GridGain In-Memory Data Fabric:

In-Memory Computing To Achieve Real-Time
Financial Regulatory Compliance

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FINANCIAL SERVICES

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Agenda

- Economic Outlook
  - Overview
  - Banking Industry Challenges
  - Banking Industry Responses
- Regulatory Initiatives
  - What's Coming in 2016
- Key Industry Trends
  - New Strategies
  - New Technologies
- GridGain and In-Memory Grid Computing for Financial Services
  - Overview
  - Advantages
  - Financial Use Cases
- Q & A

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Economic Outlook

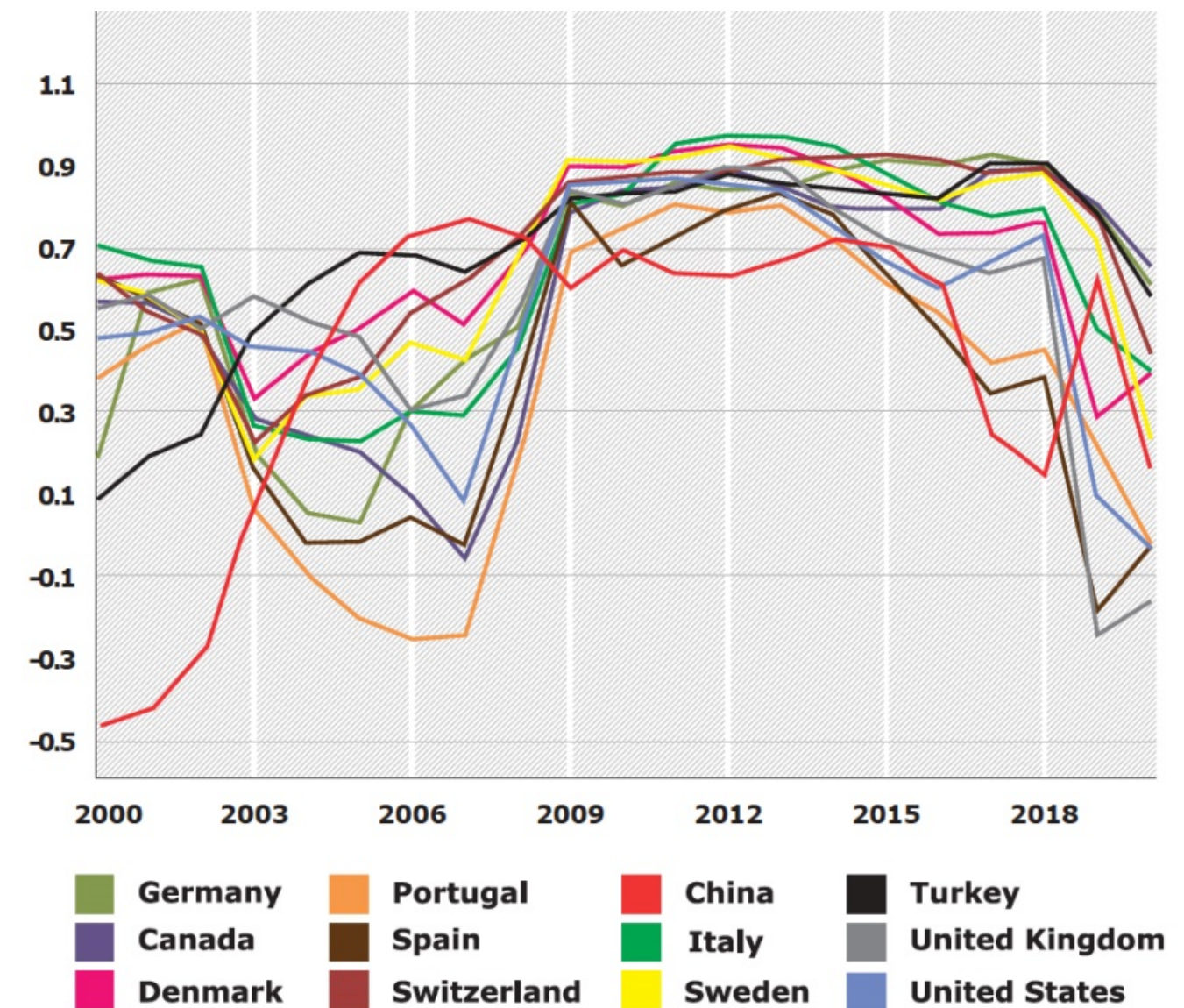*GridGain Company Confidential*

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Economic Outlook Summary for 2016: unstable slowness

- 2015-2016: Slight economic growth after crisis with low inflation, low interest rates

- Slowest economic recovery in recorded history

- Developed markets demonstrate slow unsustainable growth

- Emerging markets still in trouble: 3.2% median growth

  - Slowest EM growth since the 1998 financial crisis

  - Declining oil prices

  - China growth is slowing (10% → 7% → ~5.5% $_{forecast}$)

  - Many EMs are in deep recession: Brazil, Russia

- <u>Forecast is pessimistic:</u> divergence of economic growth across the globe continues to increase

Economic Performance for Individual Economies is Diverging

Rolling 10-Year Correlation to World GDP

Legend: Germany, Portugal, China, Turkey, Canada, Spain, Italy, United Kingdom, Denmark, Switzerland, Sweden, United States

Source: International Monetary Fund (data 2015-2020 based on IMF projections)

Banking Industry: Klondike is gone after 2008

- Return on Equity (ROE) is below 10% for top-10 global banks: no more "easy" money

Source: Roland Berger

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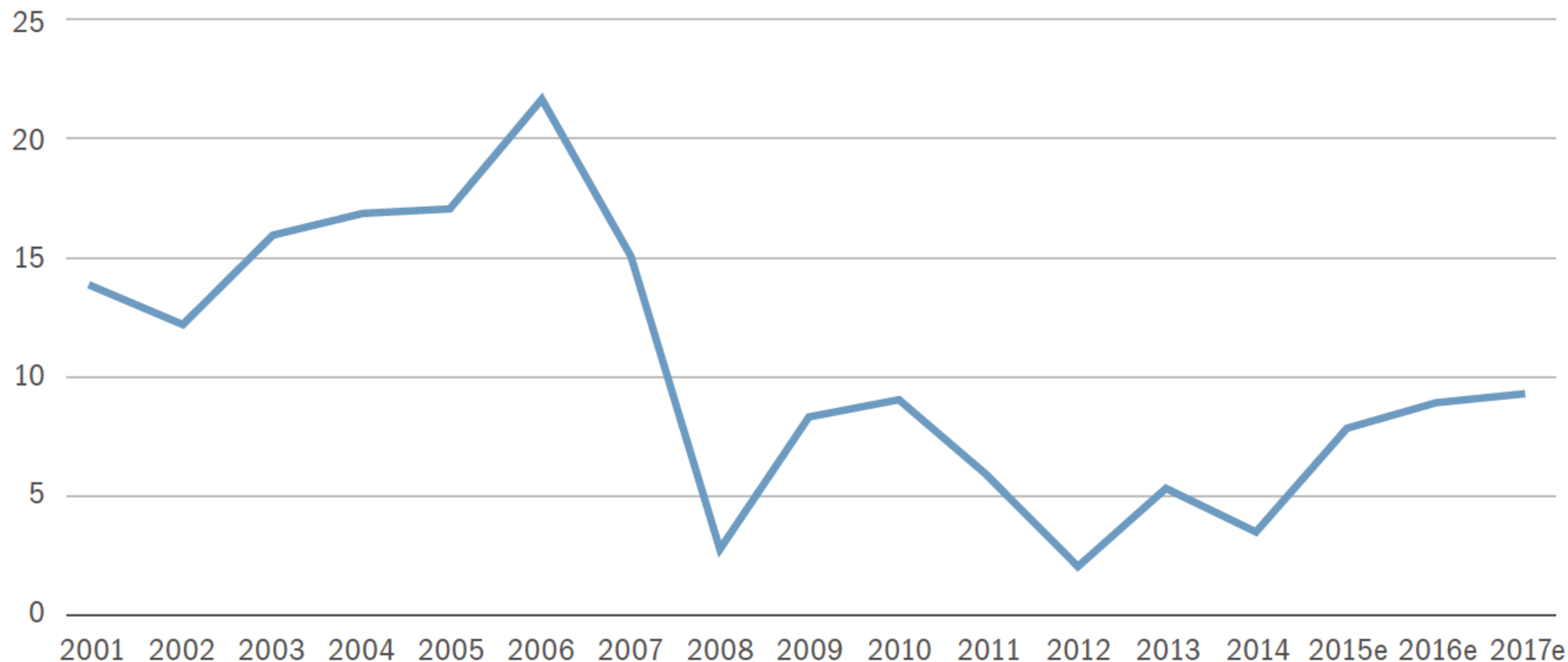
Banking Industry: the new post-2008 reality

- **Regulatory tightening**: US / EU / APAC regulators do not want a repeat of "2007-2008 crisis"

- **Shareholders are losing money on banks' stock shares**: Investors expecting ROE ~9% over 2015-2017 instead of previous 16-20%, and this is still below cost of equity

- **Deleveraging** (reduction of debt and risky assets / businesses in the balance sheet): Capital Ratios (RWA) effectively doubled under new regulatory demands

- **Compliance and Penalties Funds**: Much higher expenses for restructuring, litigation and regulatory compliance

PROFIT REDUCTION

EXHIBIT: INCREMENTAL DELEVERAGING PLANS AMONG TOP 10 GLOBAL INVESTMENT BANKS

Source: Roland Berger

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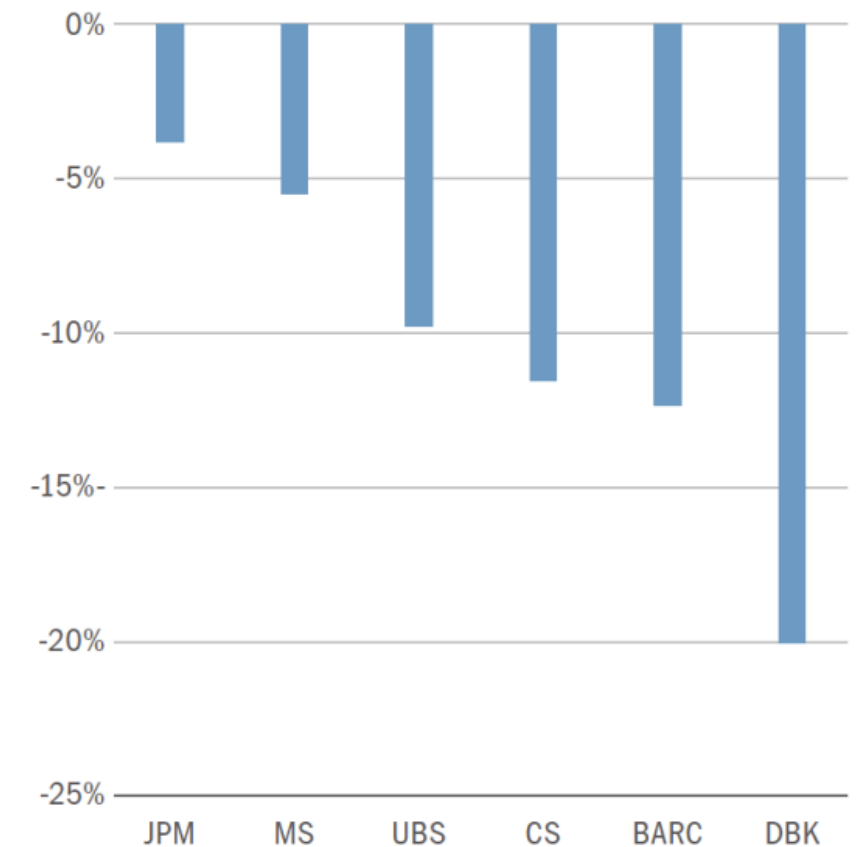
Litigation charges: the price to pay for 2000's sins

