Patterns for scalability and availability in (trading) systems

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Saxo Bank – introduction

- Global online investment bank – facilitator/broker setup - offices in 25 countries clients in 180 countries
- Specialises in online trading and investment, servicing retail clients, corporations and financial institutions
- A leading presence in online trading due to client service, competitive pricing and industry-leading trading platforms.
- Enables private investors and institutional clients to trade FX, CFDs, ETFs, Stocks, Futures, Options and other derivatives via multi-award winning online trading platform.
- 3rd generation technical platform and evolving – Microsoft based, mostly custom developed in house
- 10 of thousands of concurrent users, 100 of thousands of price updates/sec, very high transaction peaks around numbers and market state changes.

Core Business Model

Cloud based – Platform as service – White label

Truly multi-asset / single account

OTC

Forex

- ✓ 160+ crosses
- ✓ Tradable quotes
- ✓ Request for quotes
- ✓ Margin

CFD

- ✓ 8700+ stocks, 22 index trackers,20 commodities
- ✓ Tradable quotes, extensive liquidity
- ✓ Algorithmic orders/Smart order routing/DMA

FX Options

- ✓ 40+ crosses
- ✓ Tradable quotes
- ✓ Broad coverage 1d-1y
- ✓ Vanilla, binary touch

Bonds

- ✓ Wide range sovereign, government, corporate bonds
- ✓ Offline traded
- ✓ Collateral

Exchange Traded

Stocks

- ✓ 18400+ equities
- ✓ 33 exchanges
- ✓ Algorithmic orders/Smart order routing/DMA

Futures

- ✓ 230+ base contracts
- ✓ 22 exchanges
- ✓ Margin

ETFs & ETCs

- ✓ 2270+ exchange traded funds (ETF), commodities (ETC)
- ✓ Listed, traded and settled as stocks

Contract options

- ✓ 66+ base contracts (stock indicies, commodities, interest rates, forex)
- ✓ 17 exchanges
- ✓ Margin (SPAN/Portfolio)

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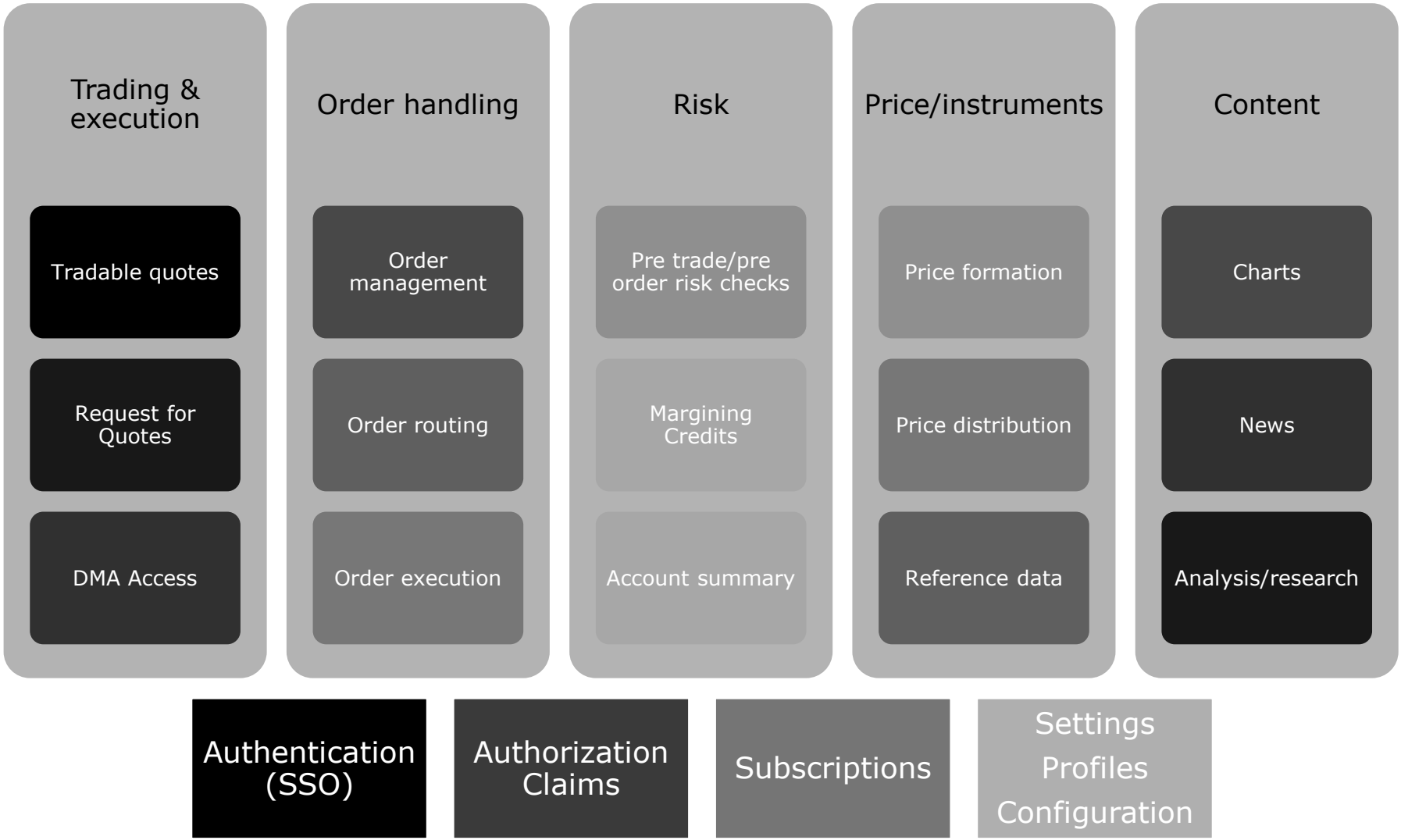
Workflow/service requirements



