RELX Group

Technology teach-in

November 19, 2015

London

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Strategic role of technology – RELX Group

Kumsal Bayazit
Chief Strategy Officer, RELX Group
Chair, Chief Technology Officer Forum

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Agenda

Strategic role of technology – RELX Group	Kumsal Bayazit, Chief Strategy Officer
Application of technology – RELX Group	Vijay Raghavan, Chief Technology Officer, Risk & Business Information
Economics of an electronic decision tools business	Mark Kelsey, Chief Executive Officer, Risk & Business Information
Government segment illustration	Haywood Talcove, Chief Executive Officer, LexisNexis Government Solutions
Insurance segment illustration	Bill Madison, Chief Executive Officer, Insurance Data Solutions
Q&A	Kumsal Bayazit, Chief Strategy Officer

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RELX Group strategic direction

Helping customers make better decisions, get better results and be more productive

Where we are going

Deliver improved outcomes to professional customers
Combine content & data with analytics & technology in global platforms
Build leading positions in long term global growth markets
Leverage institutional skills, assets and resources across RELX Group

How we are getting there

Organic development: Investment in transforming core business; build-out of new products
Portfolio reshaping: Selective acquisitions; selective divestments

Implications for business profile: Improving quality of earnings

More predictable revenues
Higher growth profile
Improving returns

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Revenue by format

Reformatting print reference into electronic reference: largely done
Transforming electronic reference into electronic decision tools: current focus
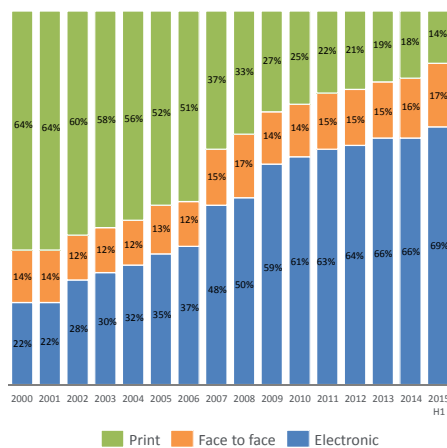
- **Print:** Print to electronic migration largely complete

- **Face-to-face:** continuing to grow

- **Electronic:** Transitioning from electronic reference to electronic decision tools
  – adding broader data sets
  – more sophisticated analytics
  – leveraging more powerful technology

Print Face to face Electronic

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Electronic reference to electronic decision tools
Improved outcomes, demonstrable and measurable customer value

Electronic reference → Electronic decision tools

Reference: search and retrieve critical information

Decision support tools: analysis of content, datasets, facts and patterns to help make a decision

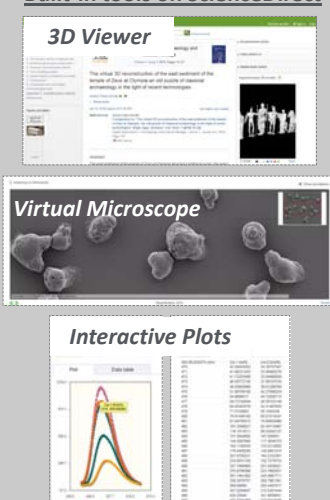Embedded machine to machine decision tools

Built-in tools   *Stand-alone tools*

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Scientific, Technical & Medical (STM)
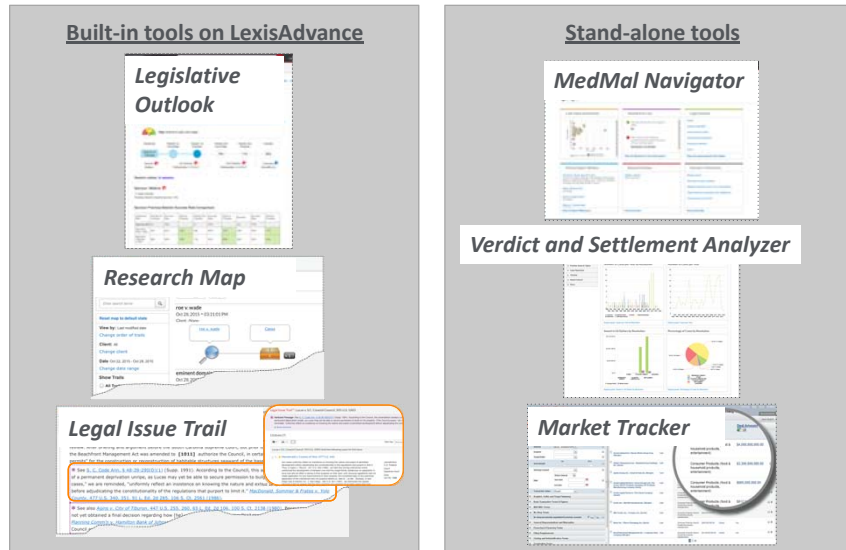*Illustrations of decision support tools*

Built-in tools on ScienceDirect

3D Viewer

Virtual Microscope

Interactive Plots

Stand-alone tools

SciVal

Pathway Studio

Reaxys

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Legal
Illustrations of decision support tools