- Litigation costs (regulatory fines and client settlements for market misconduct) are severely driving Cost / Income (profitability) ratios down
- Fines exceeded US $230+ billion (US $120+ billion for U.S. mortgages, others are for FX trading misconduct and LIBOR manipulation felonies)
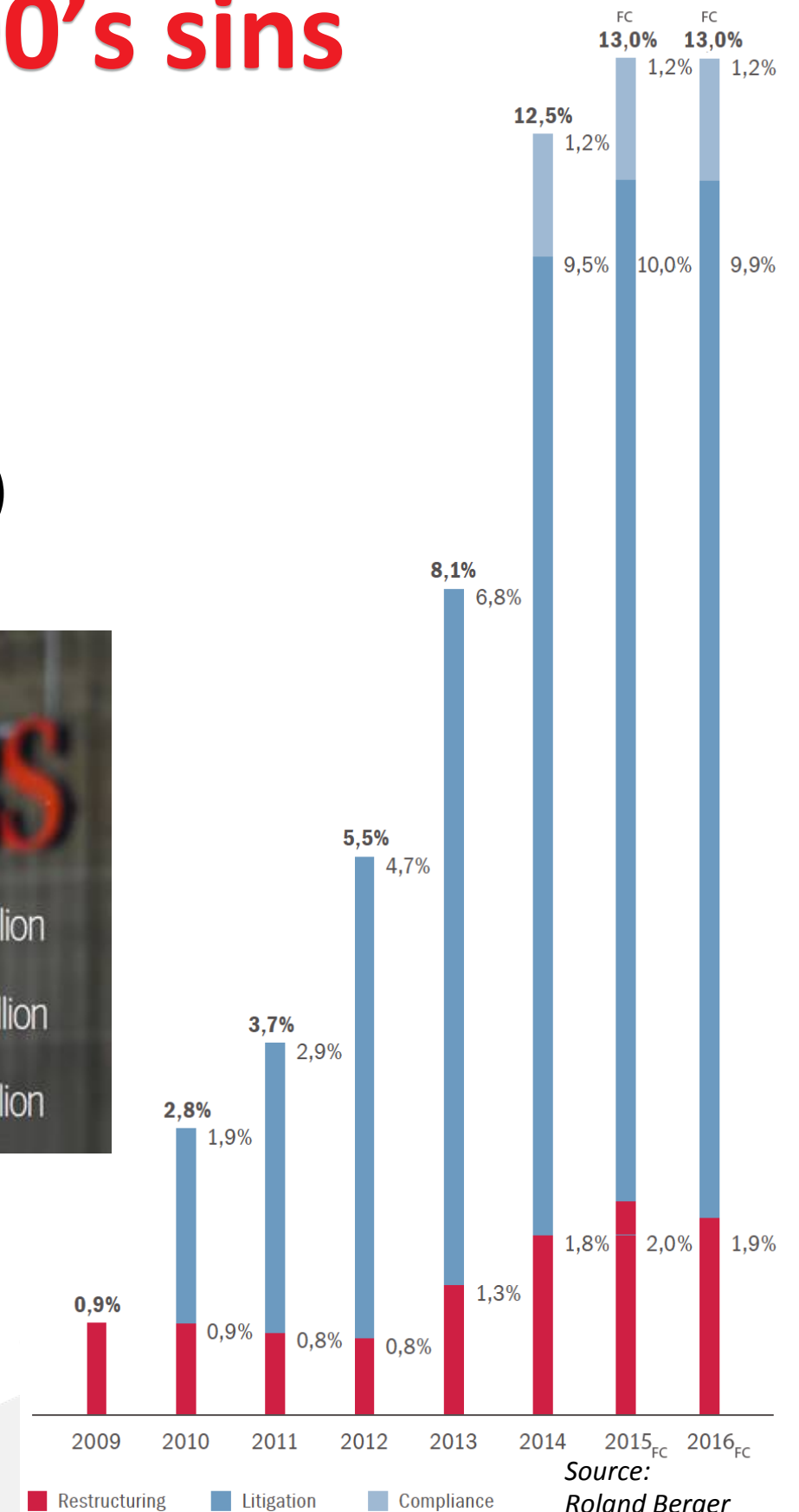

Bloomberg: SIX BANKS TO PAY $5.8 BILLION IN FINES TO SETTLE WITH U.S.

$545 million
Today's fines
$203 million
Libor fine
$342 million
Forex fine

FOX NEWS LIVE: JPMORGAN CHASE TO PAY A RECORD $13 BILLION FINE STEMMING FROM 2008 FINANCIAL MELTDOWN
ALERT A
FALL, LIFE-THREATENING FLASH FLOODS AND MUD S&P 1,745.23

GridGain Company Confidential

Chart data:
- 2009: Restructuring 0,9%
- 2010: Total 2,8%, Litigation 1,9%, Restructuring 0,9%
- 2011: Total 3,7%, Litigation 2,9%, Restructuring 0,8%
- 2012: Total 5,5%, Litigation 4,7%, Restructuring 0,8%
- 2013: Total 8,1%, Litigation 6,8%, Restructuring 1,3%
- 2014: Total 12,5%, Compliance 1,2%, Litigation 9,5%, Restructuring 1,8%
- 2015 FC: Total FC 13,0%, Compliance 1,2%, Litigation 10,0%, Restructuring 2,0%
- 2016 FC: Total FC 13,0%, Compliance 1,2%, Litigation 9,9%, Restructuring 1,9%

Legend: Restructuring | Litigation | Compliance

Source: Roland Berger
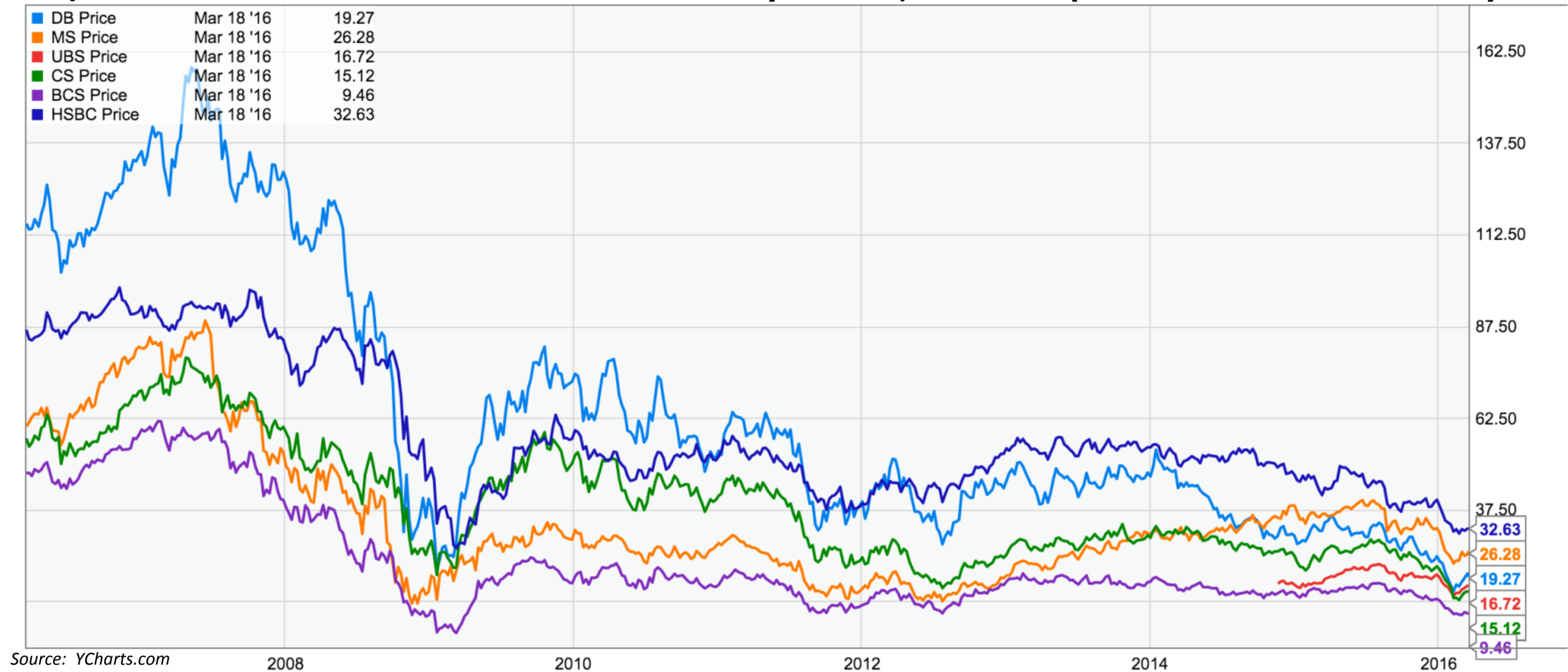
Investors sell banks… again

- Investors sell bank shares and de-value stock price multipliers: banks "Price / Book Value" ratio reduced by 50%, share prices dramatically fell

Source: YCharts.com

DB Price	Mar 18 '16	19.27
MS Price	Mar 18 '16	26.28
UBS Price	Mar 18 '16	16.72
CS Price	Mar 18 '16	15.12
BCS Price	Mar 18 '16	9.46
HSBC Price	Mar 18 '16	32.63

