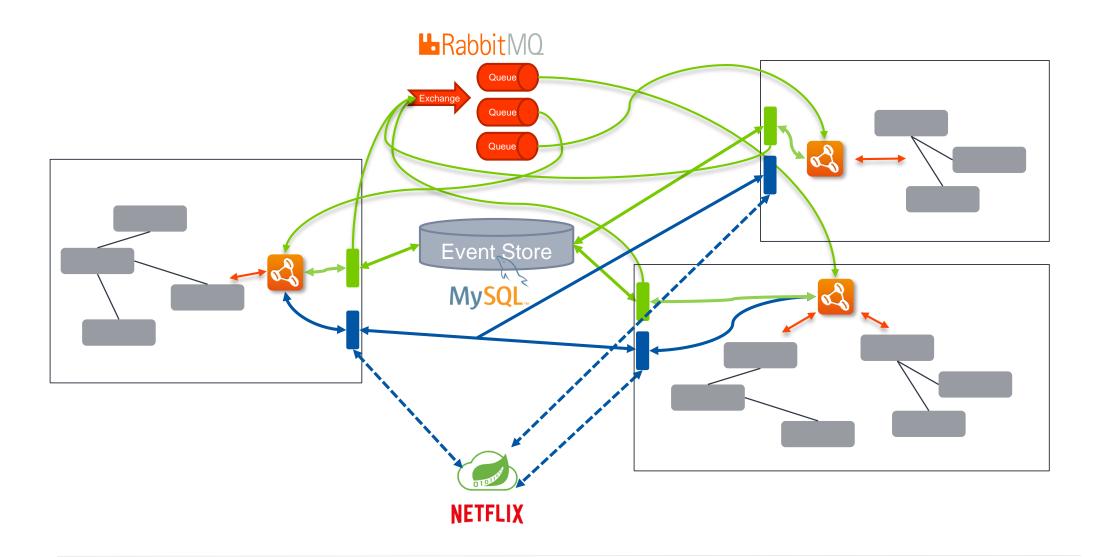










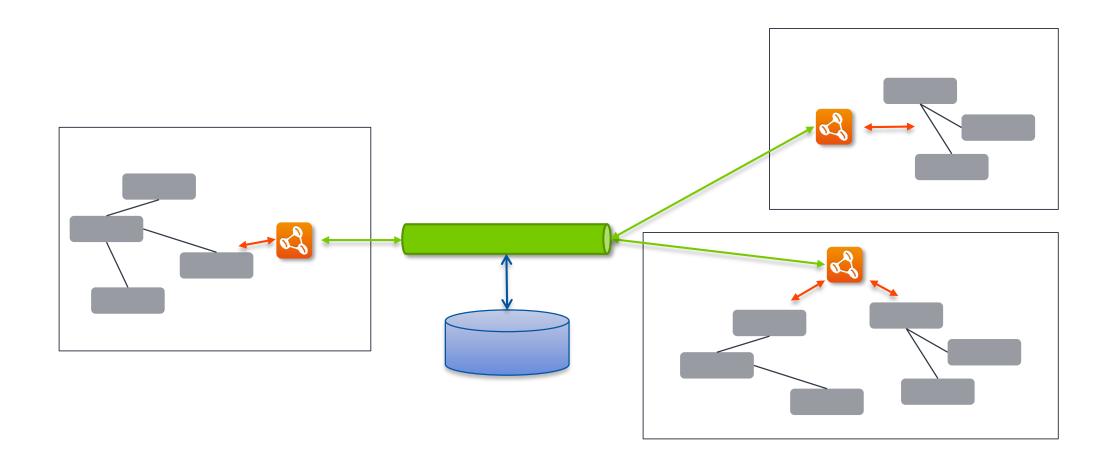












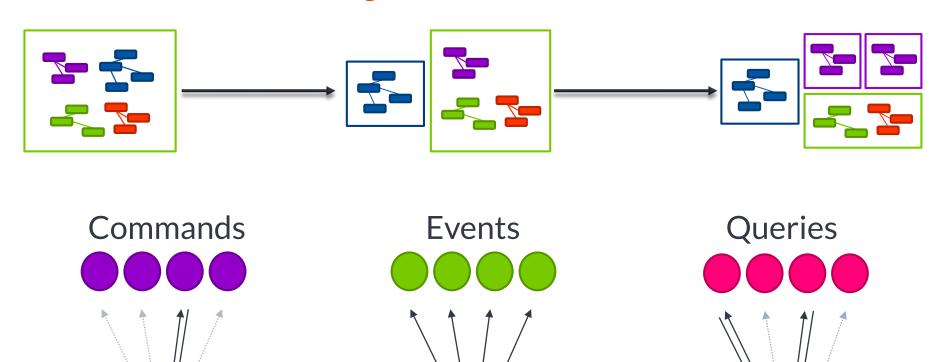








# Evolutionary microservices

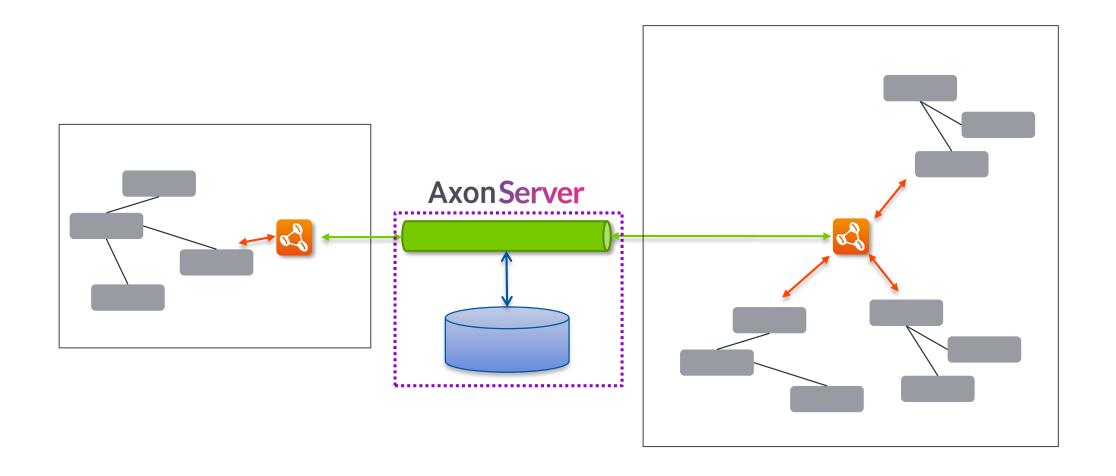










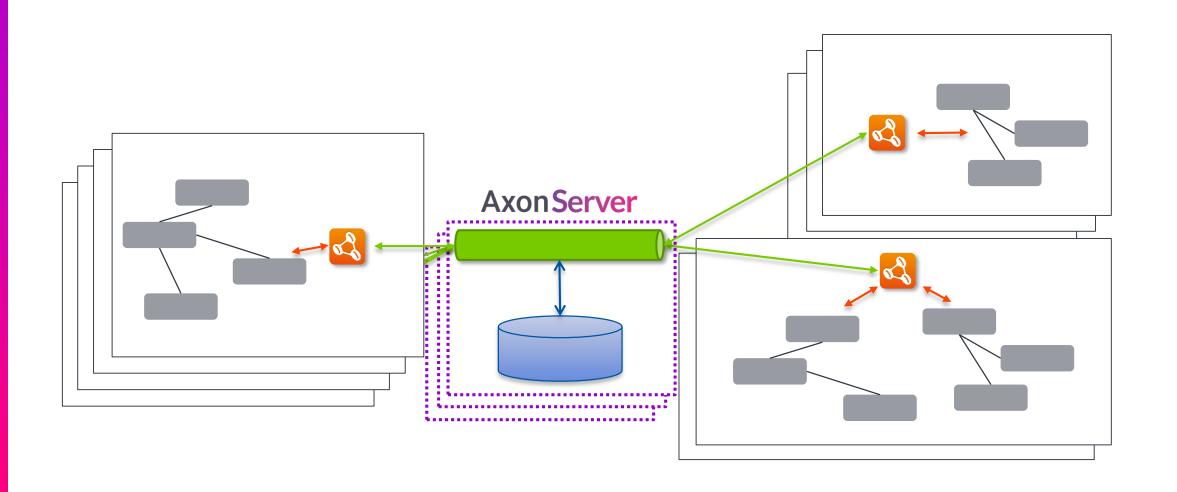






















## Unmanageable mess

Bet Placed
Bet Accepted
Bet Won
Bet Lost
Bet Reverted



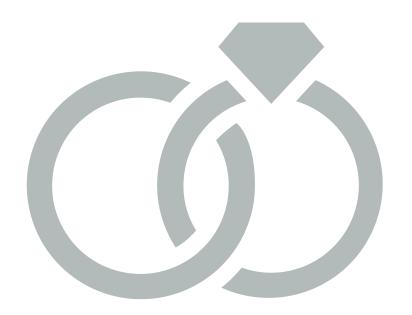