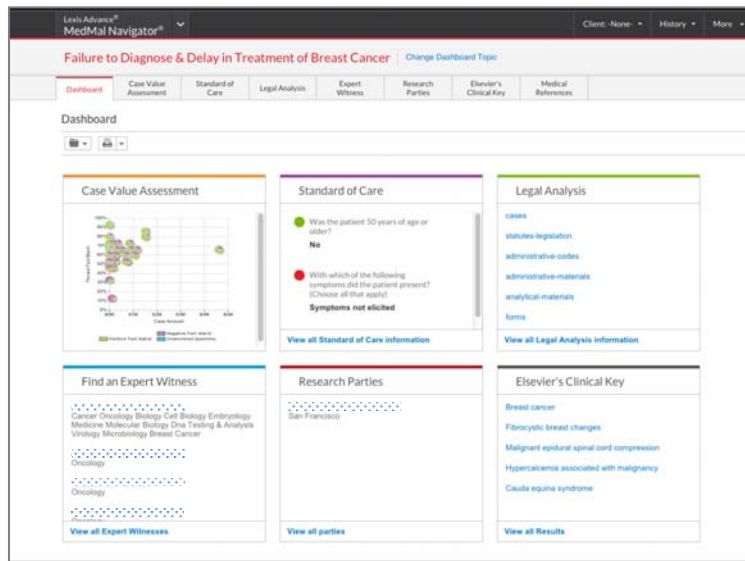| Built-in tools on LexisAdvance	Stand-alone tools
Legislative Outlook	*MedMal Navigator*
Research Map	*Verdict and Settlement Analyzer*
Legal Issue Trail	*Market Tracker*

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MedMal Navigator – legal medical litigator
Illustration of decision support tools

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MedMal Navigator – legal medical litigator
Standard of care

MedMal Navigator – legal medical litigator
Case value assessment
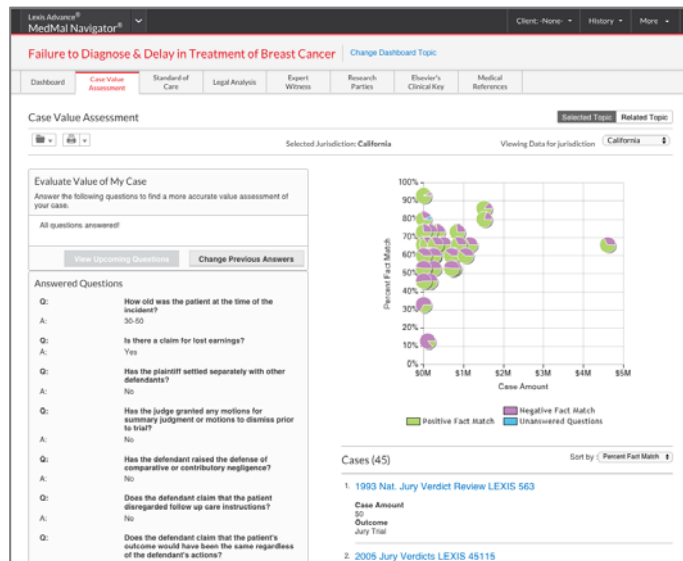
MedMal Navigator – legal medical litigator
Expert witness
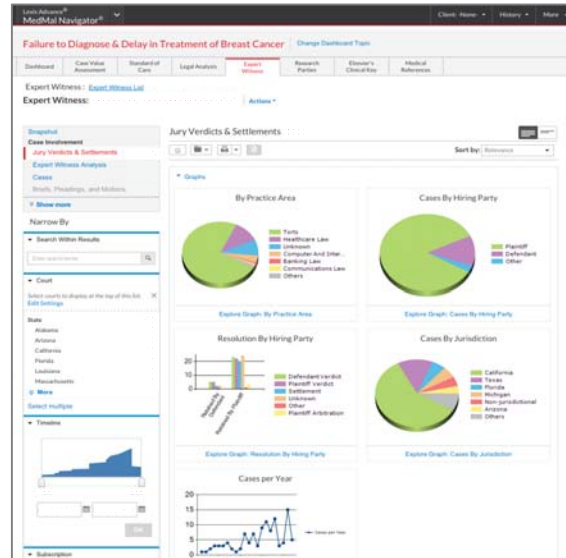
Exhibitions
Illustration of early pilots

Integrating diverse data with different update cycles
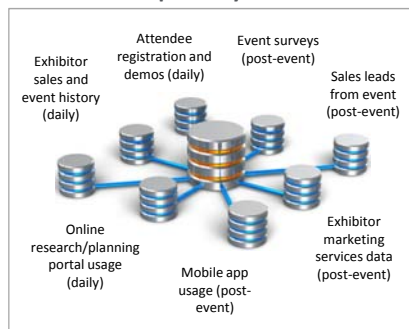
Creating a rich customer profile

Exhibitor sales and event history (daily)

Attendee registration and demos (daily)

Event surveys (post-event)

Sales leads from event (post-event)

Online research/planning portal usage (daily)

Mobile app usage (post-event)

Exhibitor marketing services data (post-event)