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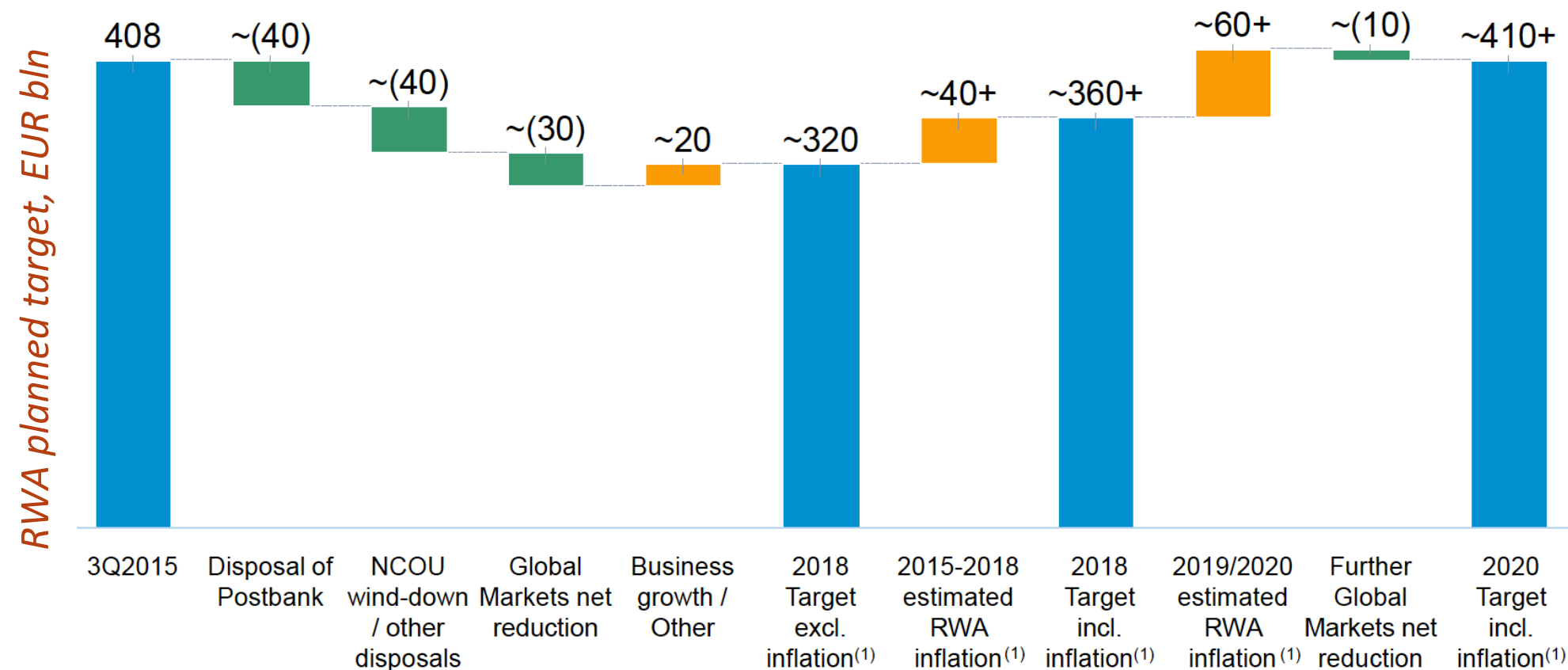
… and banks are responding

- Banks are trying to improve profitability and share prices:
  - Optimize certain business lines (e.g., Deutsche Bank re-structures Rates business);
  - Exit certain activities (e.g., UniCredit exits Equity business, Deutsche Bank exits Commodities and CDS clearing);
  - Refocus on a more profitable business (e.g., UBS focuses on Wealth Management);
  - Sell assets which require much capital or non-core assets (e.g., Deutsche Bank to spin off Non-Core Operational Unit);
  - Optimize operational and IT costs;
  - Implement automation;
  - Outsourcing

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Regulatory Outlook

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Basel 3 and 4: Planned RWA inflation in 2019

- RWA (Risk-Weighted Assets) is the sum of all bank's assets weighted by its riskiness

- Basel 3 (current): bank must hold reserved capital > 8% of RWA; Basel 4 needs more RWA

- Tier 1 capital ratio = <bank's core equity capital> / <total risk-weighted assets (RWA)>

- Capital Requirements Directive IV (CRD4) is a supervisory framework in the EU which reflects Basel III rules on capital minimum standards

- CRD4 is in force since January 1, 2014 but needs its full implementation by January 1, 2019

- Leverage ratio = <Tier 1 Capital> / <Total Exposure> and it must be >= 3%

Example: Deutsche Bank needs to reduce RWA by ~20% (EUR ~90 bln) before 2020

RWA planned target, EUR bln

3Q2015	Disposal of Postbank	NCOU wind-down / other disposals	Global Markets net reduction	Business growth / Other	2018 Target excl. inflation[1]	2015-2018 estimated RWA inflation[1]	2018 Target incl. inflation[1]	2019/2020 estimated RWA inflation[1]	Further Global Markets net reduction	2020 Target incl. inflation[1]
408	~(40)	~(40)	~(30)	~20	~320	~40+	~360+	~60+	~(10)	~410+

Source: Presentation of DB Strategy-2020 execution by John Cryan (CEO) and Marcus Schenck (CFO), London, 29 October 2015

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U.S.: Comprehensive Capital Analysis and Review (CCAR)

- CCAR is a regulatory framework introduced by the Federal Reserve (USA) in order to assess, regulate and supervise large banks

- Assessment is conducted annually and consists of two related programs:
  - Comprehensive Capital Analysis and Review (CCAR)
  - Dodd-Frank Act supervisory stress-testing

- Core part of the program assesses whether:
  - Bank has sufficient and adequate capital
  - Capital structure is stable under stress-test scenarios
  - Planned dividends are acceptable and will not bring the breach of minimum capital requirements

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U.S.: Intermediate Holding Company (IHC)

- Each non-U.S. financial organization having U.S. legal entities with >$50 bln assets must have an operating IHC

- IHC is a fundamental change to non-U.S. banks' governance model in USA

- IHC must be capitalized and operational by July 2016

- IHC to participate in Federal Reserve Comprehensive Capital Analysis and Review (CCAR) in April 2017 (private) and April 2018 (public)

Source: Davis Polk, USBasel3.com

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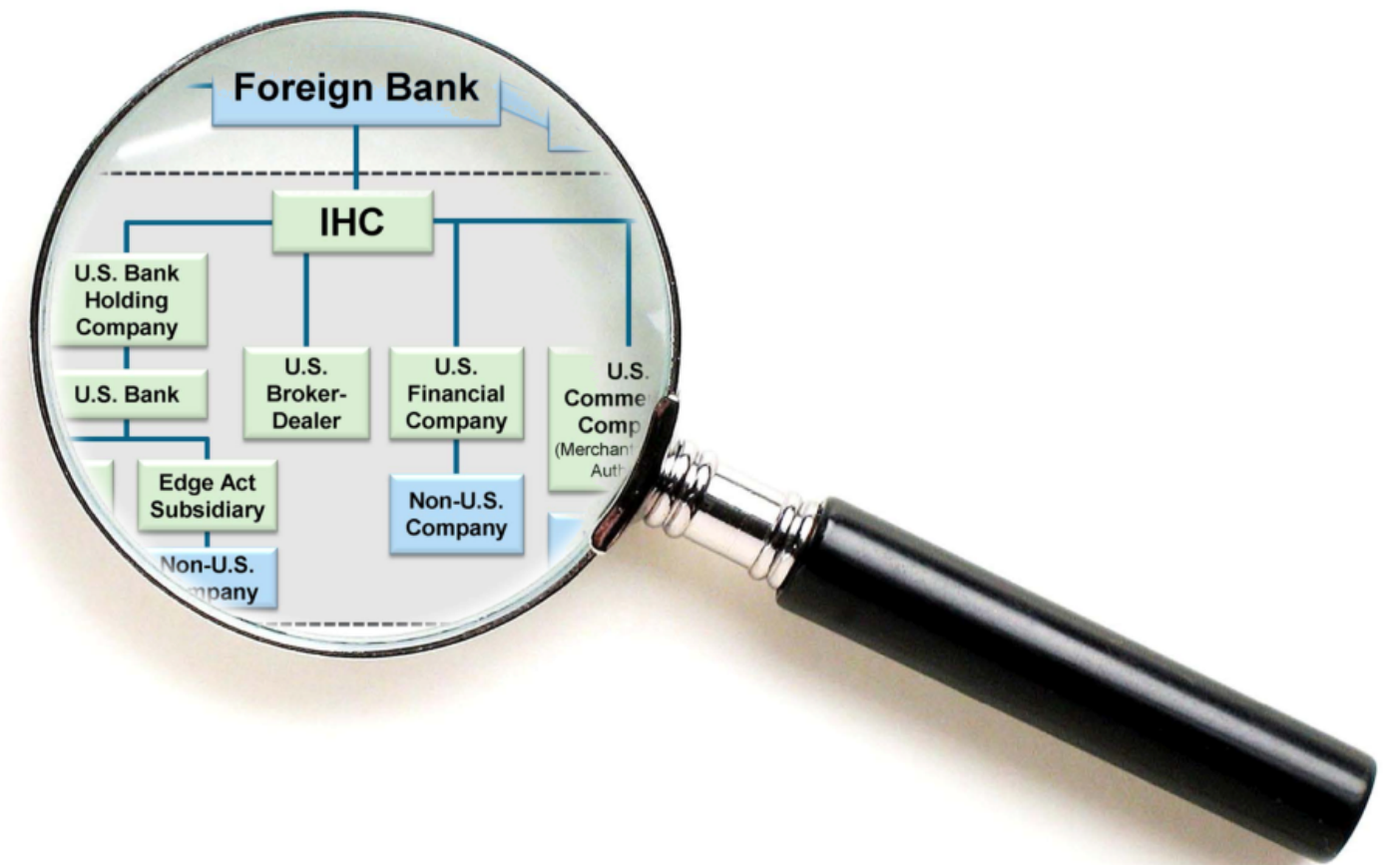
E.U.: MiFID 2

- The second version of MiFID directive
- Extends MiFID coverage onto new asset classes and markets where centralized bid/offer markets and pre- and post-transparency have never existed
- Tremendous impact on how OTC markets operate in Europe
- Summary of MiFID 2:
  - Addition of previously-unregulated organized trading facilities (OTFs);
  - New customer safety for algorithmic (Algo) and high-frequency trading (HFT) activities;
  - Additional supervision of derivatives markets (coordinated with ESMA);
  - Stricter requirements for portfolio management, investment advice
  - Other investor protections

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Other Regulatory Initiatives Coming in 2016

- Basel Committee: **Net Stable Funding Ratio** to be obligatory in USA
  - Need to hold cash to cover potential losses during the year
- Federal Reserve: **Enhanced Prudential Standards** in USA
  - Need to build independent enterprise risk management function
- Financial Stability Board (FSB) and Basel: **Culture and Ethic Standards** in banking
- Dodd-Frank (USA): **Living Wills** are mandatory for banks with >$50 bln assets – a detailed trouble resolution financial plan
- Enhanced **consumer protection** in USA

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Banks to build controls to avoid further litigation burden

- Implement better AML
- Implement better KYC
- Sanctions and Cybercrime
- Implement Anti-Fraud, Corruption and Anti-Bribery controls
- Real time trade compliance, surveillance and monitoring
- Supervisory accountability
- Proactive monitoring
- Review client relationships in risky countries
- Ethics code and accountability for conduct issues across the bank
- Align reward system to better reflect ethics and conduct

Dear Shareholders,

2015 was a challenging year for Deutsche Bank. We announced a new strategy which charts our course for the next five years, and embarked decisively on implementing it. The goal of our Strategy 2020 is simple:

Some of the necessary measures we took had a significant impact on last year's financial results. We took impairments totalling €6.5 billion, charges of €5.2 billion for legal and regulatory matters, and restructuring and severance charges of €1.0 billion.

