John Davies
CTO

Incept5

In-Memory Message & Trade Repositories

QCon - London
8th March 2013

I really don't like

- Writing slides
- I try to talk independently from the slides
- Yesterday there was a great keynote talk on minimising slides
- Sadly I missed it because I was writing my slides :-(
- So today might just be my last slide deck!

I do like

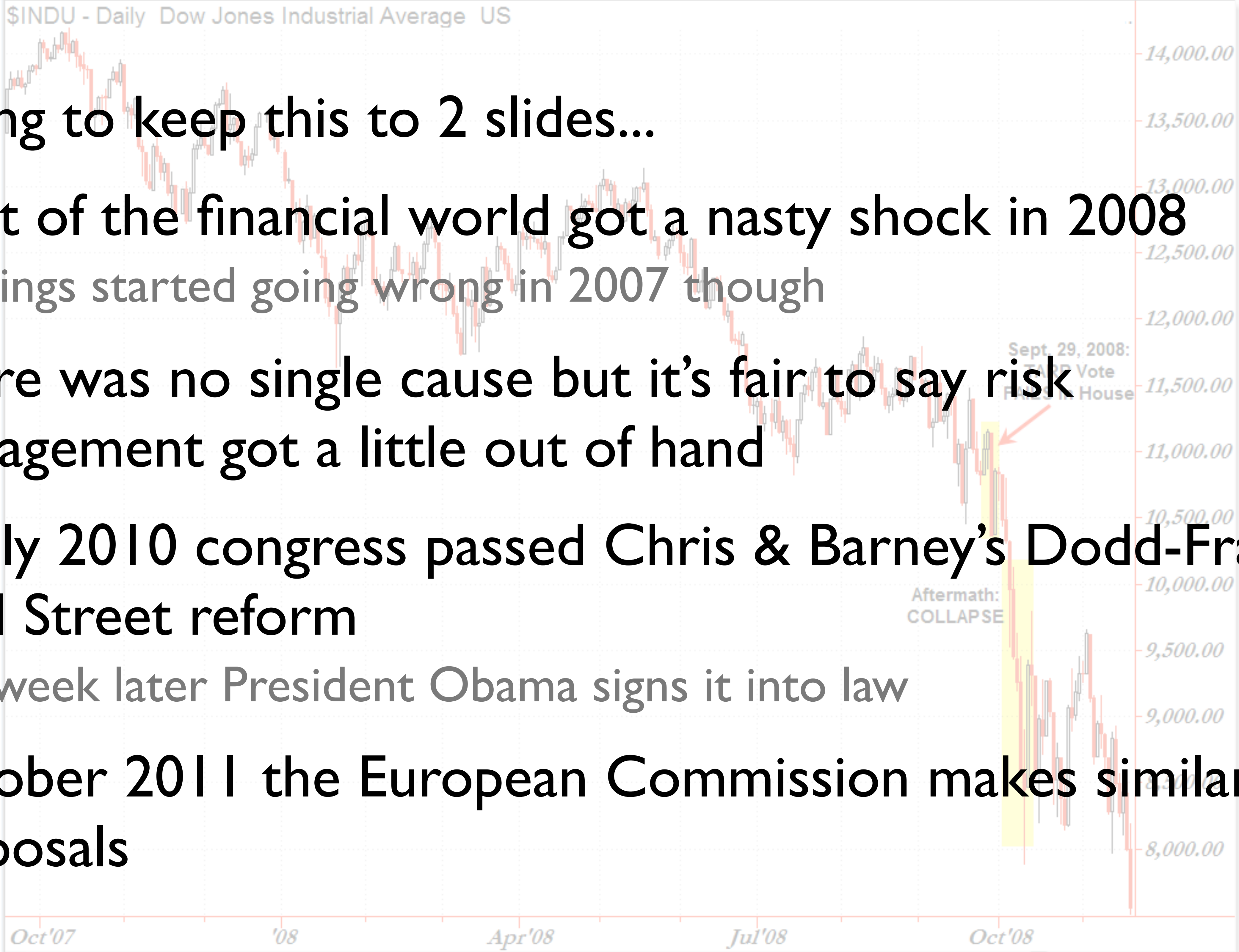
- Talking at conferences
- Meeting all the interesting people
- Sharing my experiences
- And drinking beer

Agenda

- External influences on the banks
- The scale of the changes
- The scale of complexity
- Just chuck it into a database with ORM! - NOT!
- In-Memory
  - Perhaps a demo

Dodd-Frank Wall Street Reform

- Trying to keep this to 2 slides...
- Most of the financial world got a nasty shock in 2008
  - Things started going wrong in 2007 though
- There was no single cause but it's fair to say risk management got a little out of hand
- In July 2010 congress passed Chris & Barney's Dodd-Frank Wall Street reform
  - A week later President Obama signs it into law
- October 2011 the European Commission makes similar proposals



So what’s happening?

- The Dodd-Frank act is wide ranging, the impact varies by geography and business domain
  - broker/dealers, asset managers, hedge funds in the OTC market
- It is already live in the US (12th Oct 2012), EMEA reporting begins in early/mid-2013
- The bodies (above) have to register certain types of Swap (the majority) with a central Swap Data Repository (SDR)
  - The DTCC is one of these SDRs
- Basically then all these financial institutions have a lot of work to do to comply

OK just one more slide...