The numbers…

Over ***13,000*** concurrent online clients - operational and open 5.5 days * 24 hours

In excess of ***400,000*** price feed updates per second

Intraday execution of up to ***900*** trades per second

Over ***500,000*** trades booked and processed daily

160,000 unique users monthly to our trading portal

While maintain latencies in the single digit millisecond range throughout

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Business challenges

Unified and compelling client experience

- Across devices/platforms
- Across products
- Across segments
- Across geographies

Cost-efficiency

- Technology sharing
- Reuse
- Avoid duplication and proliferation

Faster time to market and flexibility

- New products
- Features/sophistication
- New geographies

Compliance and regulation

- Regulated in many geographies direct/indirect

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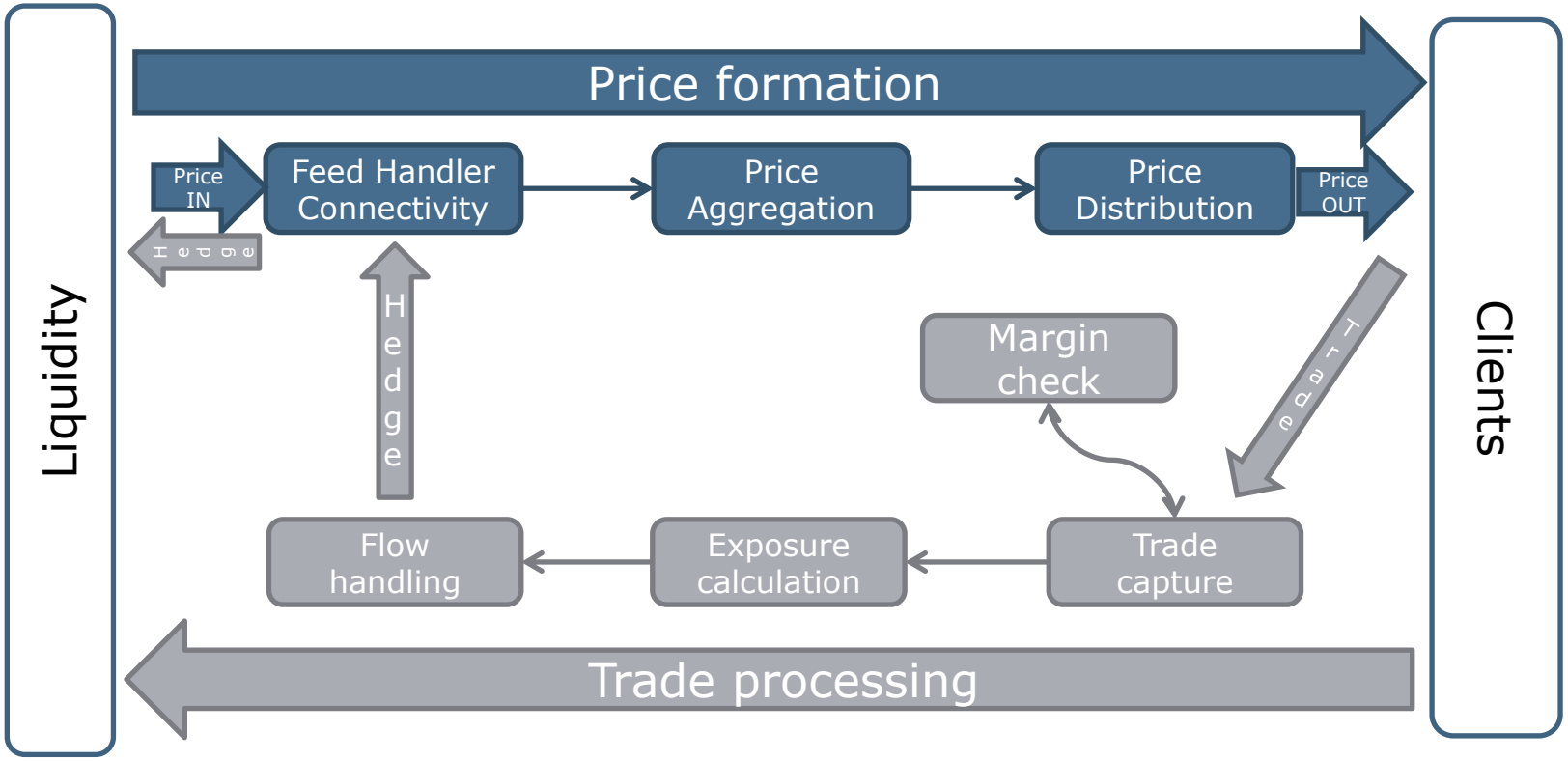
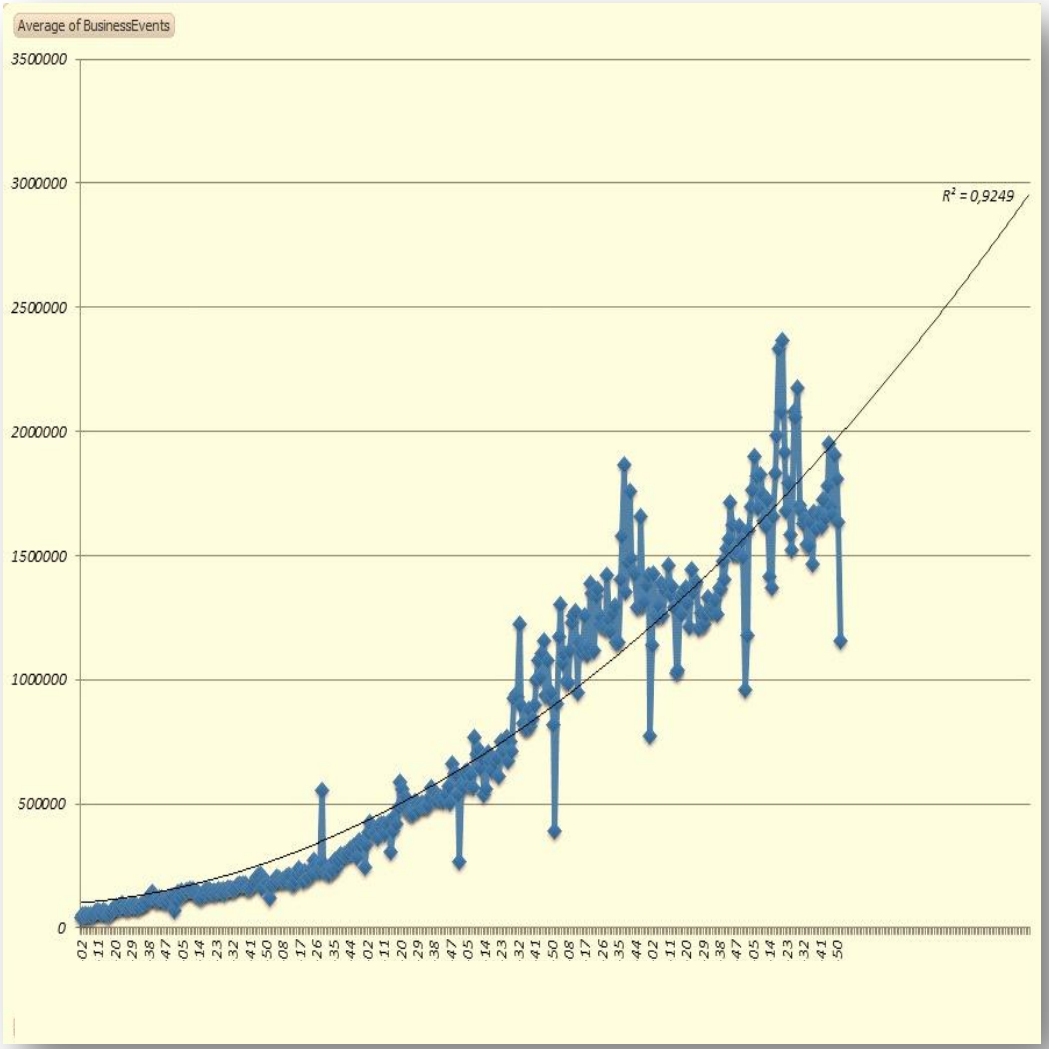
Critical business flows – where milliseconds matter



Challenge - Business growth – with corresponding data growth



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Trading systems are ”Reactive systems” - at heart …