Visited event for 2 days; attended multiple sessions

Attends every other year

Actively researches exhibiting companies / segments prior to event

Is "somewhat satisfied" with event; has high need

Logged in 5 times; searched specific companies

John Q. Customer

- Drive better matchmaking
- Predict attrition

Our four key capabilities to deliver electronic decision tools

1. Deep customer understanding

2. Leading content and data sets

3. Sophisticated analytics

4. Powerful technology in global platforms

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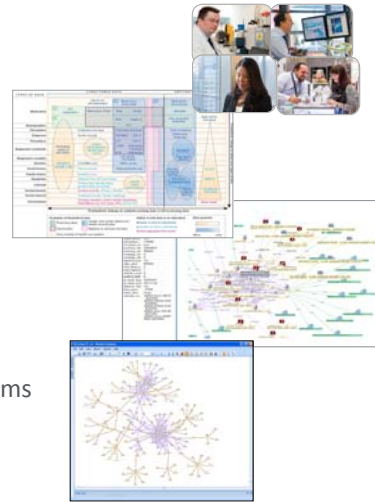
1. Deep customer understanding

Scientists and doctors	Risk professionals	Lawyers	Exhibitors

• c10m researchers
• 1.8m authors
• 17,000 editors
• 700,000 reviewers
• >10m monthly unique visitors
	• 100% of US P&C insurers
	• Top 50 banks
	• Transactions per annum:
	  – >300m user
	  – >3bn machine to machine
	  – >400m batch
		• Top 250 Global Law firms
		• AmLaw 200
		• c75% of Fortune 500
		• c1m subscribed users
		• >250m searches per year
		• c2bn document views
			• >500 events
			• >7m event participants
			• >140k exhibitors
			• >40 sectors

2. Leading content and data sets

Scientific, Technical & Medical

- >1m article submissions per year
- 16% of global research
- >13m articles on Science Direct
- c2,500 journals
- US drugs database (>100k drug packages)
- Global disease pathways (>5m molecular facts)
- Global chemical compound and reaction databases (>50m compounds; >35m reactions)

Risk & Business Information

- >1bn miles of UK driving behaviour
- >4bn US motor vehicle registrations
- >9bn unique US personal identifiers
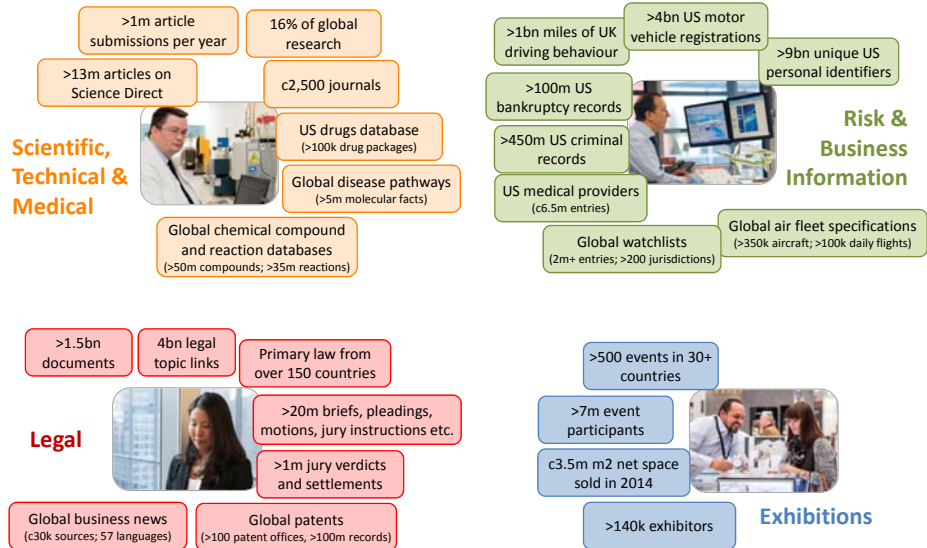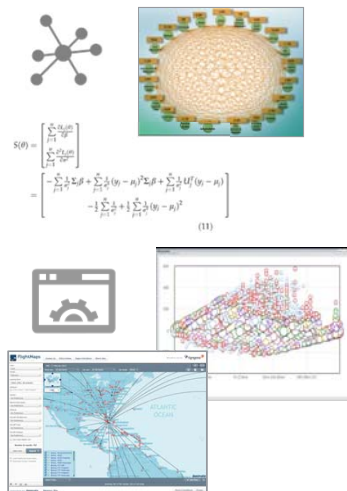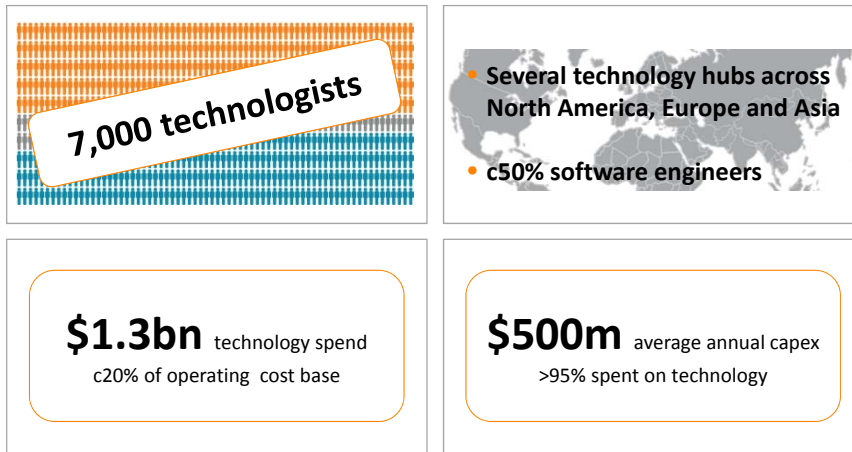- >100m US bankruptcy records
- >450m US criminal records
- US medical providers (c6.5m entries)
- Global watchlists (2m+ entries; >200 jurisdictions)
- Global air fleet specifications (>350k aircraft; >100k daily flights)