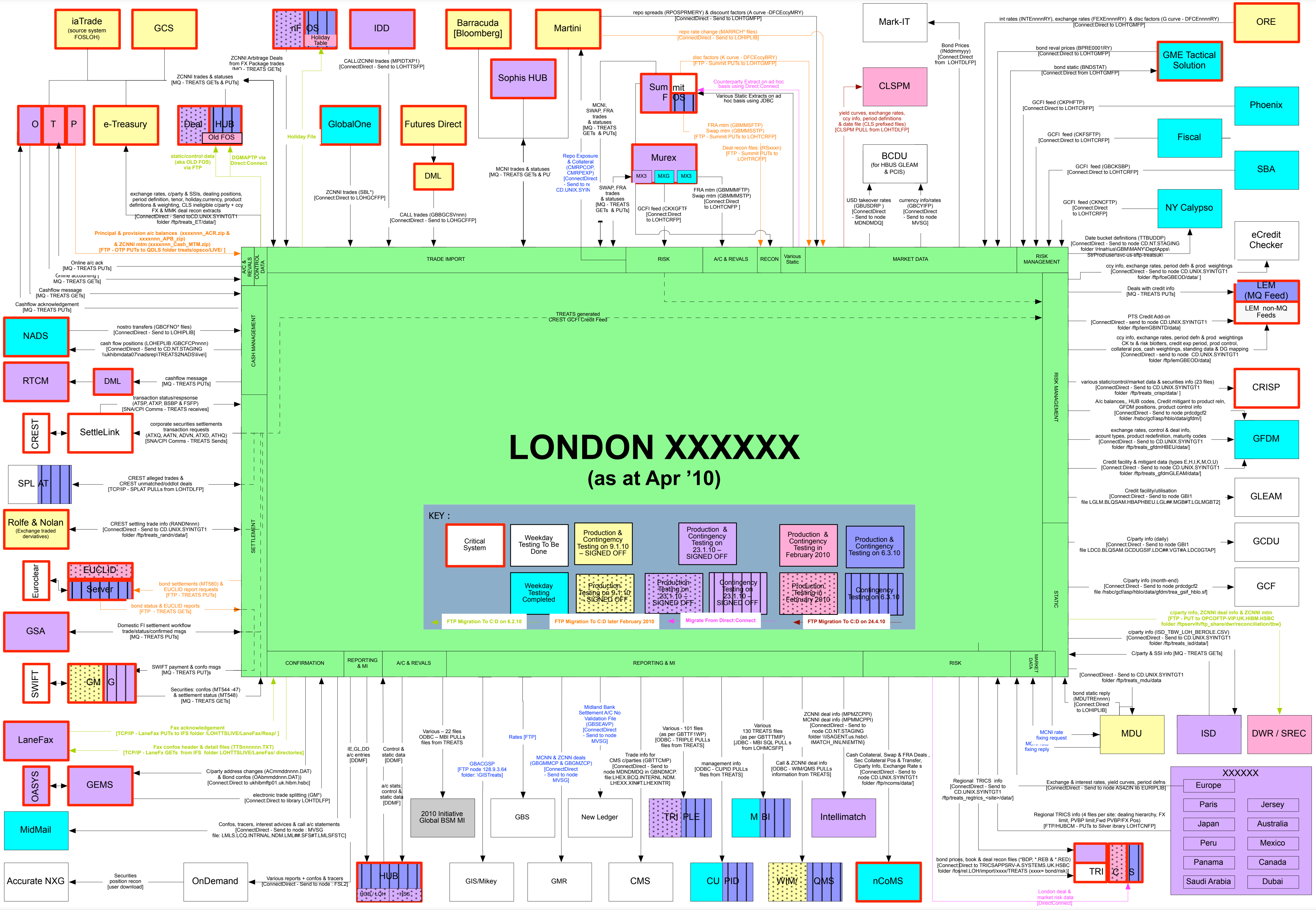
- Dodd-Frank is not the only catalyst for change this year...

- SWIFTNet Derivatives (FpML over SWIFT)
- Accelerated ISO-20022 adoption
  - DTCC Corporate Actions, JASDEC and T2S

- And a lot more...

- Basically there are thousands of institutions world-wide being mandated to change their internal systems and external interfaces

System Architecture View



LONDON XXXXXX
(as at Apr '10)

KEY :

Critical System

Weekday Testing To Be Done

Weekday Testing Completed

Production & Contingemcy Testing on 9.1.10 – SIGNED OFF

Production Testing on 9.1.10 – SIGNED OFF

Production & Contingency Testing on 23.1.10 – SIGNED OFF

Production Testing on 23.1.10 – SIGNED OFF

Contingency Testing on 23.1.10 – SIGNED OFF

Production & Contingency Testing in February 2010

Production Testing in February 2010

Production & Contingency Testing on 6.3.10

Contingency Testing on 6.3.10

FTP Migration To C:D on 6.2.10

FTP Migration To C:D later February 2010

Migrate From Direct:Connect

FTP Migration To C:D on 24.4.10

TRADE IMPORT | RISK | A/C & REVALS | RECON | Various Static | MARKET DATA | RISK MANAGEMENT

A/C & REVALS | CONTROL DATA | CASH MANAGEMENT | SETTLEMENT

RISK MANAGEMENT | STATIC

CONFIRMATION | REPORTING & MI | A/C & REVALS | REPORTING & MI | RISK | MARKET DATA

TREATS generated CREST GCFI Credit Feed

iaTrade (source system FOSLOH)

GCS

nF OS Holiday Table

IDD

Barracuda [Bloomberg]

Martini

Sophis HUB

Sum mit F OS

Murex: MX3, MXG, MX3

Mark-IT

CLSPM

BCDU (for HBUS GLEAM & PCIS)

ORE

GME Tactical Solution

Phoenix

Fiscal

SBA

NY Calypso

eCredit Checker

O T P

e-Treasury

Deal HUB Old FOS

GlobalOne

Futures Direct

DML

ZCNNI Arbitrage Deals from FX Package trades [MQ - TREATS GETs]

ZCNNI trades & statuses [MQ - TREATS GETs & PUTs]

CALL/ZCNNI trades (MPIDTXP1) [ConnectDirect - Send to LOHTTSFP]

Holiday File

static/control data (aka OLD FOS) via FTP

DGMAPTP via Direct:Connect

exchange rates, c/party & SSIs, dealing positions, period definition, tenor, holiday,currency, product defintions & weighting, CLS ineligible c/party + ccy FX & MMK deal recon extracts [ConnectDirect - Send toCD.UNIX.SYINTGT1 folder /ftp/treats_ET/data/]

Principal & provision a/c balances (xxxxnnn_ACR.zip & xxxxnnn_APB_zip) & ZCNNI mtm (xxxxnnn_Cash_MTM.zip) [FTP - OTP PUTs to QDLS folder treats/opsco/LIVE/]

ZCNNI trades (SBL*) [Connect:Direct to LOHGCFFP]

CALL trades (GBBGCSVnnn) [ConnectDirect - Send to LOHGCFFP]

MCNI trades & statuses [MQ - TREATS GETs & PU

MCNI, SWAP, FRA trades & statuses [MQ - TREATS GETs & PUTs]

Repo Exposure & Collateral (CMRPCOP, CMRPEXP) [ConnectDirect - Send to nc CD.UNIX.SYIN

SWAP, FRA trades & statuses [MQ - TREATS GETs & PUTs]

GCFI feed (CKXGFTF [Connect:Direct to LOHTCRFP]

FRA mtm (GBMMMFTP) Swap mtm (GBMMMSTP) [Connect:Direct to LOHTCNFP]

repo spreads (RPOSPRMERY) & discount factors (A curve -DFCEccyMRY) [ConnectDirect - Send to LOHTGMFP]

repo rate change (MARRCH* files) [ConnectDirect - Send to LOHIPLIB]

disc factors (K curve - DFCEccyBRY) [FTP - Summit PUTs to LOHTGMFP]

Counterparty Extract on ad hoc basis using Direct:Connect

Various Static Extracts on ad hoc basis using JDBC

FRA mtm (GBMMSFTP) Swap mtm (GBMMSSTP) [FTP - Summit PUTs to LOHTCRFP]

Deal recon files: (RSxxxn) [FTP - Summit PUTs to LOHTRCFP]

Bond Prices (INddmmyyy) [Connect:Direct from LOHTDLFP]

yield curves, exchange rates, ccy info, period definitions & date file (CLS prefixed files) [CLSPM PULL from LOHTDLFP]

USD takeover rates (GBUSDRP) [ConnectDirect - Send to node MDNDMDQ]

currency info/rates (GBCYIFP) [ConnectDirect - Send to node MVSG]

int rates (INTEnnnnRY), exchange rates (FEXEnnnnRY) & disc factors (G curve - DFCEnnnnRY) [Connect:Direct to LOHTGMFP]

bond reval prices (BPRE0001RY) [Connect:Direct to LOHTGMFP]

bond static (BNDSTAT) [Connect:Direct from LOHTGMFP]