…core design principles mapped to tenets of reactive

Responsive	Elastic	Resilient	Message Driven
• Casual/eventual consistency guarantee • Horizontal scaling/partitioning of work sets • Asynchrounous/fire and forget interaction where it can be supported • Very high throughput and tight latency requirements	• Scale out on commodity hardware • Horizontal scaling/partitioning of work sets • Swift capacity growth by horizontal scaling	• Redundancy (active/active) • No single points of failure • Automated seamless failover • Survive with reduced service a datacenter failure/outage • State replication	• Event driven / Message based • Losely coupled through topic based pub/sub (location independent)

http://www.reactivemanifesto.org/

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Technical Environment

Microsoft through and through

- *Windows 2008/2012 servers*
- *SQL Server 2012*

Middleware/Messaging

- *29West / Informatica (Multicast messaging and persistence)*
- *WCF*
- *MS Biztalk (Integration backoffice/enterprise)*
- *Plain old sockets*

Standard Windows Services (.NET C#, C++, IIS 7.5)

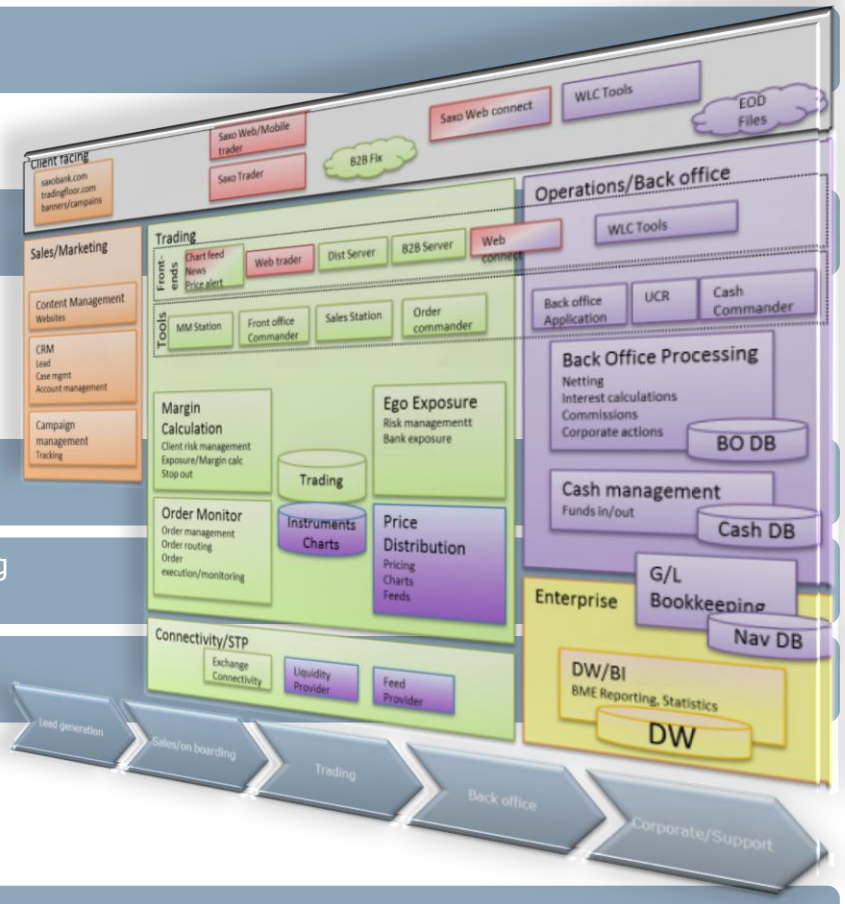
Shared in process components for business logic and caching

Monitoring, instrumentation & tracing

- *Velocimetrics*
- *SCOM*
- *Standard Windows performance counters*
- *Eventlog and Logfiles*