Legal

- >1.5bn documents
- 4bn legal topic links
- Primary law from over 150 countries
- >20m briefs, pleadings, motions, jury instructions etc.
- >1m jury verdicts and settlements
- Global business news (c30k sources; 57 languages)
- Global patents (>100 patent offices, >100m records)

Exhibitions

- >500 events in 30+ countries
- >7m event participants
- c3.5m m2 net space sold in 2014
- >140k exhibitors

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3. Sophisticated analytics

- Entity resolution, linking and clustering

- Scoring models and attributes

$$S(\theta) = \begin{bmatrix} \sum_{j=1}^{n} \frac{\partial l_j(\theta)}{\partial \beta} \\ \sum_{j=1}^{n} \frac{\partial l_j(\theta)}{\partial \sigma^2} \end{bmatrix}$$

$$= \begin{bmatrix} -\sum_{j=1}^{n} \frac{1}{\sigma_j^2} \Sigma_j \beta + \sum_{j=1}^{n} \frac{1}{\sigma_j^2} (y_j - \mu_j)^T \Sigma_j \beta + \sum_{j=1}^{n} \frac{1}{\sigma_j^2} U_j^T (y_j - \mu_j) \\ -\frac{1}{2} \sum_{j=1}^{n} \frac{1}{\sigma_j^2} + \frac{1}{2} \sum_{j=1}^{n} \frac{1}{\sigma_j^4} (y_j - \mu_j)^2 \end{bmatrix}$$

(11)

- Descriptive, diagnostic, predictive and prescriptive analytics

- Visualisation to represent clusters, links and insights

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4. Our technology capabilities

7,000 technologists

- **Several technology hubs across North America, Europe and Asia**
- **c50% software engineers**

$1.3bn technology spend
c20% of operating cost base

$500m average annual capex
>95% spent on technology

Summary

- Combining content & data with analytics & technology is at the core of our strategy

- Decision tools add significant value to our customers and to our business

- We are migrating reference to decision tools across the whole of the RELX Group
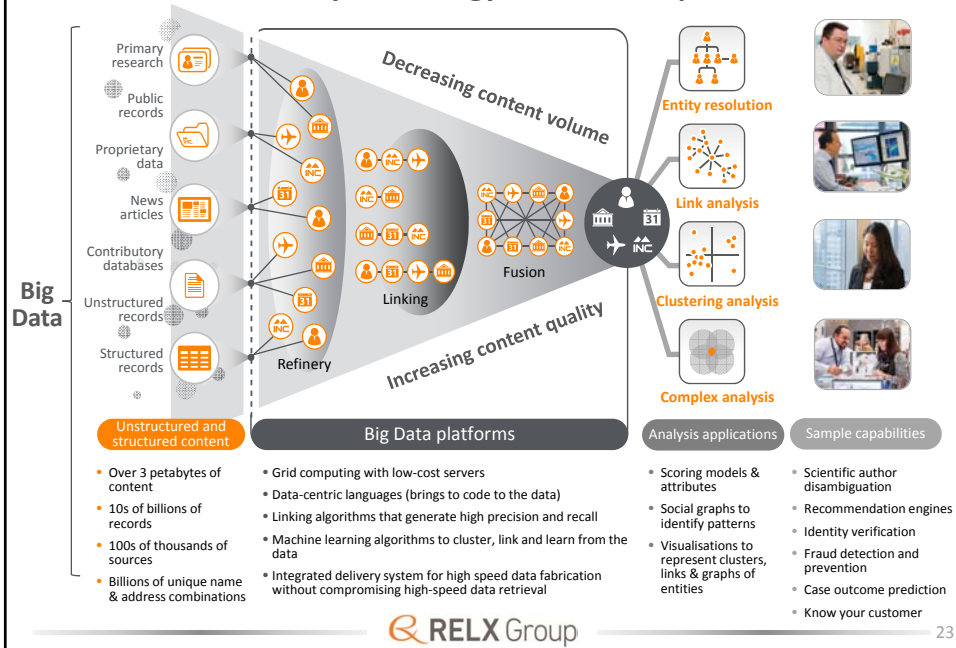
Application of technology – RELX Group

Vijay Raghavan
Chief Technology Officer, Risk & Business Information

RELX Group approach to technology

- Technology agnostic – open sourced, third party and proprietary

- Algorithms are the "secret sauce"

- Re-use approaches and technologies across the Group

- Attract and retain best talent

What do we mean by technology at RELX Group?