GCFI feed (CKPHFTP) [Connect:Direct to LOHTCRFP]

GCFI feed (CKFSFTP) [Connect:Direct to LOHTCRFP]

GCFI feed (GBCKSBP) [Connect:Direct to LOHTCRFP]

GCFI feed (CKNCFTP) [Connect:Direct to LOHTCRFP]

Date bucket definitions (TTBUDDP) [ConnectDirect - Send to node CD.NT.STAGING folder \Hnah\us\GBM\MANY\DeptApps\ StrProd\user\svc-us-sftp-treatsuk\

Online a/c ack [MQ - TREATS PUTs]

Online accounting [MQ - TREATS GETs]

Cashflow message [MQ - TREATS GETs]

Cashflow acknowledgement [MQ - TREATS PUTs]

NADS

nostro transfers (GBCFNO* files) [ConnectDirect - Send to LOHIPLIB]

cash flow positions (LOHEPLIB /GBCFCPnnnn) [ConnectDirect - Send to CD.NT.STAGING \\ukhibmdata07\nadsrep\TREATS2NADS\live\]

RTCM

DML

cashflow message [MQ - TREATS PUTs]

transaction status/respsonse (ATSP, ATXP, BSBP & FSFP) [SNA/CPI Comms - TREATS receives]

CREST

SettleLink

corporate securities settlements transaction requests (ATXQ, AATN, ADVN, ATXD, ATHQ) [SNA/CPI Comms - TREATS Sends]

SPL AT

CREST alleged trades & CREST unmatched/oddlot deals [TCP/IP - SPLAT PULLs from LOHTDLFP]

Rolfe & Nolan (Exchange traded derviatives)

CREST settling trade info (RANDNnnn) [ConnectDirect - Send to CD.UNIX.SYINTGT1 folder /ftp/treats_randn/data/]

Euroclear

EUCLID Server

bond settlements (MT580) & EUCLID report requests [FTP - TREATS PUTs]

bond status & EUCLID reports [FTP - TREATS GETs]

GSA

Domestic FI settlement workflow trade/status/confirmed msgs [MQ - TREATS PUTs]

SWIFT

GM G

SWIFT payment & confo msgs [MQ - TREATS PUT]s

Securities: confos (MT544 -47) & settlement status (MT548) [MQ - TREATS GETs]

LaneFax

Fax acknowledgement [TCP/IP - LaneFax PUTs to IFS folder /LOHTTSLIVE/LaneFax/Resp/]

Fax confos header & detail files (TTSnnnnnn.TXT) [TCP/IP - LaneFx GETs from IFS folder LOHTTSLIVE/LaneFax/ directories]

OASYS

GEMS

C/party address changes (ACmmddnnnn.DAT) & Bond confos (OAbmmddnnn.DAT)) [Connect:Direct to ukhibmftp01.uk.hibm.hsbc]

electronic trade splitting (GM*) [Connect:Direct to library LOHTDLFP]

MidMail

Confos, tracers, interest advices & call a/c statements [ConnectDirect - Send to node : MVSG file: LMLS.LCQ.INTRNAL.NDM.LML##.SFS#T.LMLSFSTC]

Accurate NXG

Securities position recon [user download]

OnDemand

Various reports + confos & tracers [ConnectDirect - Send to node : FSL2]

HUB HGB / LOH HSS

IE,GL,DD a/c entries [DDMF]

Control & static data [DDMF]

a/c stats; control & static data [DDMF]

Various – 22 files ODBC – MBI PULLs files from TREATS

2010 Initiative Global BSM MI

GBACGSP [FTP node 128.9.3.64 folder: \GISTreats]

GIS/Mikey

Rates [FTP]

GBS

MCNN & ZCNN deals (GBGMMCP & GBGMZCP) [ConnectDirect - Send to node MVSG]

GMR

Midland Bank Settlement A/C No Validation File (GBSEAVP) [ConnectDirect - Send to node MVSG]

New Ledger

Trade info for CMS c/parties (GBTTCMP) [ConnectDirect - Send to node MDNDMDQ in GBNDMCP. file:LHEX.BCQ.INTERNL.NDM. LHEXX.XIN#T.LHEXINTR]

CMS

Various - 101 files (as per GBTTF1WP) [ODBC - TRIPLE PULLs files from TREATS]

TRI PLE

management info [ODBC - CUPID PULLs files from TREATS]

CU PID

Various 130 TREATS files (as per GBTTTMIP) [JDBC - MBI SQL PULL s from LOHMCSFP]

M BI

Call & ZCNNI deal info [ODBC - WIM/QMS PULLs information from TREATS]

WIM/ QMS

ZCNNI deal info (MPMZCPPI) MCNNI deal info (MPMMCPPI) [ConnectDirect - Send to node CD.NT.STAGING folder \\ISAGENT.us.hsbc\ IMATCH_IN\LN\EMTN\}

Intellimatch

Cash Collateral, Swap & FRA Deals , Sec Collateral Pos & Transfer, C/party Info, Exchange Rate s [ConnectDirect - Send to node CD.UNIX.SYINTGT1 folder /ftp/ncoms/data/]

nCoMS

Regional TRICS info [ConnectDirect - Send to CD.UNIX.SYINTGT1 /ftp/treats_regtrics_<site>/data/]

Exchange & interest rates, yield curves, period defns [ConnectDirect - Send to node AS4ZIN lib EURIPLIB]

Regional TRICS info (4 files per site: dealing hierarchy, FX limit, PVBP limit,Fwd PVBP/FX Pos) [FTP/HUBCM - PUTs to Silver ibrary LOHTCNFP]

bond prices, book & deal recon files (*BDP, *.REB & *.RED) [Connect:Direct to TRICSAPPSRV-A.SYSTEMS.UK.HSBC folder /fos/rel.LOH/import/xxxx/TREATS (xxxx= bond/risk)]

TRI C S

London deal & market risk data [DirectConnect]

XXXXXX

Europe	
Paris	Jersey
Japan	Australia
Peru	Mexico
Panama	Canada
Saudi Arabia	Dubai

MCNI rate fixing request

MCNI rate fixing reply

MDU

bond static reply (MDUTREnnnn) [Connect:Direct to LOHIPLIB]

[ConnectDirect - Send to CD.UNIX.SYINTGT1 folder /ftp/treats_mdu/data

ISD

DWR / SREC

C/party & SSI info [MQ - TREATS GETs]

c/party info (ISD_TBW_LOH_BEROLE.CSV) [ConnectDirect - Send to CD.UNIX.SYINTGT1 folder /ftp/treats_isd/data/]

c/party info, ZCNNI deal info & ZCNNI mtm [FTP - PUT to OPCOFTP-VIP.UK.HIBM.HSBC folder /ftpservlh/ftp_share/dwr/reconciliation/tbw}

ccy info, exchange rates, period defn & prod weightings [ConnectDirect - Send to node CD.UNIX.SYINTGT1 folder /ftp/fceGBEOD/data/]