Together, these items had a negative after-tax impact of €12.4 billion, resulting in a net loss after tax of €6.8 billion for the year.

Yours sincerely,

John Cryan
Co-Chairman of the Management Board,
Deutsche Bank AG

Jürgen Fitschen
Co-Chairman of the Management Board,
Deutsche Bank AG

Frankfurt am Main, March 2016

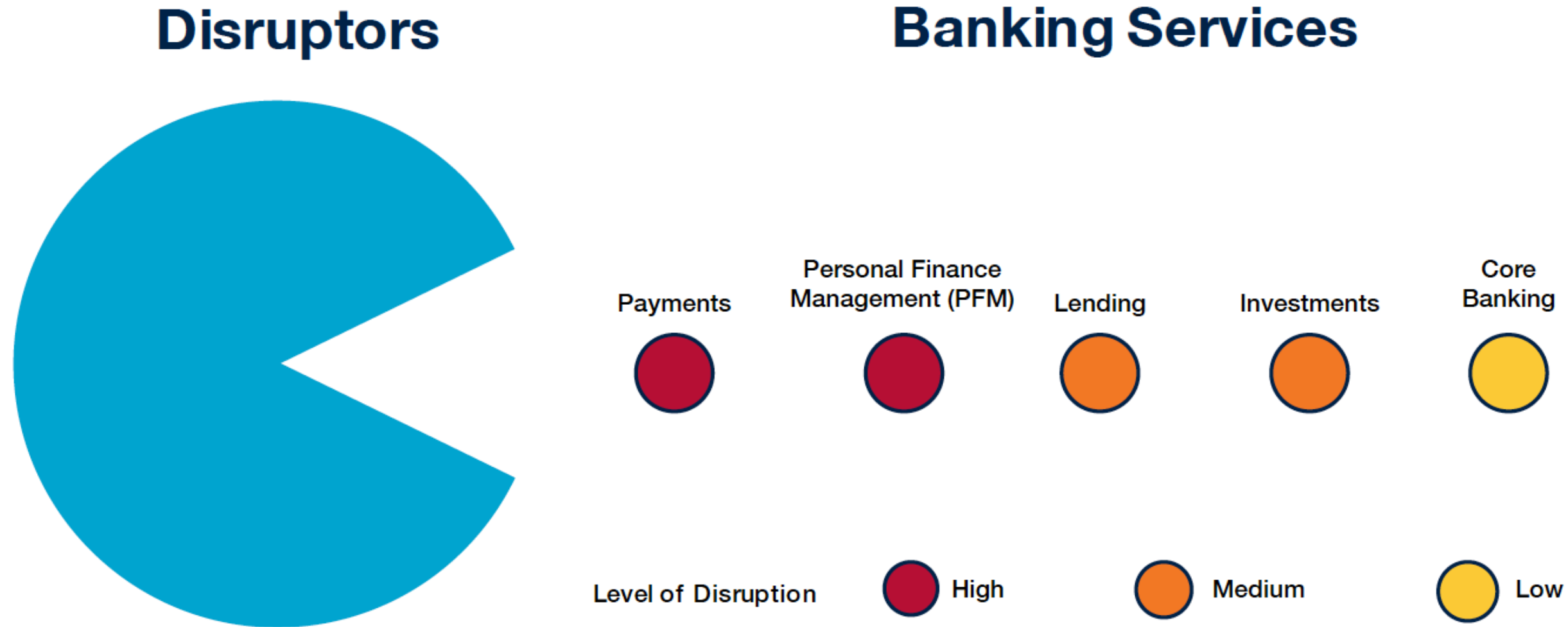*Source: Deutsche Bank Annual Report 2015*

Key Trends

**in banking
for 2016**

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Trend 1: Disruptive players (FinTechs)

- Fintech firms are targeting profitable aspects of the banking business. Banks are scared!
- More than 20% of financial services business is at risk to FinTechs by 2020

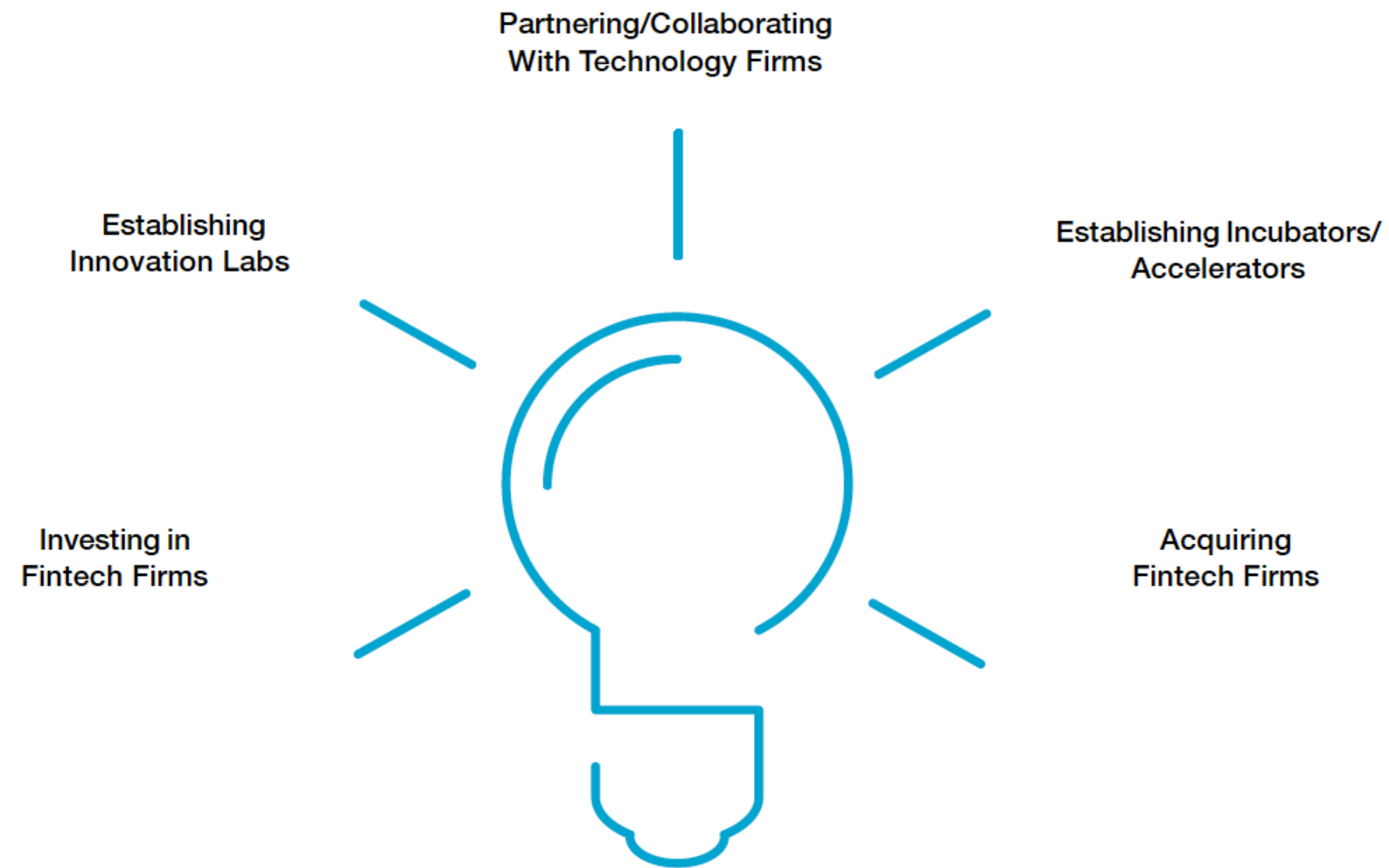*"We thought we knew our customers, but FinTechs really know our customers."*

A senior executive at a global banking organisation.

Disruptors

Banking Services

Payments	Personal Finance Management (PFM)	Lending	Investments	Core Banking
● High	● High	● Medium	● Medium	● Low

Level of Disruption: ● High   ● Medium   ● Low

Source: PwC, Capgemini

Trend 2: Banks focus on investments into innovation

- Technology is evolving so fast that banks must adapt to retain customers

Partnering/Collaborating With Technology Firms

Establishing Innovation Labs

Establishing Incubators/Accelerators

Investing in Fintech Firms

Acquiring Fintech Firms

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Trend 3: Digitalization

- Banks are leveraging digital technologies to enhance customer experience
- Saving on personnel and physical branches for the sake of better and integrated customer channels
- Higher level of use of automated trading strategies (algos, HFT, etc.)