Primary research
Public records
Proprietary data
News articles
Contributory databases
Unstructured records
Structured records

Big Data

Decreasing content volume

Increasing content quality

Refinery
Linking
Fusion

Entity resolution
Link analysis
Clustering analysis
Complex analysis

Unstructured and structured content	Big Data platforms	Analysis applications	Sample capabilities
• Over 3 petabytes of content • 10s of billions of records • 100s of thousands of sources • Billions of unique name & address combinations	• Grid computing with low-cost servers • Data-centric languages (brings to code to the data) • Linking algorithms that generate high precision and recall • Machine learning algorithms to cluster, link and learn from the data • Integrated delivery system for high speed data fabrication without compromising high-speed data retrieval	• Scoring models & attributes • Social graphs to identify patterns • Visualisations to represent clusters, links & graphs of entities	• Scientific author disambiguation • Recommendation engines • Identity verification • Fraud detection and prevention • Case outcome prediction • Know your customer

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Example: LexisNexis Risk Solutions (LNRS)
What questions does LNRS answer for its customers?

1. "Are you who you say you are?"

2. "Who else might you be, or claim to have been in the past?"

3. "What other people and/or assets are associated with you?"

4. "What kind of a risk are you in a given context?"
   a) …in calculating your insurance premium, or…
   b) …in processing your claim, or…
   c) …in granting you access to credit, or...
   d) …in doing business with you as a vendor or customer…

5. "Can I quantify the risk that you represent in the form of a score?"

6. "Which of these millions of transactions should I look at in case there's something suspicious"?

7. "What small subset of these thousands (or millions) of events have something in common – which will cause me to look more closely without wasting time on false positives?"
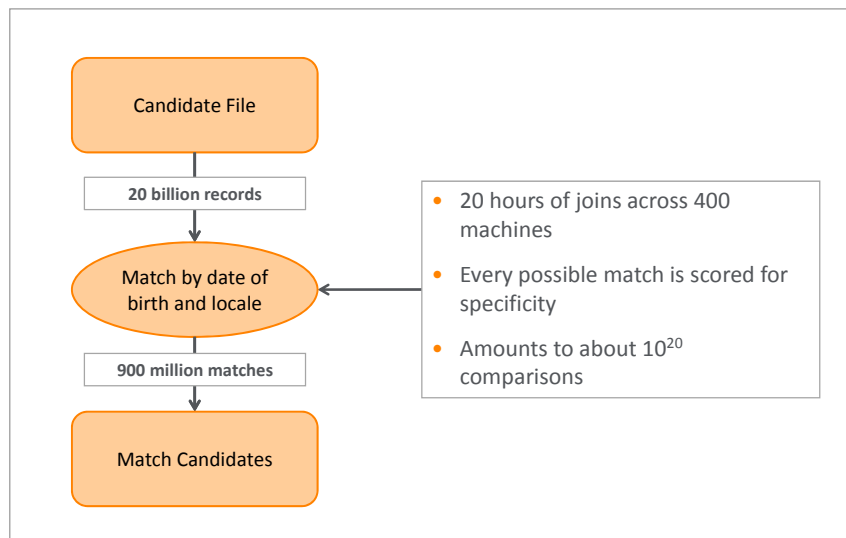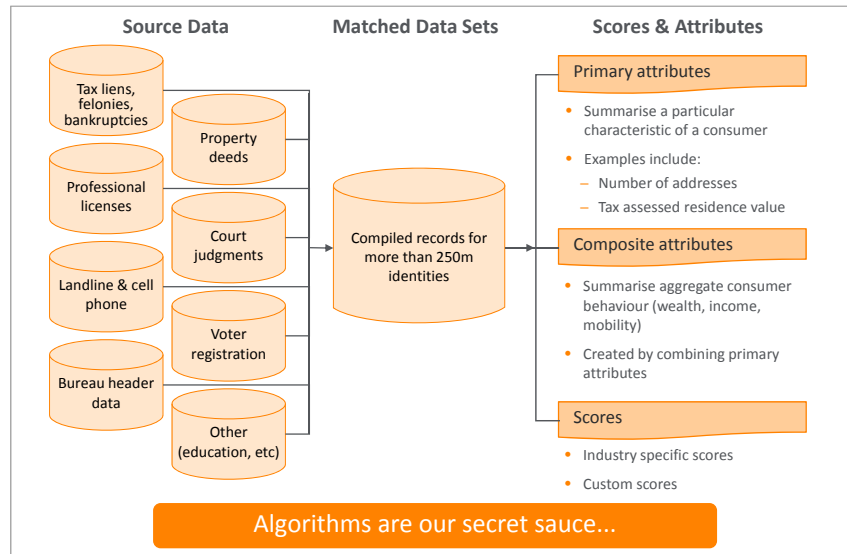
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It all starts with the data!

Break-down of record counts for the more popular data sets:

Data source	# of records	Data source	# of records
Associates/relatives	1.8 billion	Private phones	172 million
Bankruptcy	111 million	Professional licenses	94 million
Business BDID's	283 million	Property	2.5 billion
Business people links	959 million	Sex offenders	550,000
Canadian phones	62 million	SSN's	7.2 billion
Consumer header	10.8 billion	Student records	38 million
Criminal	450 million	TIN	2.9 million
Date of birth	5.2 billion	Unique ADLs - active	257 million
Death	98 million	Utility	645 million
Drivers licenses	397 million	Vehicle titles	635 million
EDA phones	124 million	Vehicle registrations	4 billion
FEINs	10.4 million	White pages	116 million
Historical phones	800 million	Wireless phones	101 million
Hunting and fishing licenses	67 million	Yellow pages	14 million
Liens and judgments	244 million	…	…
People at work	1.5 billion	…	etc…. …

So why is this a "Big Data" problem?