LEM (MQ Feed)

LEM non-MQ Feeds

Deals with credit info [MQ - TREATS PUTs]

PTS Credit Add-on [ConnectDirect - send to node CD.UNIX.SYINTGT1 folder /ftp/lemGBINTD/data]

ccy info, exchange rates, period defn & prod weightings CK tx & risk blotters, credit exp period, prod control, collateral pos, cash weightings, standing data & DG mapping [ConnectDirect - send to node CD.UNIX.SYINTGT1 folder /ftp/lemGBEOD/data]

CRISP

various static/control/market data & securities info (23 files) [ConnectDirect - Send to CD.UNIX.SYINTGT1 folder /ftp/treats_crisp/data/]

GFDM

A/c balances,, HUB codes, Credit mitigant to product reln, GFDM positions, product control info [ConnectDirect - Send to node prdcdgcf2 folder /hsbc/gcf/asp/hblo/data/gfdm/]

exchange rates, control & deal info, acount types, product redefinition, maturity codes [ConnectDirect - Send to CD.UNIX.SYINTGT1 folder /ftp/treats_gfdmHBEU/data/]

Credit facility & mitigant data (types E,H,I,K,M,O,U) [Connect:Direct - Send to node CD.UNIX.SYINTGT1 folder /ftp/treats_gfdmGLEAM/data/]

GLEAM

Credit facility/utilisation [Connect:Direct - Send to node GBI1 file LGLM.BLQSAM.HBAPHBEU.LGL##.MGB#T.LGLMGBT2]

GCDU

C/party info (daily) [Connect:Direct - Send to node GBI1 file LDC0.BLQSAM.GCDUGSIF.LDC##.VGT#A.LDC0GTAP]

GCF

C/party info (month-end) [Connect:Direct - Send to node prdcdgcf2 file /hsbc/gcf/asp/hblo/data/gfdm/trea_gsif_hblo.sf]

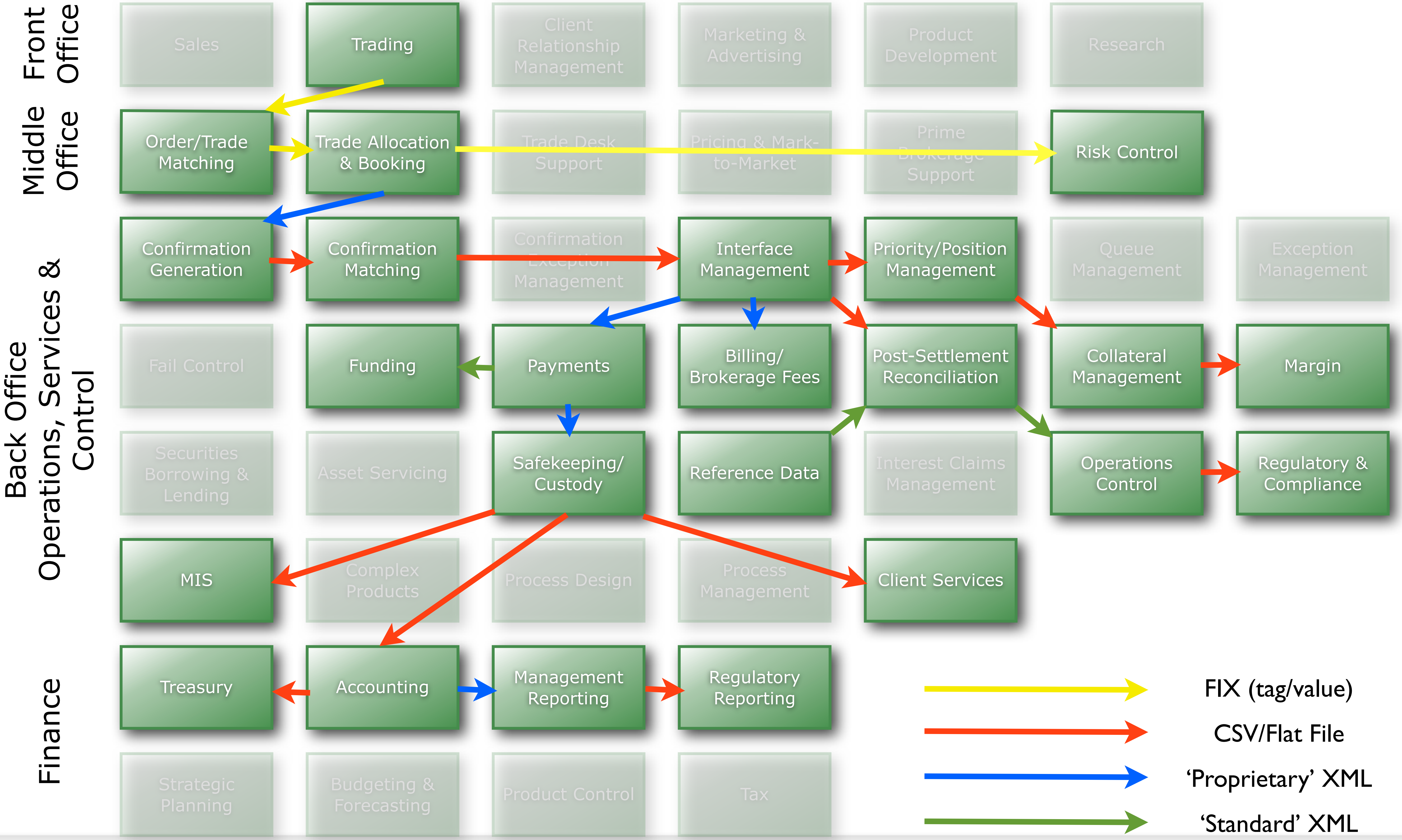
Data everywhere

- Most of the larger banks have literally thousands, many tens of thousands of relational database
- Oracle and IBM spend is usually in 9 (€£$) figures!
- System age varies between a few months to tens of years
- Data is spread all over the place and in hundreds of different formats, models and schema

Functional Landscape

Front Office	Sales	Trading	Client Relationship Management	Marketing & Advertising	Product Development	Research	
Middle Office	Order/Trade Matching	Trade Allocation & Booking	Trade Desk Support	Pricing & Mark-to-Market	Prime Brokerage Support	Risk Control	
Back Office Operations, Services & Control	Confirmation Generation	Confirmation Matching	Confirmation Exception Management	Interface Management	Priority/Position Management	Queue Management	Exception Management
	Fail Control	Funding	Payments	Billing/ Brokerage Fees	Post-Settlement Reconciliation	Collateral Management	Margin
	Securities Borrowing & Lending	Asset Servicing	Safekeeping/ Custody	Reference Data	Interest Claims Management	Operations Control	Regulatory & Compliance
	MIS	Complex Products	Process Design	Process Management	Client Services		
Finance	Treasury	Accounting	Management Reporting	Regulatory Reporting			
	Strategic Planning	Budgeting & Forecasting	Product Control	Tax			