Mobile Banking
User base expected to grow from 0.8 bn in 2014 to 1.8 bn in 2019

New Analytics Initiatives
Customer Experience represents 24% of overall new analytics initiatives

Branch Operations
Average teller transaction per month (U.S.) declined from 8.9 K in 2007 to 6.4 K in 2015

Source: Juniper Research

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# Trend 4: Banks are using Clouds for core activities

- Banks are investing heavily into cloud services for its core business activities
- Those who adopted earlier have significant benefits in cost savings, IT agility, scalability

Public 10%
Hybrid 20%
Private 70%

Source: Gartner, Capgemini

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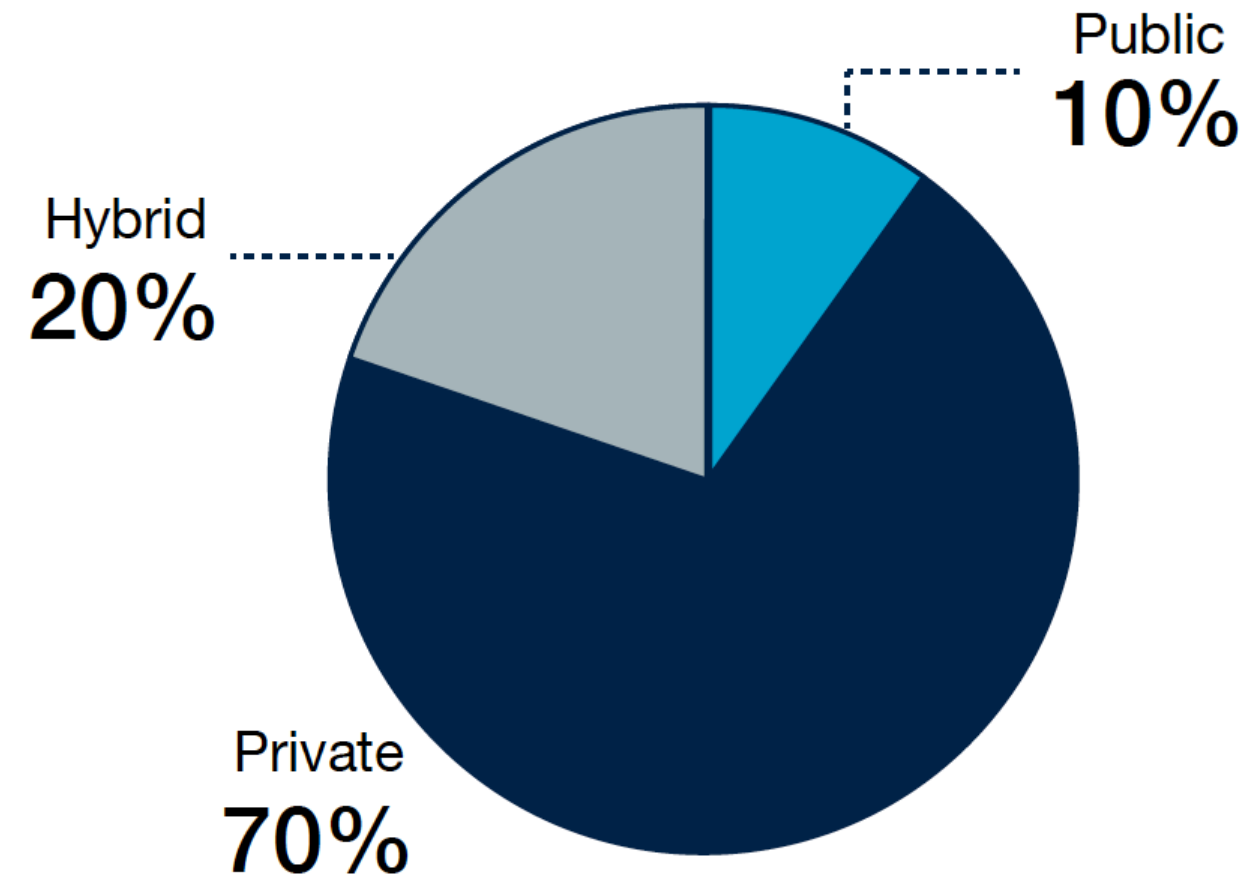
Trend 5: Banks are simplifying architecture and get rid of legacy systems

- Increased regulation requires more platform agility and sometimes near-real-time data access

- New channels and products require fast time-to-market which legacy systems can't provide
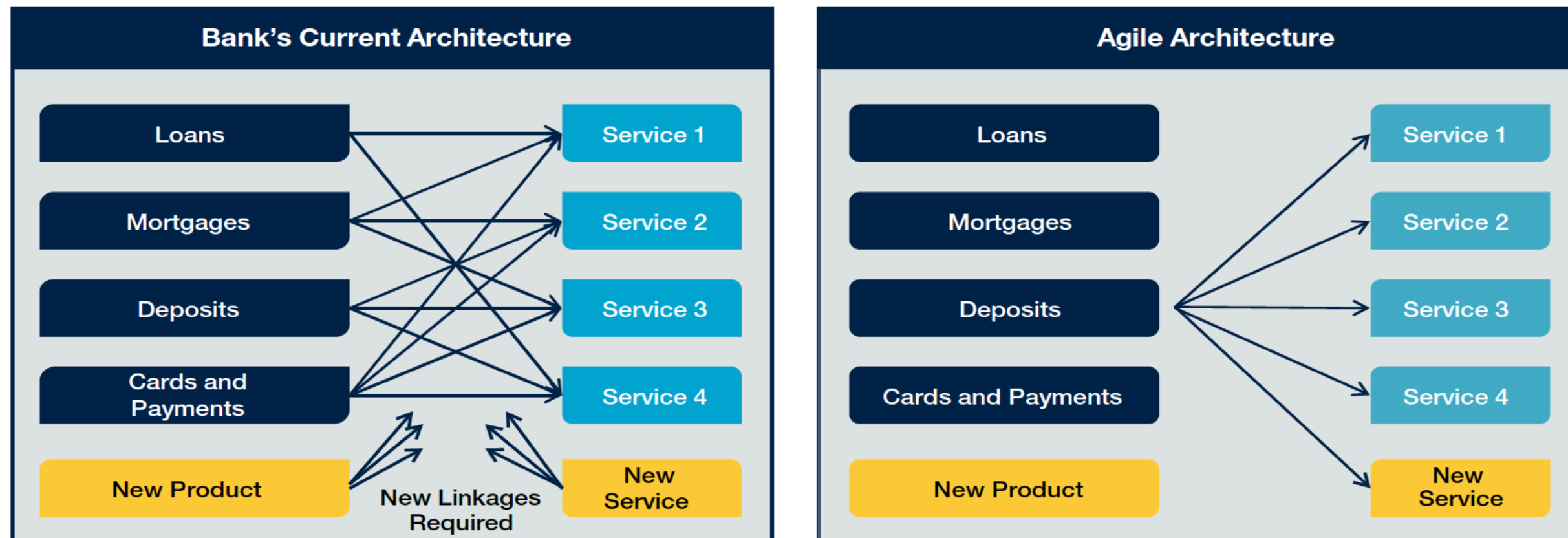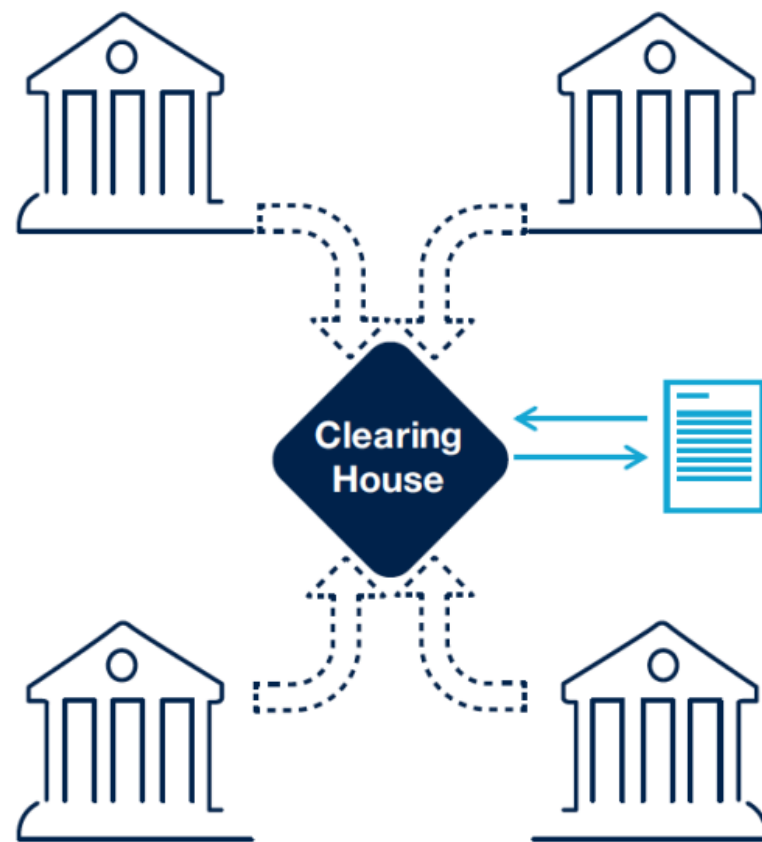

Source: AF Capital, Capgemini
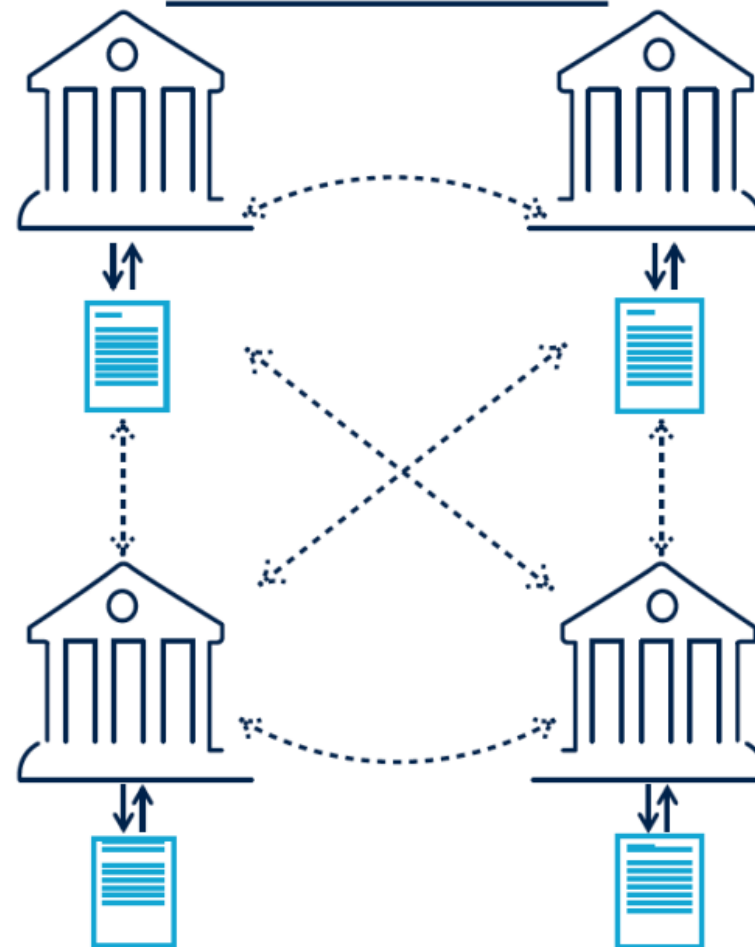
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Trend 6: Blockchain and distributed ledgers