Candidate File

20 billion records

↓

Match by date of birth and locale ←

900 million matches

↓

Match Candidates

- 20 hours of joins across 400 machines
- Every possible match is scored for specificity
- Amounts to about 10^{20} comparisons

After we link records, we can then create unique insights...

Source Data

- Tax liens, felonies, bankruptcies
- Property deeds
- Professional licenses
- Court judgments
- Landline & cell phone
- Voter registration
- Bureau header data
- Other (education, etc)

Matched Data Sets

Compiled records for more than 250m identities

Scores & Attributes

Primary attributes
- Summarise a particular characteristic of a consumer
- Examples include:
  - Number of addresses
  - Tax assessed residence value

Composite attributes
- Summarise aggregate consumer behaviour (wealth, income, mobility)
- Created by combining primary attributes

Scores
- Industry specific scores
- Custom scores

Algorithms are our secret sauce...

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What do we mean by "algorithms are our secret sauce"?
An example (SALT)

A single source of data is insufficient to overcome inaccuracies in the data

A **single data source** view – the holes represent inaccuracies

Instead, absorb data from multiple data sources and link it very accurately using a "probabilistic linking" algorithm

A **multiple data source** view – the holes in the core data have been eliminated using "field value specificities" to derive the probability of a match

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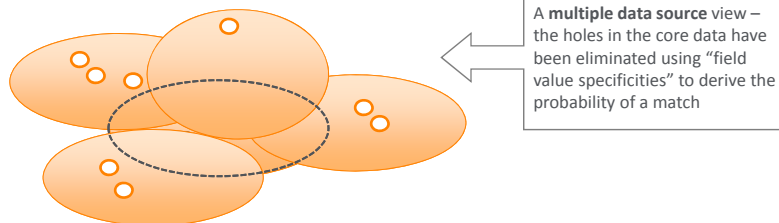
It might sound easy, but it is an evolution over time

Better, Faster, Cheaper

1 Data centric approach

2 Data flow oriented Big Data technology

3 Data disambiguation & linking technology

4 Data graph processing technology

5 Real-time enabled technology

6 Visualisation & workflow technology
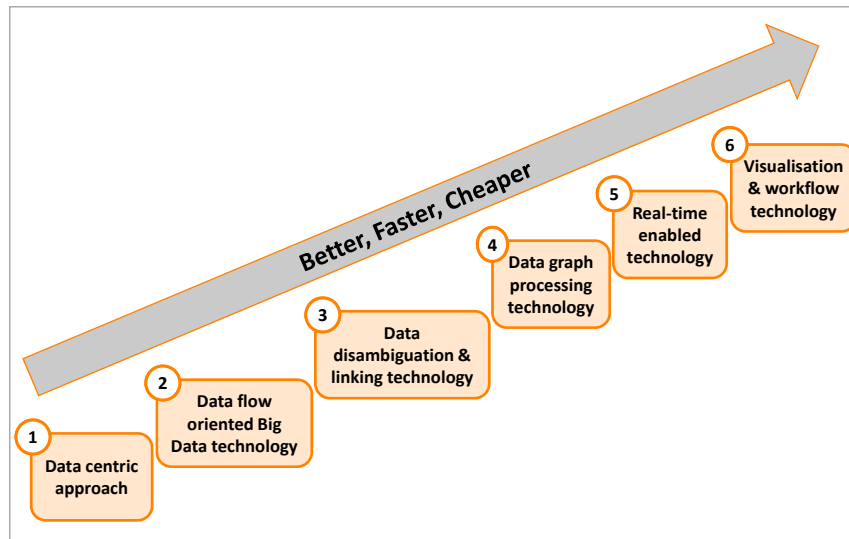
Our technology platform is "Better, Faster, Cheaper"

Analytics and algorithms
- War chest of algorithms, written in a "data scientist-friendly" language (ECL)

Big Data technology (HPCC)
- Open sourced Big Data platform that underpins a substantial portion of RELX Group revenue

Hardware and operating system
- Parallel computing on commodity servers and Linux OS, augmented by other open source modules as needed

- **Better**: Advanced linking ability improves data quality and precision; reduces false positives. Our algorithms are our secret sauce.
  Produces superior products

- **Faster**: High speed of processing and response; rapid development environment that frees up resources
  Solves more problems in less time

- **Cheaper**: Combination of commodity hardware, high-level language, and extremely effective algorithms requires fewer people and resources
  Reduces technology expense

We use our Big Data platform across RELX Group

- ScienceDirect Advanced Recommender – doubled the click-through rate
- SciVal platform
- RealPulse

- Lexis Advance Media-Neutral Content Repository –data process time cut from days to hours
- Content enrichments
- Relationship engine

- "Empower + Engage" – uncovered attrition factors, engaged at-risk exhibitors

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Engagement with external technology community drives further innovation