Just one transaction…



Front Office

Sales

Trading

Client Relationship Management

Marketing & Advertising

Product Development

Research

Middle Office

Order/Trade Matching

Trade Allocation & Booking

Trade Desk Support

Pricing & Mark-to-Market

Prime Brokerage Support

Risk Control

Back Office Operations, Services & Control

Confirmation Generation

Confirmation Matching

Confirmation Exception Management

Interface Management

Priority/Position Management

Queue Management

Exception Management

Fail Control

Funding

Payments

Billing/ Brokerage Fees

Post-Settlement Reconciliation

Collateral Management

Margin

Securities Borrowing & Lending

Asset Servicing

Safekeeping/ Custody

Reference Data

Interest Claims Management

Operations Control

Regulatory & Compliance

MIS

Complex Products

Process Design

Process Management

Client Services

Finance

Treasury

Accounting

Management Reporting

Regulatory Reporting

Strategic Planning

Budgeting & Forecasting

Product Control

Tax

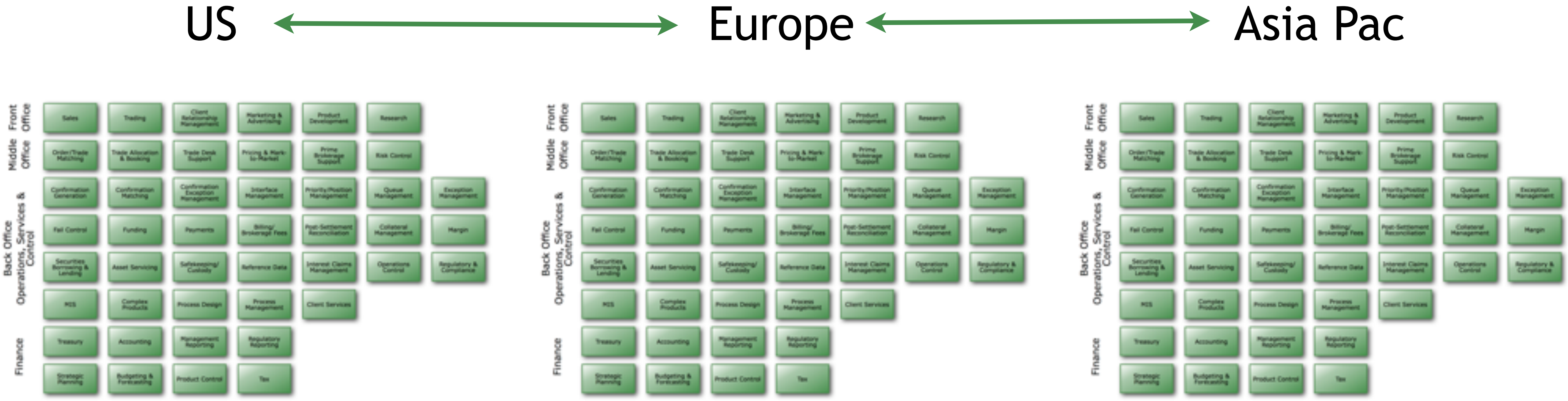
🟨 → FIX (tag/value)

🟥 → CSV/Flat File

🟦 → 'Proprietary' XML

🟩 → 'Standard' XML

Now add the geography...



US ⟷ Europe ⟷ Asia Pac

US

Front Office	Sales	Trading	Client Relationship Management	Marketing & Advertising	Product Development	Research	
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Europe

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Asia Pac

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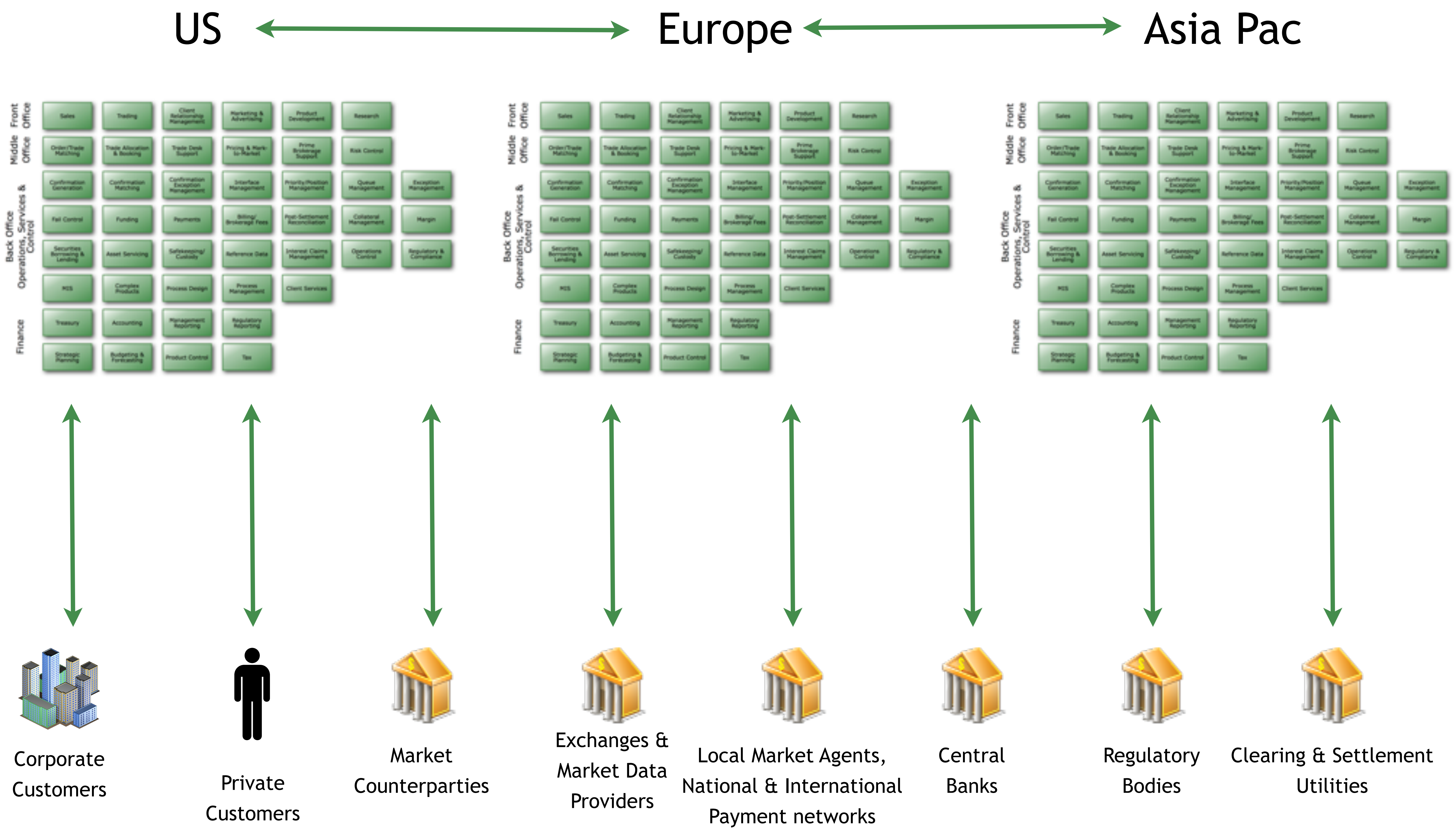
And the rest of the world...