- Bitcoin demonstrated the strength of distributed ledger idea
- Blockchain technology is expected to reduce banks' infrastructure costs by ~$20 bln p.a. by 2022

Since 2015 industry is moving:

Centralized Ledger

Distributed Ledger

Source: Capgemini, Santander InnoVentures, Oliver Wyman
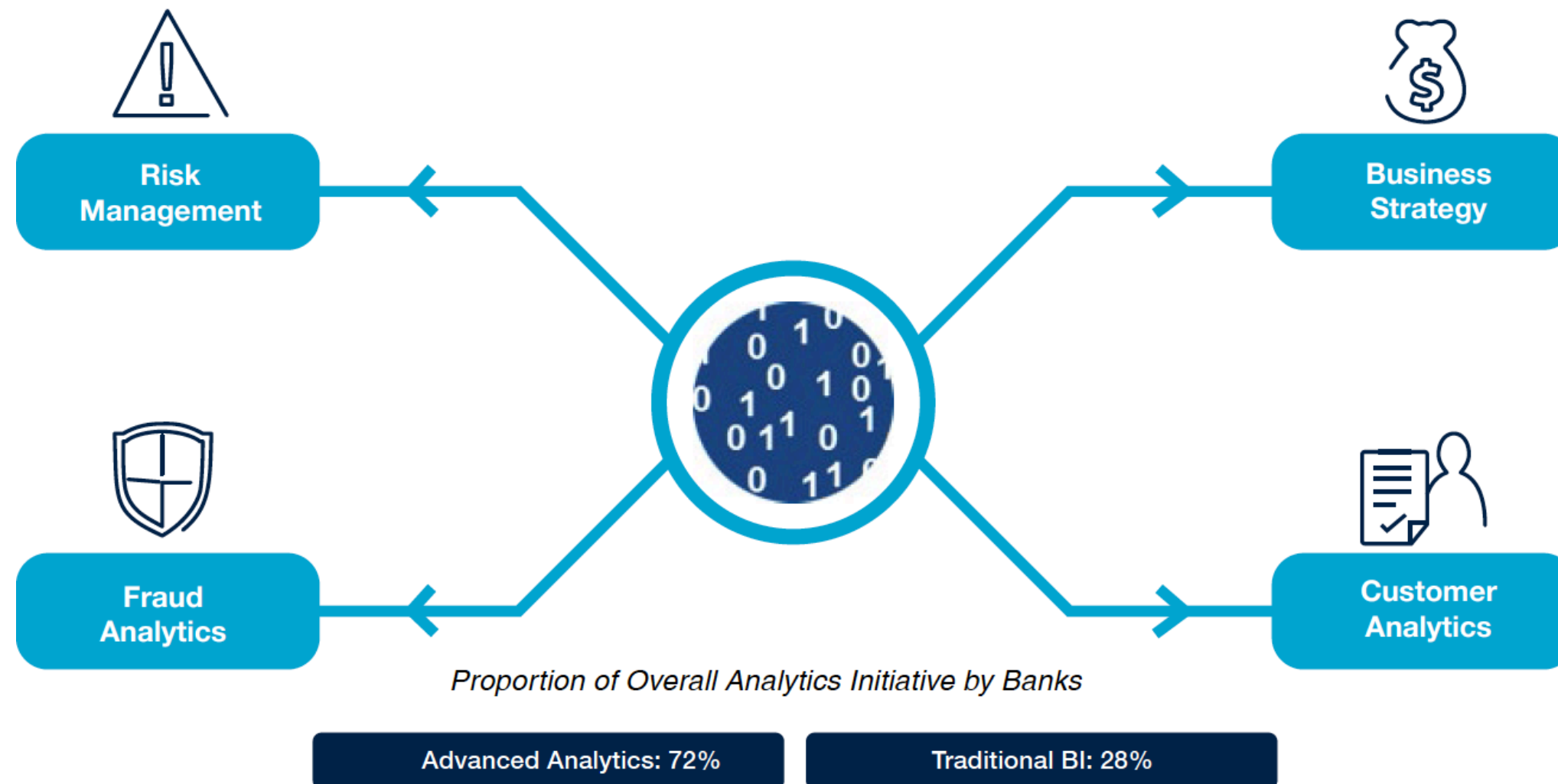
- Use of blockchain for trading, payments, registry, AML and KYC
- Instant settlement of smart contracts
- Citibank, HSBC, DB and other 40 banks have partnered with R3CEV (Blockchain Tech Co.)
- Investment in Chain.com by Visa, Nasdaq, Citi, Capital One, Fiserv and Orange
- RBS is developing blockchain PoC as part of £3.5 bln IT upgrade
- Barclays is developing blockchain system to trade equity swaps, options and swaptions

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Trend 7: Big Data and Advanced Analytics

- Basic BI using traditional DWH now takes only 28% of all data initiatives
- Advanced analytics include predictive analysis, data mining, Big Data, simulation, optimization, location-based intelligence

Risk Management

Business Strategy

Fraud Analytics

Customer Analytics

Proportion of Overall Analytics Initiative by Banks

Advanced Analytics: 72%   Traditional BI: 28%

Source: Gartner, Capgemini

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Trend 8: Grids and In-Memory Computing

- Disk is too slow to trade, process events or perform risk and compliance functions

- Parallel systems are to provide needed scale
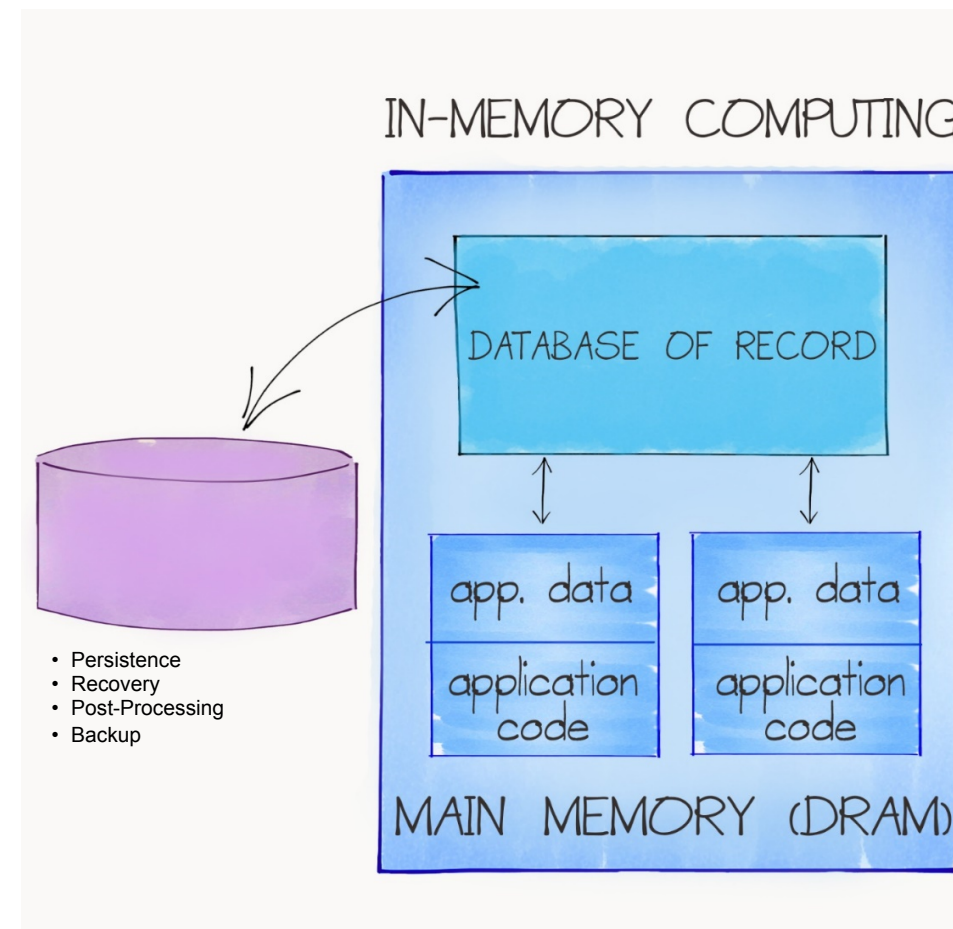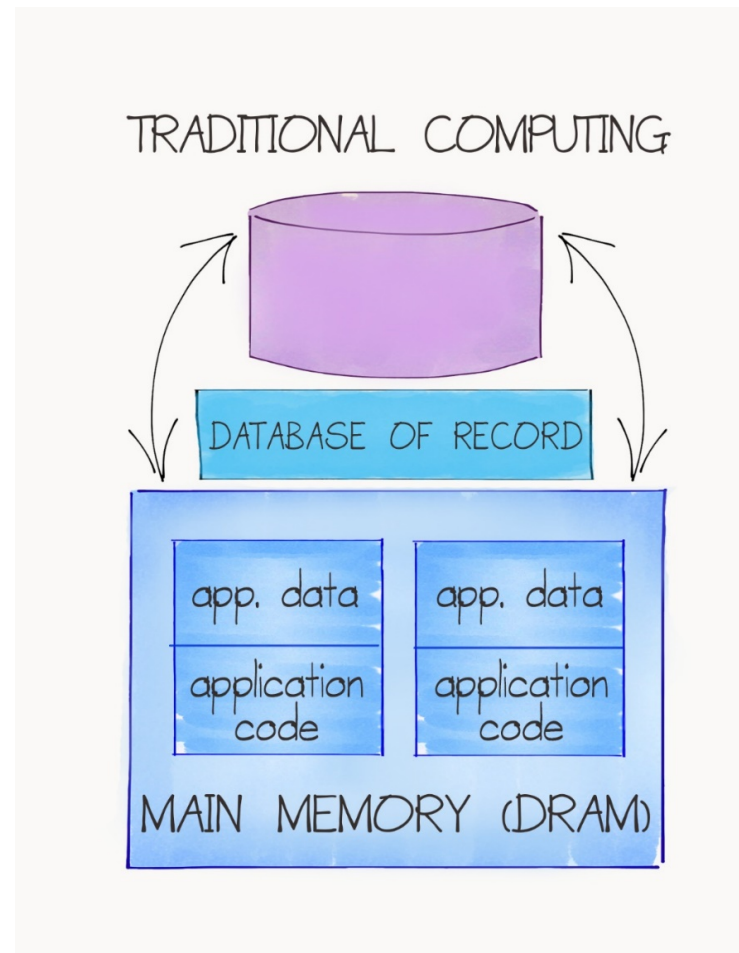
Source: Gartner, Capgemini

Deeper Look at In-Memory Grid Computing

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Evolution of In-Memory Grid Computing

- Move from Disk to 100% In-Memory (RAM)
- Leverage Clustered Memory and Parallel Distributed Processing
- Results: 100x Faster, 10x ROI Improvement
- Making "Big Data" Fast

"In-memory will have an industry impact comparable to web and cloud."