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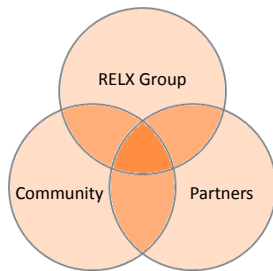
Our strong technology talent drives innovation

Product innovation driven by the businesses

Innovation at the tooling level (for developers/modelers)

Innovation at the algorithms/languages level

Innovation at the platform level

Innovation at the hardware level

Technology innovation to drive time-to-market
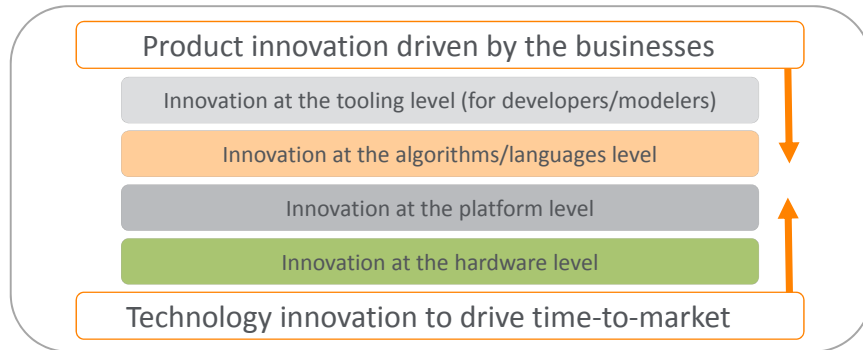
- The attrition within LN Risk Solutions is less than 7%
- Employee satisfaction scores are in the 70% range
- The average tenure of a technologist at Risk Solutions is 10 years

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Summary

- Expert in using technology to solve Big Data problems

- Embedded in Risk & Business Information, extending across RELX Group

- Deep talent pool leveraged across RELX Group

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Economics of an electronic decision tools business

Mark Kelsey
Chief Executive Officer, Risk & Business Information

Risk & Business Information: a key part of RELX Group

Revenue
H1 2015 underlying growth: +3%

+6%

+2%

Exhibitions

Scientific,
Technical &
Medical

+1%

Legal

Risk &
Business
Information

+7%

Adjusted operating profit
H1 2015 underlying growth: +5%

+3%

+5%

Exhibitions

Scientific,
Technical &
Medical

+8%

Legal

Risk &
Business
Information

+7%
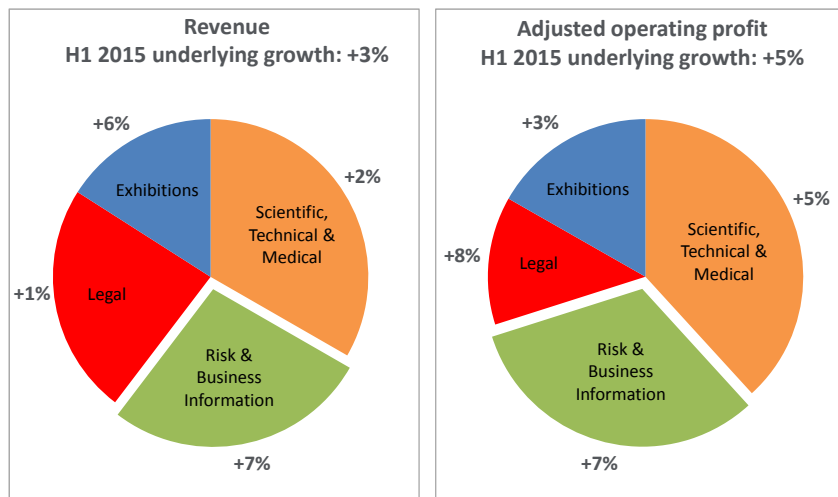
Leader in data and analytics that enable customers to evaluate risk and support key decisions

- $2.4bn* revenues with strong growth drivers
- Margins of 35%*
- Low capital intensity – capex c4% of sales
- Market-leading data, technology, and proprietary analytics

Risk & Business Information revenue
proforma 2015 continuing businesses

by format

Face to face
2%
Print
7%
Electronic
91%

by geography

Rest of world
5%
Europe
16%
North America
79%

by type

Advertising
3%
Subscription
34%
Transactional
63%
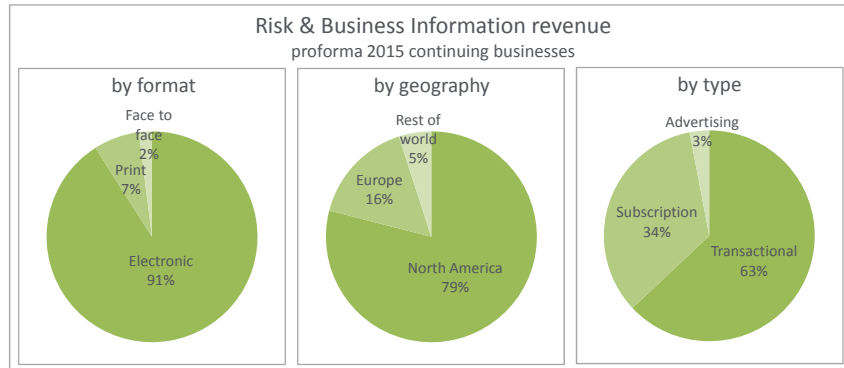
*FY 2014