US ⟷ Europe ⟷ Asia Pac

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Asia Pac

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Corporate Customers

Private Customers

Market Counterparties

Exchanges & Market Data Providers

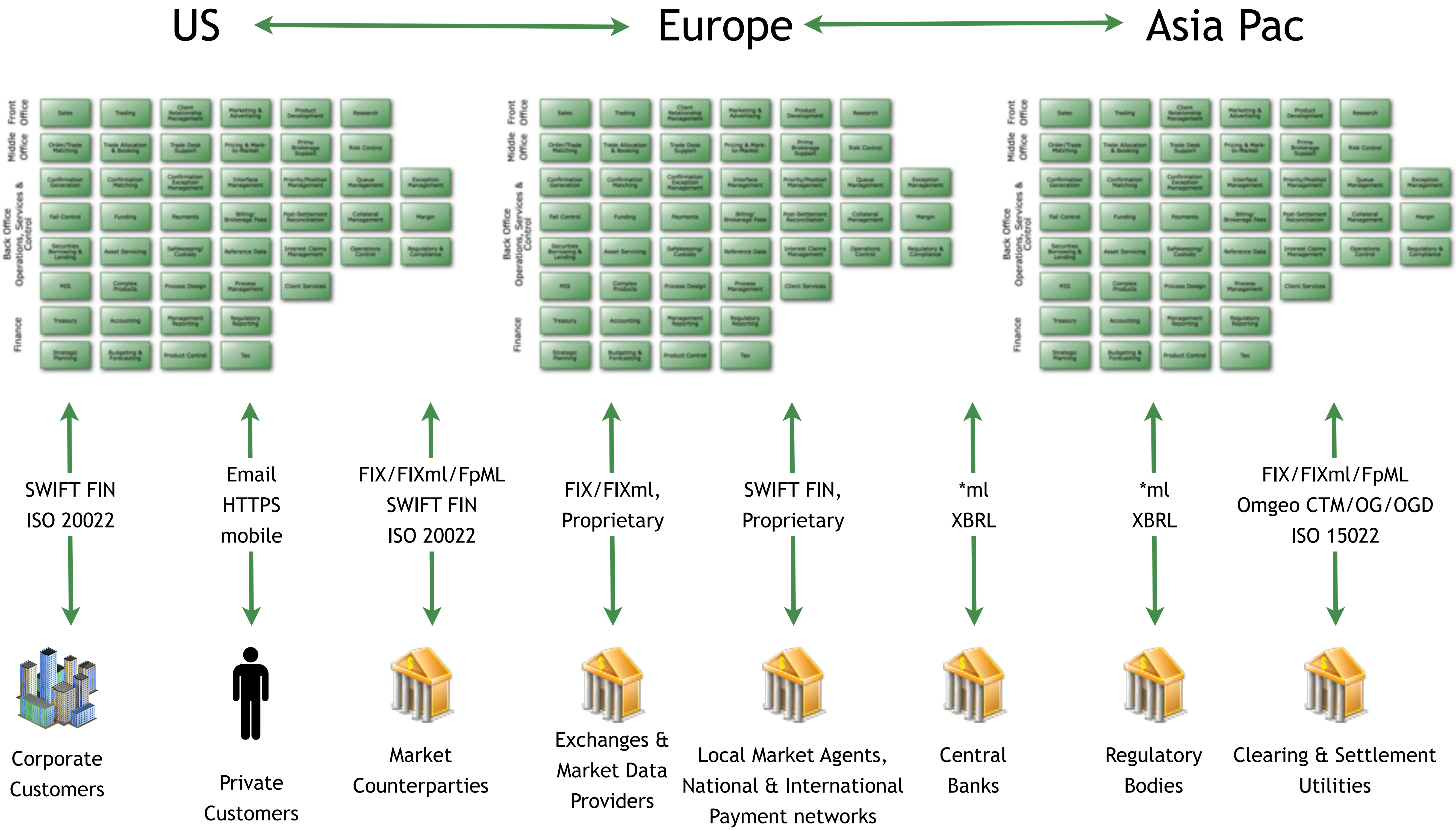
Local Market Agents, National & International Payment networks

Central Banks

Regulatory Bodies

Clearing & Settlement Utilities

Add a few standards...