"RAM is the new disk, and disk is the new tape."

Gartner.

In-Memory Computing Market:
- $10B in 2019
- CAGR 22%

Gartner.

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Financial Customer Use Cases

Data Velocity, Data Volume, Data Consistency, Real-Time Performance and Analysis

- **Trading Platforms**
  Order Management and Execution Management Systems, algorithmic trading, high volume transactions, ultra low latencies.

- **Risk Management**
  Modeling, financial engineering, pricing, hedging, what-if analysis.

- **Financial Analytics**
  Real time analysis of trading positions, trending, market data analysis, sentiment analysis, complex event processing, hedging, transaction cost analysis, time series, volatility analysis, Monte Carlo simulations, Black-Scholes, derivatives pricing.

- **Big Data Analytics**
  Customer and counter party 360 view, master data management, securities masters, reference data, real-time analysis of P&L, up-to-the-second operational BI.

- **Compliance and Monitoring**
  Fraud, AML, KYC, market manipulation and abuse, pre and post trade compliance modeling.

- **Financial SaaS Platforms**
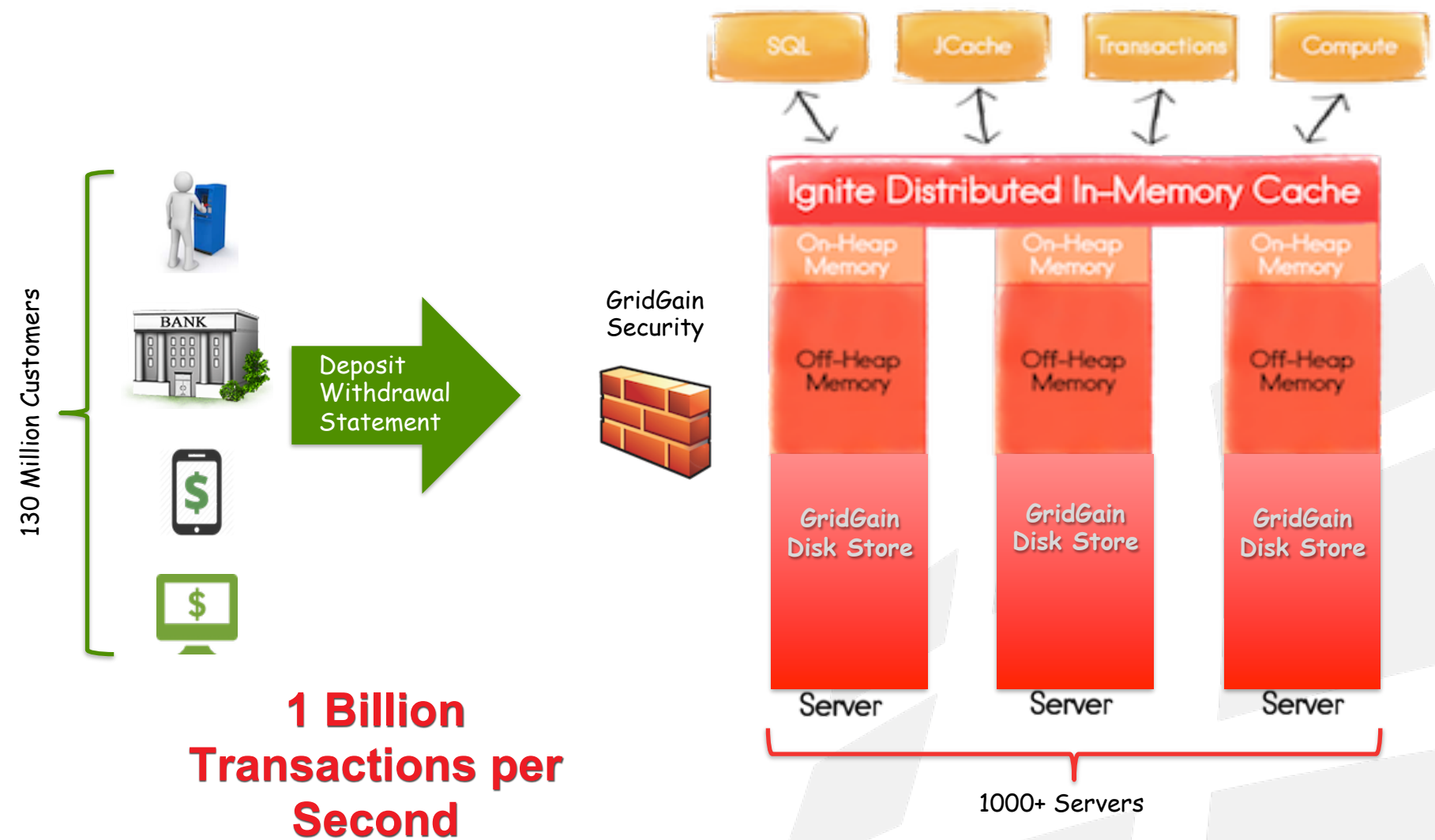 High performance next-generation architectures for Software as a Service Application vendors.

Use Case: SBERBANK
Largest bank in Russia and Eastern Europe, and the third largest in Europe

- **Sberbank Requirements**
  - Migrate to data grid architecture
  - Minimize dependency on Oracle
  - Move to open source

- **Why GridGain Won**
  - Best performance
    - 10+ competitors evaluated
  - Demonstrated best
    - Fault tolerance & scalability
    - ANSI-99 SQL Support
    - Transactional consistency
  - Strict SLAs
    - Less then 5 min cluster restart
    - Fully Operational from disk & memory

130 Million Customers

Deposit Withdrawal Statement

GridGain Security

SQL | JCache | Transactions | Compute

Ignite Distributed In–Memory Cache

On-Heap Memory | On-Heap Memory | On-Heap Memory

Off-Heap Memory | Off-Heap Memory | Off-Heap Memory

GridGain Disk Store | GridGain Disk Store | GridGain Disk Store

Server | Server | Server

1000+ Servers

1 Billion Transactions per Second

10 Dell R610 blades 1 TB Memory = **$25K**

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From RBC article – January, 2016

German Gref
CEO & Chairman, Sberbank

"The new Sberbank IT plan is to create a platform that enables the bank to introduce new products in hours, not weeks. The platform will have virtually unlimited performance and very high reliability. It will be much cheaper and will significantly reduce human interaction during customer transactions. The system will use machine-learning, flexible pricing, and artificial intelligence," said German Gref, head of Sberbank.

"The new system will use technology from GridGain, which won the tender from Oracle, IBM and others, and turned out to deliver an order of magnitude higher performance than those of the largest companies," he added.

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Gartner names GridGain a 2014 "Cool Vendor" for IMC

GridGain named a AlwaysOn Global 250 Top Private Company For 2014 & 2015

Gartner 2014
CoolVendor

"This positions GridGain as one of the few IMC open-source technologies available and the only one… providing such a rich set of functionality."

Gartner

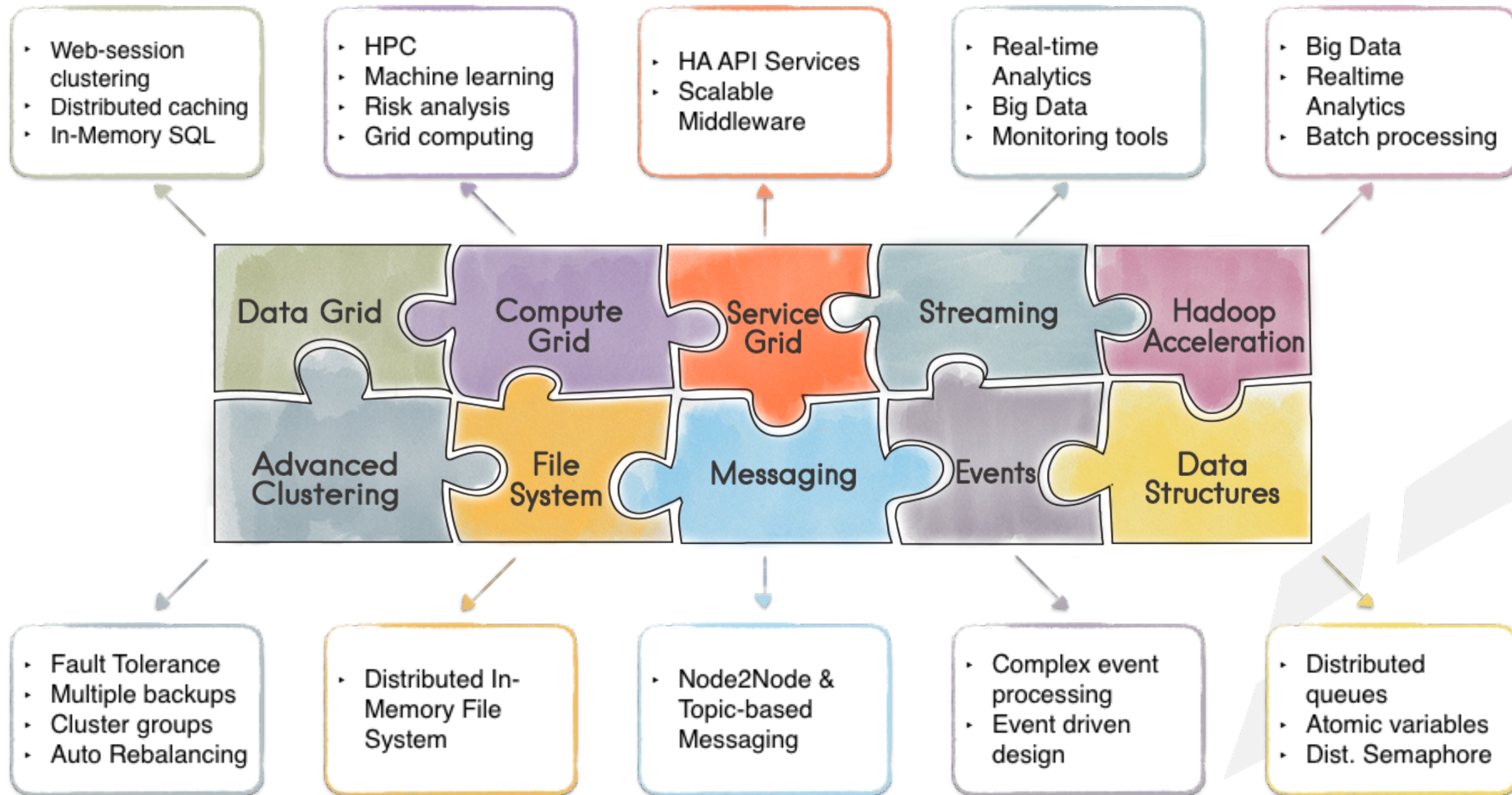GridGain

GridGain Enterprise and Open Source Strategy

- GridGain Enterprise Edition is based on Apache Ignite
- Open source is intended to provide an easy entry point for learning, testing and non-critical use
- Enterprise Edition customers benefit from many exclusive enterprise-class features along with support and indemnification