## **Communication = Contract**











#### Bounded context

Explicitly define the context within which a model applies. Explicitly set boundaries in terms of <u>team organization</u>, usage within specific parts of the application, and <u>physical manifestations</u> such as code bases and database schemas. Keep the <u>model strictly consistent</u> within these bounds, but don't be <u>distracted or confused by issues outside</u>.

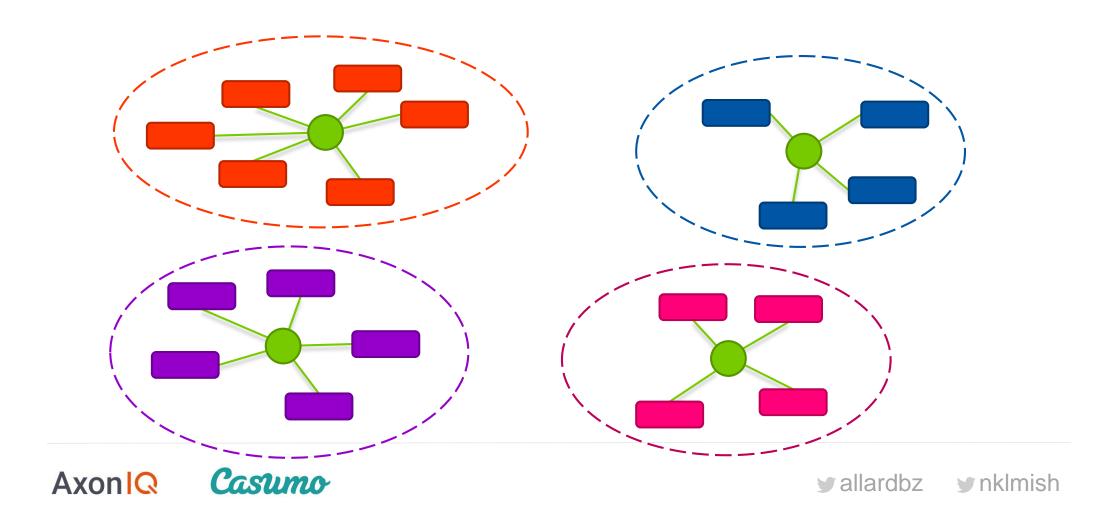








# Within a context, share 'everything'



Between contexts, share 'consciously' As a Wallet module I want to know when to withdraw money from the wallet Bet placed → Claim Funds **Bet Placed** Bet Accepted Bet Won Bet Lost Bet Reverted Axon Casumo **y** allardbz **y** nklmish

## Lessons learned



















## References

- Axon
  - axoniq.io
  - github.com/axonframework
  - **y** @axonframework
- Casumo
  - casumo.com