US ↔ Europe ↔ Asia Pac

SWIFT FIN
ISO 20022

Corporate
Customers

Email
HTTPS
mobile

Private
Customers

FIX/FIXml/FpML
SWIFT FIN
ISO 20022

Market
Counterparties

FIX/FIXml,
Proprietary

Exchanges &
Market Data
Providers

SWIFT FIN,
Proprietary

Local Market Agents,
National & International
Payment networks

*ml
XBRL

Central
Banks

*ml
XBRL

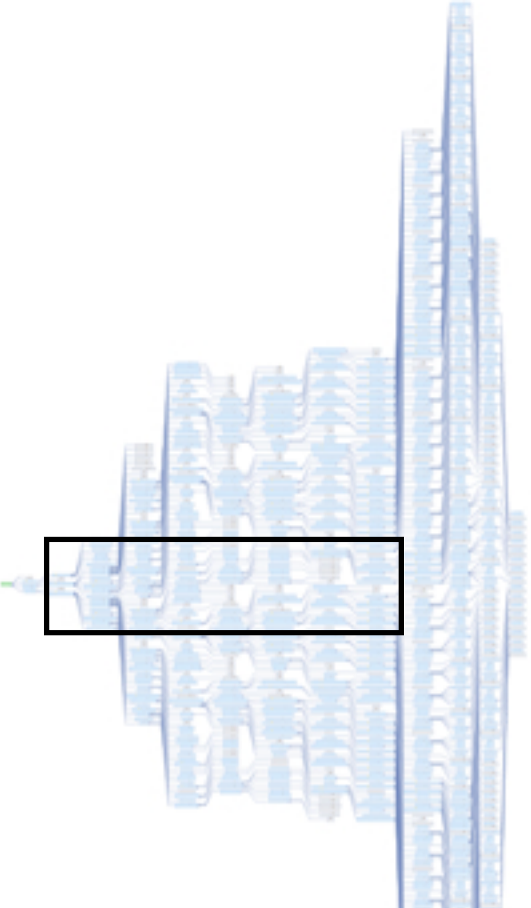
Regulatory
Bodies

FIX/FIXml/FpML
Omgeo CTM/OG/OGD
ISO 15022

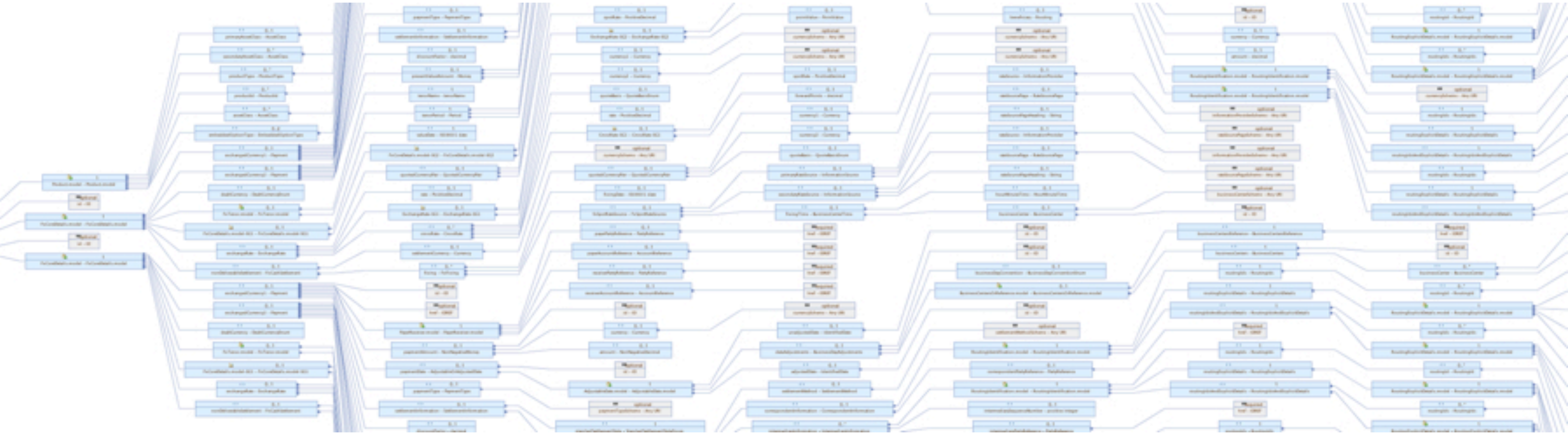
Clearing & Settlement
Utilities

A quick look at FpML

- An FX Swap
  - 14 Level of hierarchy
  - Over 3,000 elements

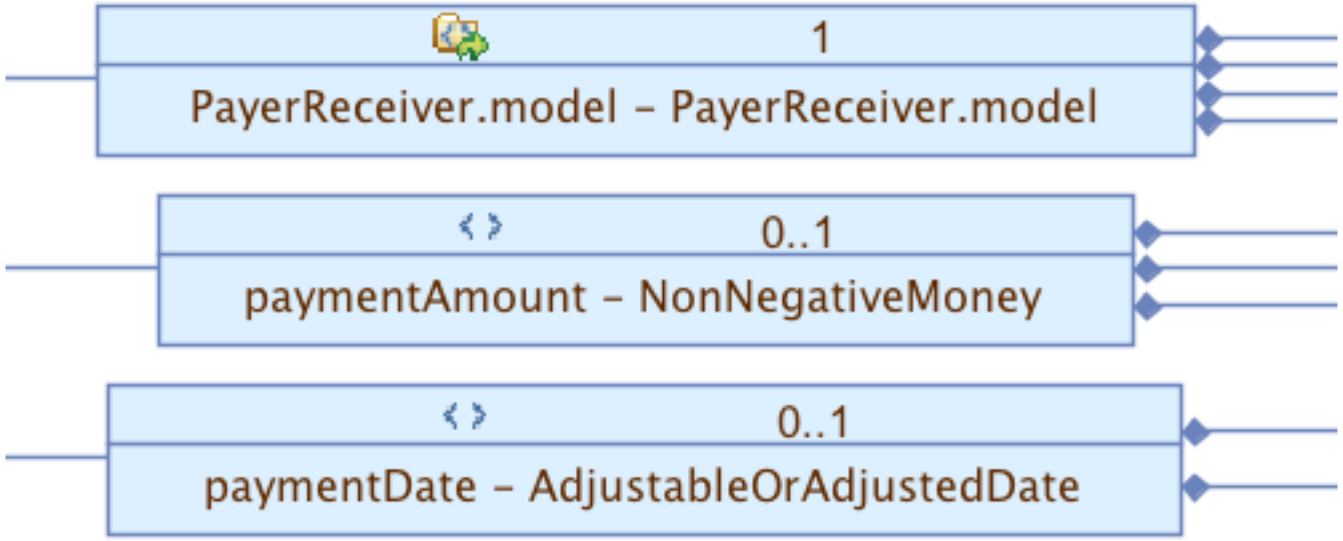


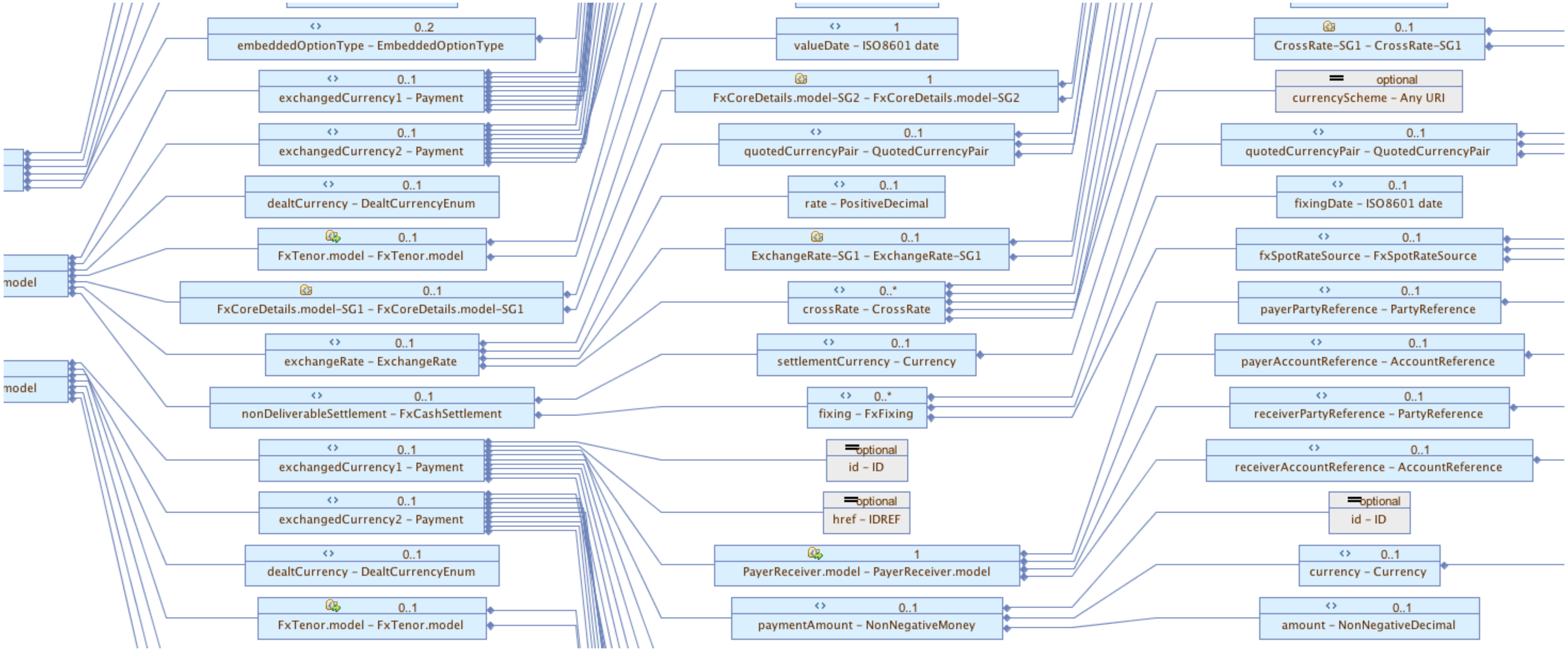
- To the right is the fill message zoomed out
- Below is the part in the box zoomed in a little...