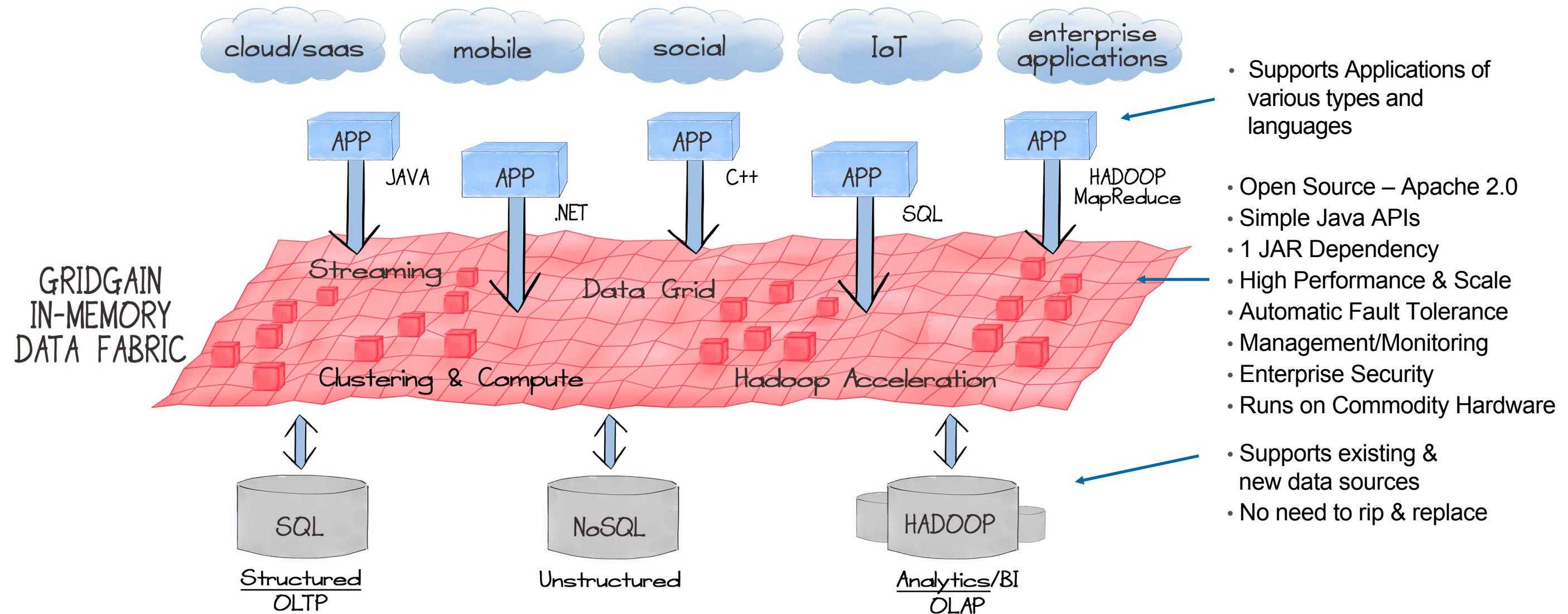# What is an In-Memory Data Fabric?
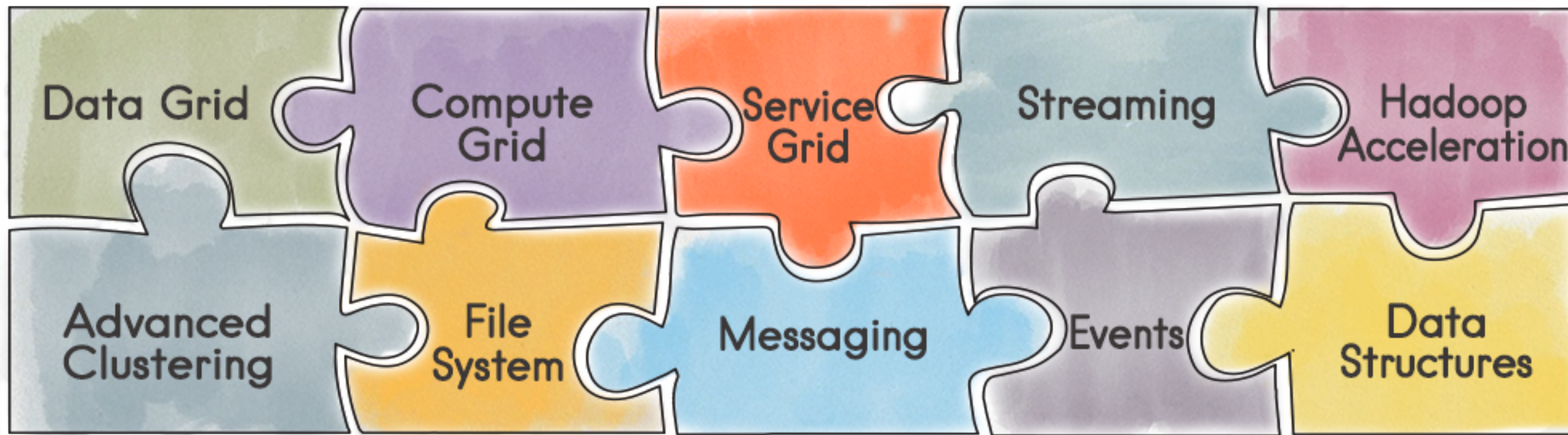
High-performance distributed in-memory platform for computing and transacting on large-scale data sets in near real-time.

In-Memory Data Fabric Use Cases

Flexibility and Enterprise Breadth of In-Memory Data Fabric

cloud/saas

mobile

social

IoT

enterprise applications

APP   JAVA

APP   .NET

APP   C++

APP   SQL

APP   HADOOP MapReduce

GRIDGAIN IN-MEMORY DATA FABRIC

Streaming

Data Grid

Clustering & Compute

Hadoop Acceleration

SQL
Structured
OLTP

NoSQL
Unstructured

HADOOP
Analytics/BI
OLAP

- Supports Applications of various types and languages

- Open Source – Apache 2.0
- Simple Java APIs
- 1 JAR Dependency
- High Performance & Scale
- Automatic Fault Tolerance
- Management/Monitoring
- Enterprise Security
- Runs on Commodity Hardware

- Supports existing & new data sources
- No need to rip & replace

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In-Memory Data Fabric: Main Benefits

- Performance
  - High Throughput
  - Low Latency
  - Load Balancing
  - Caching
  - In-Memory Indexing
  - Eliminate Java Garbage Collection Pauses
- Scalability
  - Add Cluster Members (cores)
  - Unlimited Vertical Scale
  - Add Memory (RAM)
- High Availability
  - Data Backups
  - Datacenter Replication
  - Automatic Failover
  - Persistence
  - Fault Tolerance
  - Fast Recovery

- Transactions
  - Fully ACID Compliant
  - Optimistic & Pessimistic
  - Data Streaming
- Persistence
  - SQL, NoSQL, Hadoop
  - Tiered Memory: On-Heap ->
- Security
  - Auth & Auth
  - Encryption
  - Tracing & Auditing

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GridGain's In-Memory Data Fabric Enterprise Edition

GridGain Enterprise Subscriptions include:

> Right to use GridGain Enterprise Edition

> Bug fixes, patches, updates and upgrades

> 9x5 or 24x7 Support

> Training and Consulting Services from GridGain

Features	Apache Ignite	GridGain Enterprise
In-Memory Data Grid	✓	✓
In-Memory Compute Grid	✓	✓
In-Memory Service Grid	✓	✓
In-Memory Streaming	✓	✓
In-Memory Hadoop Acceleration	✓	✓
Distributed In-Memory File System	✓	✓
Advanced Clustering	✓	✓
Distributed Messaging	✓	✓
Distributed Events	✓	✓
Distributed Data Structures	✓	✓
Portable Binary Objects	✓	✓
Management & Monitoring GUI		✓
Enterprise-Grade Security		✓
Network Segmentation Protection		✓
Recoverable Local Store		✓
Rolling Production Updates		✓
Data Center Replication		✓
Integration with Oracle GoldenGate		✓
Basic Support (9×5)	✓	✓
Enterprise Support (9×5 and 24×7)		✓
Security Updates		✓
Maintenance Releases & Patches		✓
	Free **w/ optional Paid Support**	**Annual License** **Subscription**

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Analyst Validation

"This positions GridGain as one of the few IMC open-source technologies available and **the only one... providing such a rich set of functionality**." (Massimo Pezzini, Gartner)

"IMDGs, in general, suffer from a caching stereotype. **GridGain smashes that stereotype** by offering a general purpose compute grid. **If you need an IMDG and a super-computer all in one then take a look at GridGain Systems**." (Mike Gualtieri, Forrester)

"The company has strong expertise with regard to in-memory data processing ... The **move to contribute its core in-memory data processing capabilities to the Apache Software Foundation as Apache Ignite could prove to be an inspired one for GridGain** – raising the profile of its core technology and encouraging adopters toward its supported In-Memory Data Fabric product. **The company stands to gain significantly from proposing Apache Ignite** and becoming part of one of the largest families of open source software projects." (Matt Aslett, 451 Research)

"EMA **considers GridGain a leading innovator** of the type of in-memory processing platforms that helps the transition from traditional processing methodologies to in-memory processing across a wide set of use cases. CIOs, Chief Data Officers (CDOs) and technology architects should regard GridGain as a viable option to add competitive advantage via near-realtime processing requirements now and going forward (John Myers, Enterprise Management Associates)

"Solutions such as GridGain (which is an optimizer layer that sits on top of existing solutions) are **focusing on this market segment**..." (Lynn Langit, GigaOm Research)

"GridGain has now put their key IP out for the world to use as Apache Ignite. **We predict an enthusiastic adoption curve** since GridGain's approach leverages current developer skills and accelerates existing Hadoop apps without modification, **providing an easy transition into in-memory computing**." (Mike Matchett, The Taneja Group)

THANK YOU