Cisco infrastructure

- *ISP Grade*
- *MPLS*



Target architecure – front office

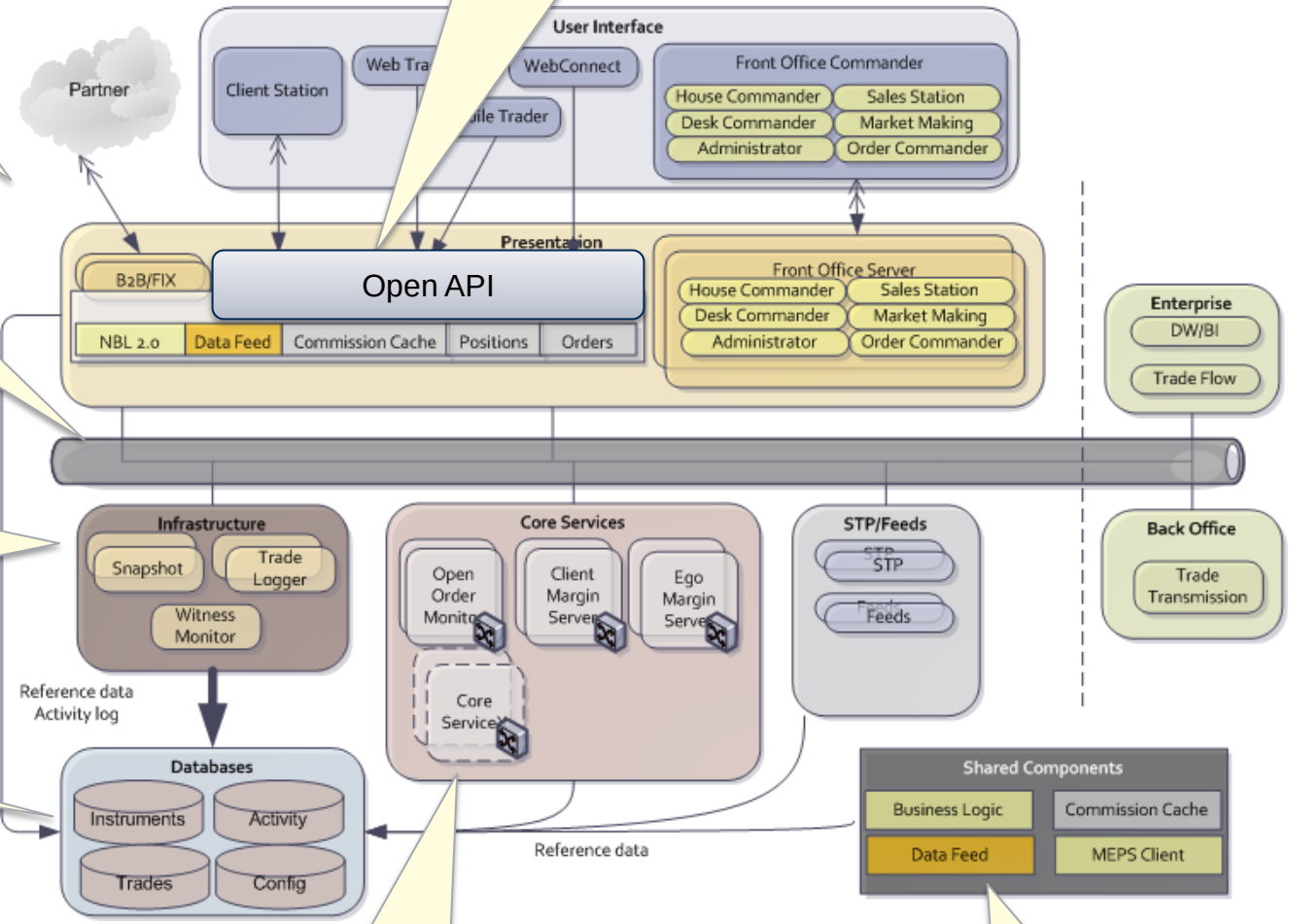
REST based Open API with streaming over websockets for services

Presentation layer for different clients and front ends. Scales horisontally. Sticky sessions. Front loading of business logic.

High performance messaging middleware with horisontally scalable persistence (Prices, Trades, Orders)

Back end, infrastructure services, horisontally partitioned and fault tolerant (redundant)

Data store running mirroring/HA. Single instance.