Yes FpML is Complex

- Zooming in a little further…


1
PayerReceiver.model – PayerReceiver.model
0..1
paymentAmount – NonNegativeMoney
0..1
paymentDate – AdjustableOrAdjustedDate


model
model
0..2
embeddedOptionType – EmbeddedOptionType
0..1
exchangedCurrency1 – Payment
0..1
exchangedCurrency2 – Payment
0..1
dealtCurrency – DealtCurrencyEnum
0..1
FxTenor.model – FxTenor.model
0..1
FxCoreDetails.model-SG1 – FxCoreDetails.model-SG1
0..1
exchangeRate – ExchangeRate
0..1
nonDeliverableSettlement – FxCashSettlement
0..1
exchangedCurrency1 – Payment
0..1
exchangedCurrency2 – Payment
0..1
dealtCurrency – DealtCurrencyEnum
0..1
FxTenor.model – FxTenor.model
1
valueDate – ISO8601 date
1
FxCoreDetails.model-SG2 – FxCoreDetails.model-SG2
0..1
quotedCurrencyPair – QuotedCurrencyPair
0..1
rate – PositiveDecimal
0..1
ExchangeRate-SG1 – ExchangeRate-SG1
0..*
crossRate – CrossRate
0..1
settlementCurrency – Currency
0..*
fixing – FxFixing
optional
id – ID
optional
href – IDREF
1
PayerReceiver.model – PayerReceiver.model
0..1
paymentAmount – NonNegativeMoney
0..1
CrossRate-SG1 – CrossRate-SG1
optional
currencyScheme – Any URI
0..1
quotedCurrencyPair – QuotedCurrencyPair
0..1
fixingDate – ISO8601 date
0..1
fxSpotRateSource – FxSpotRateSource
0..1
payerPartyReference – PartyReference
0..1
payerAccountReference – AccountReference
0..1
receiverPartyReference – PartyReference
0..1
receiverAccountReference – AccountReference
optional
id – ID
0..1
currency – Currency
0..1
amount – NonNegativeDecimal

Not always so bad though

- The schema describes the worse-case but many of the simpler “contracts” (XML instances) are vastly simpler
- The FX swap on the right is pretty much all of the information needed to describe the contract
  - There are no options in this example

```
<trade>
  <tradeHeader>
    ...
    <tradeDate>2002-01-23</tradeDate>
  </tradeHeader>
  <fxSwap>
    <productType>FxSwap</productType>
    <nearLeg>
      <exchangedCurrency1>
        ...
        <paymentAmount>
          <currency>GBP</currency>
          <amount>10000000</amount>
        </paymentAmount>
      </exchangedCurrency1>
      <exchangedCurrency2>
        ...
        <paymentAmount>
          <currency>USD</currency>
          <amount>14800000</amount>
        </paymentAmount>
      </exchangedCurrency2>
      <valueDate>2002-01-25</valueDate>
      <exchangeRate>
        ...
        <rate>1.48</rate>
      </exchangeRate>
    </nearLeg>
    <farLeg>
      ...
    </farLeg>
  </fxSwap>
</trade>
```

To the Database

- If we were just storing FX swaps in a database we'd have no problem
- Twenty years ago this is exactly what we did, we had database tables for each type of trade
  - Another for the currencies, counter parties, nostos, holidays etc. etc.
- But as the derivative market started to mature in the early 2000 we needed better ways to describe the options
- As we continue the relational database ends up being a real problem

ORM - OMG!

- Object Relational Mapping (ORM) is sheer craziness!

- The ORM version of the FpML swap has well over 1,000 tables and a single join is several ‘k’ in size
- We could create new tables for each contract but that’s what we started doing in 2000 and that didn’t work
  - Many of these systems are what we have today and this is causing more and more pain
- ORM - Hibernate, JPA etc. was designed for simpler cases

We've got an RDBMS let's use it!

- The usual answer is that we already have Oracle and we pay a lot of money for it so let's use it
- Oracle has an XML type too so what's wrong with that?
- The problem is that Oracle doesn't really want you putting hierarchical data into it's relational database
    - They provide a solution but it's not very performant and very proprietary - so you continue to be locked in
- Could we design a better solution but still using Oracle?
    - BTW - For "Oracle" I also include Sybase, DB2 etc.

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Store the FpML in a CLOB

- Back in 2005/6 a few customers started to look at putting their XML into Oracle
  - We looked at native "Oracle XML" and a more generic API
- With this API we parsed the XML, extracted a few key elements and stored those as keys with the XML as the value (in a CLOB)
- And it worked!
- This became the first working version (in financial services production) that I'm aware of

Problem solved?

- Did this solve the problem? - YES

- But why are we using a relational database to store key/value pairs?
  - Worse why are we using a horribly expensive relational database?

- The main reason is that they've already got Oracle and why should they spend more money on something new?

- So we have to wait until we have new issues to solve...

Performance

- Imagine tens of thousands of FpML trades per day, many of them last for years - tens of millions in total
  - Volumes increasing day by day
  - New types of trade every few months
  - New regulations
  - New ways to calculate value and risk

- Needless to say our Oracle DB is starting to become the bottleneck
  - Coherence is one solution we've seen many banks use but it's expensive and "new"

Two new Solutions

- Assuming we're going to move away from the classic RDBMS we now have two new technologies to look at

- NoSQL DBs - Hierarchical data storage

CouchDB relax

Cassandra

riak

HBASE

mongoDB

redis

- In-Memory - Relational or Hierarchical but we're interested in Hierarchical here

GridGain REAL TIME BIG DATA

GIGASPACES

HAZELCAST SOFTWARE

GEMFIRE

Neo4j the graph database

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Here's the flow...

1. Find, gather, read all the trades/messages
   - Any ESB/SOA will do - Mule, Fuse, Camel, Spring Integration etc.

2. Extract the information you need for indices
   - We use C24's Integration Objects for FpML binding to Java

3. Write the trades/messages to your "database"
   - In-memory or NoSQL - GemFire, GigaSpaces, MongoDB etc.

4. Other requirements...
   - Ad-hoc queries, rules, CRUD facilities - Combine the above

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Enough Slides...

- Time to look at some code and a demo...

It's question time...

- John.Davies@Incept5.com
- Twitter: @jtdavies