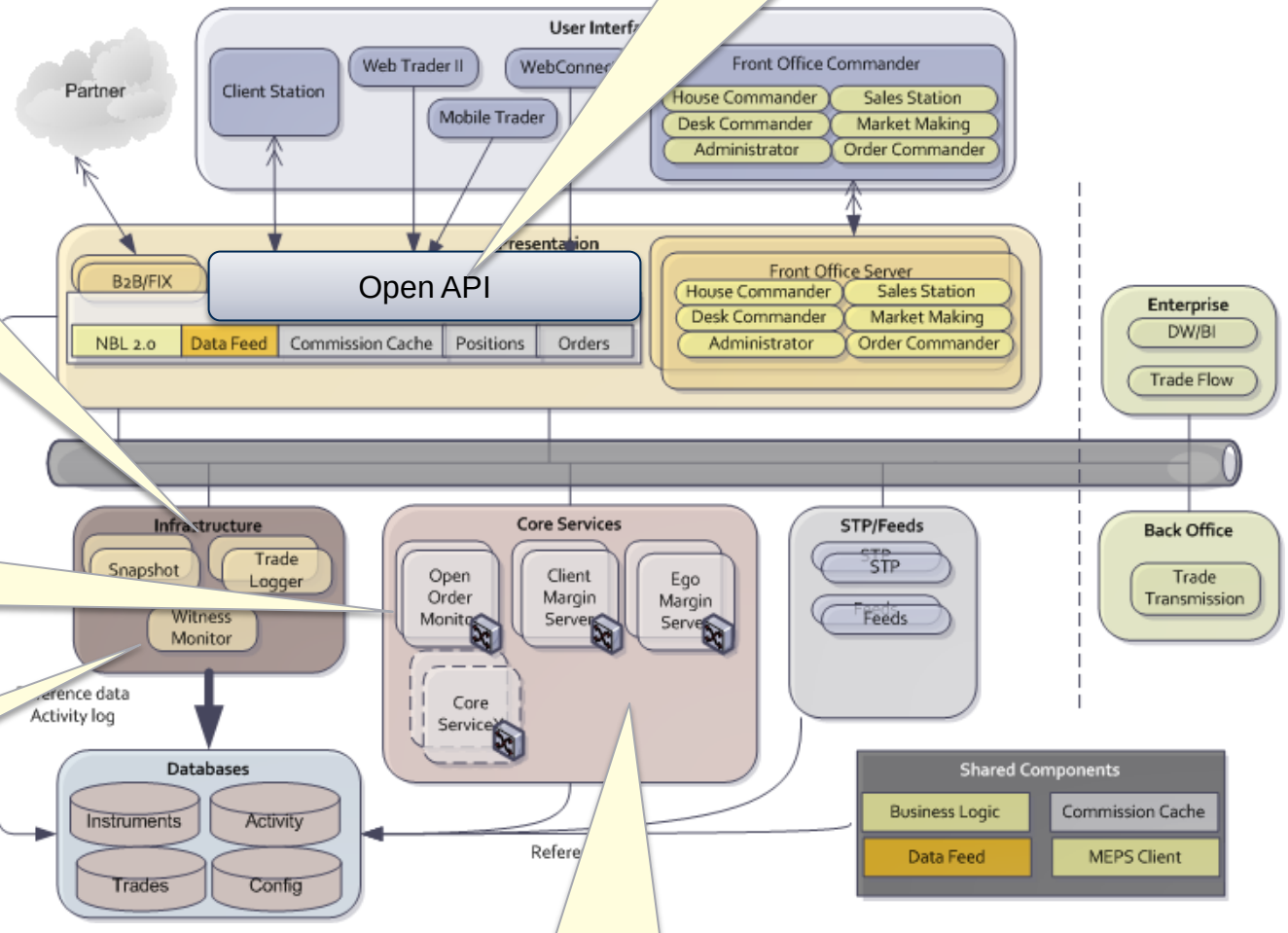
Active/active MESH segmenting/partioning of workloads along some axis

Large grained shared components encapsulating in-process buslogic and in memory data

Interesting patterns

Scalable session managment shared streaming channel among service groups, pluggable servic groups

Asynchrous transaction logging backed by messaging system



Meshes of partioned servers executing realtime automated business processes and actions

Witness server to acheive seamless failover (active/active)

Monitoring/Tracking

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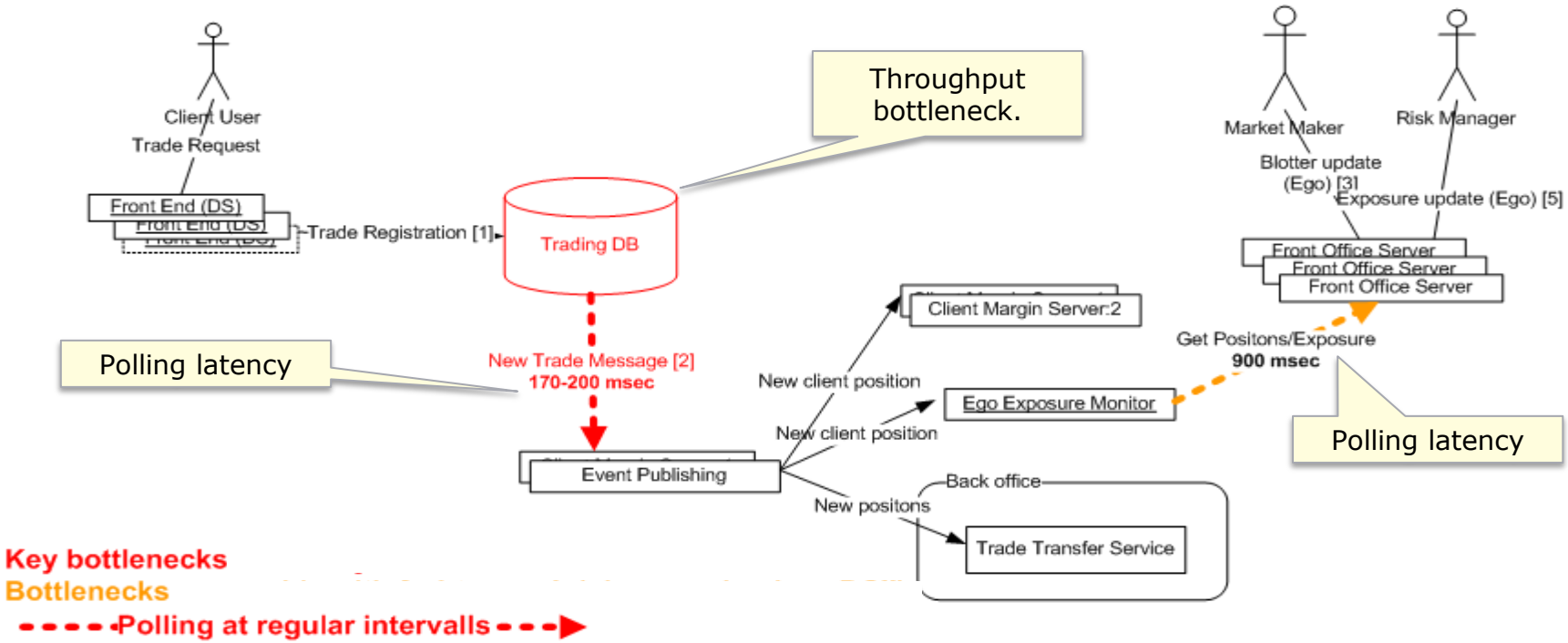
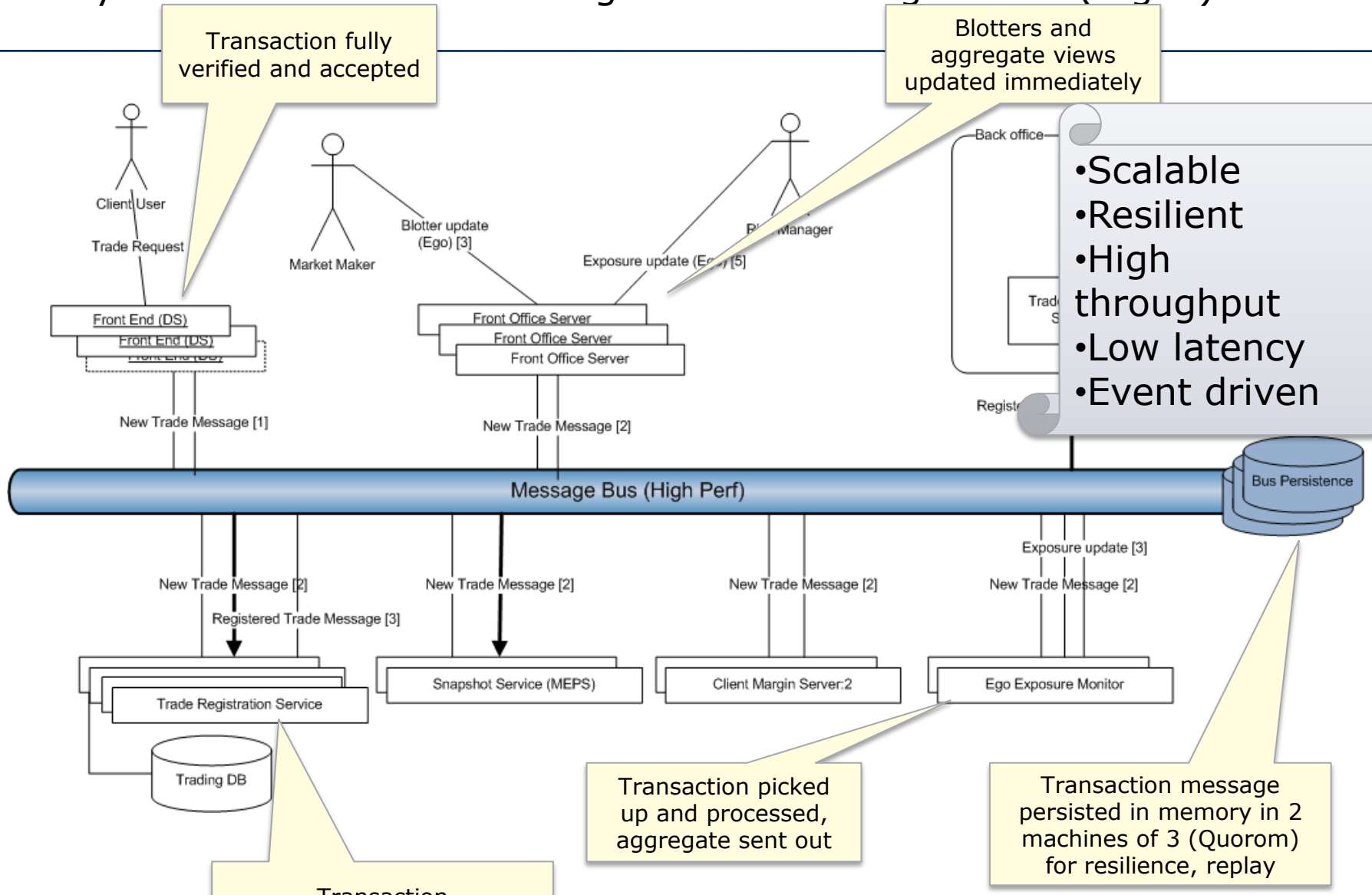
Traditional architecture – start state

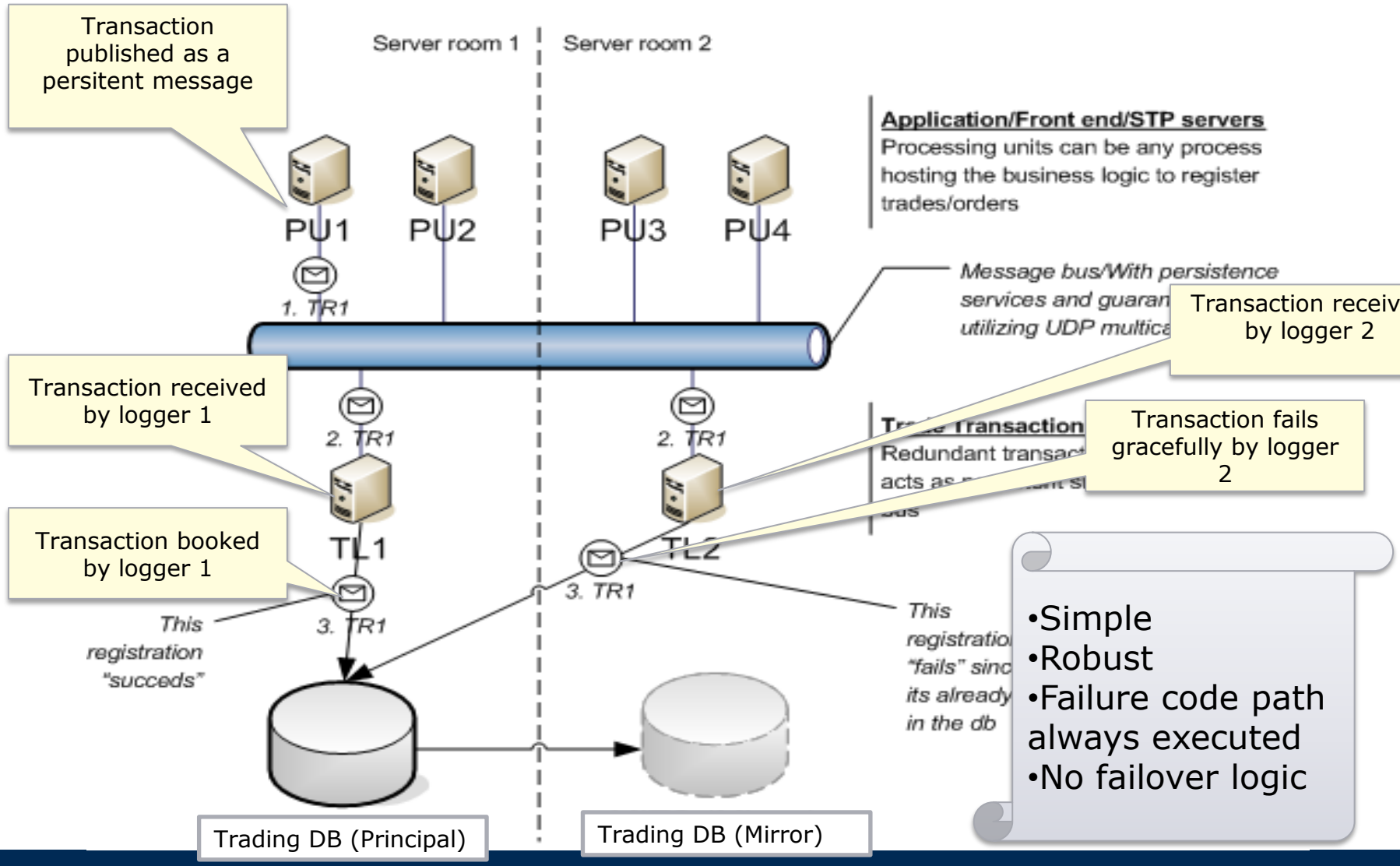


- Long latency
- Database bottleneck
- Capped throughput (by DB)

Asynchronous Transaction Registrations – Target state (3 gen)



Asynchrounous Transaction Registrations – Final Twist (fully active)



Its not all architecture and technology

People

- Hire the best
- Performance culture
- Cultivate engineering mindset and agility
- Supporting management

Process

- Change/Release
- Test/quality
- Incident management
- Monitoring

Business

- Close cooperation
- Agile methodology
- Change managment
- Hamper complexity

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Learning points - liabilities

- Architecture needs resilience, scalability, monitoring, supportability built in and taken care from the start due to complexity and number of nodes/ci
- Synchronize projects and implementation with infrastructure (machine rooms, firewalls, network segmentation - is also part of the solution)
- Do gradual rollout and provide rollback and backwards compatibility to decrease operational risk of large architectural impacting changes.
  - This comes at a cost both in development and phasing out of old style clients
- Test and verify thoroughly

- Your architects might get skinny and loose some hair

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