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Risk & Business Information revenue by segment

Proforma 2015 continuing businesses

Other magazines and services

Major Data Services

Government & Health Care

Insurance Solutions

Business & Data Services

Our customers
- c100% of US P&C insurance carriers
- All top 100 global banks
- c90% of Fortune 500
- All 50 US states
- c70% of US local governments
- c80% of US federal agencies
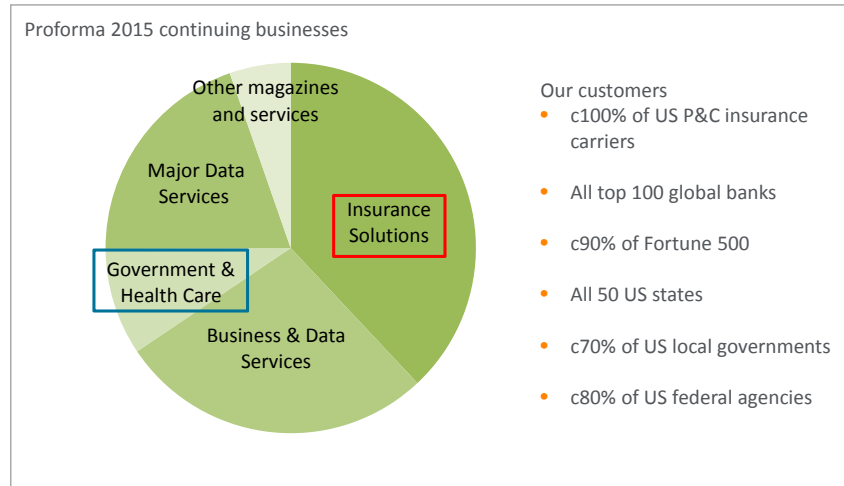
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Risk & Business Information underlying revenue growth

Risk & Business Information underlying revenue growth contribution
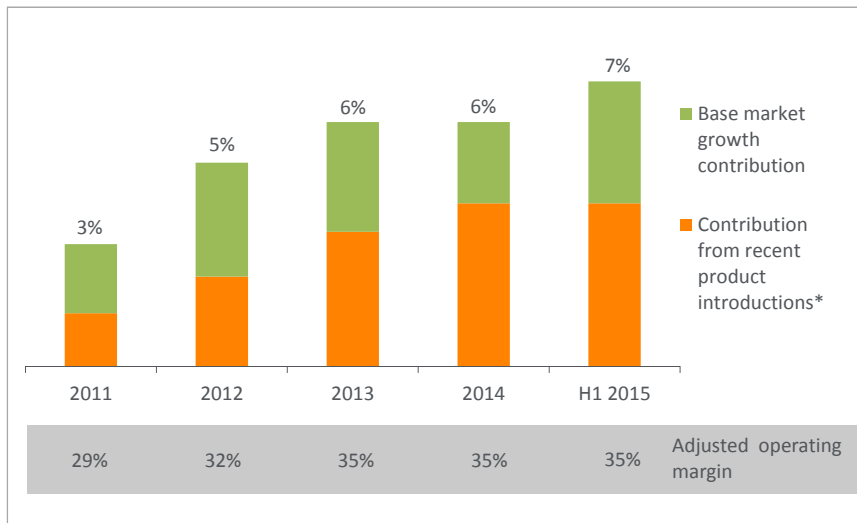
Strategic priorities for driving organic growth

Core markets
- Continuous product innovation to improve customer outcome; effectiveness, efficiency and compliance
- Drive deeper into innovative applications and increase penetration across customer workflows

Adjacent markets
- Pursue growth in attractive adjacent markets where our core strengths can be leveraged

International
- Address international opportunities in selective geographies: leveraging skill sets, technology, analytics and experiences

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Government segment illustration

Haywood Talcove
Chief Executive Officer, LexisNexis Government Solutions

LNRS provides analytics solutions to solve problems across US government segments

Our focus includes:
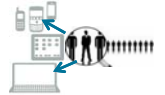
- Stopping fraud and catching criminals

- Making customers more efficient in a challenged budgetary environment

- Solutions cost around 1% of savings

We use:

- Deep customer insight

- Unique data content

- Visual analytics

- Leading technology

Who we serve

- 49 out of 50 States Dept. of Revenue
- 48 out of 50 States Dept. of Health & Human Services

- All executive level federal agencies
- Top 100 largest state & local US law enforcement agencies

Public Safety	Intelligence Agencies	Tax & Revenue	Health & Social
• Locate person of interest • Identify asset ownership • Find non-obvious relationships	Detect patterns and hidden relationships between persons of interest • Conduct cyber forensics investigations • Monitor insider threat	Prevent tax fraud and identify tax evasion • Discover new sources of revenue by detecting tax fraudsters and non-filers • Prioritise collection efforts	Ensure welfare program integrity • Validate claimant identity • Assess claimant eligibility • Monitor payments to the right individual

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LNRS Government solves complex government identity and fraud problems

New York Police Department

Using Accurint for Law Enforcement plus for solving Cold Cases, it makes difficult and time consuming tasks easy and fast, and it's a fantastic lead generator.

Indiana Department of Revenue

"Using the TRIS* program without slowing down the refund process, allows us to identify those culprits," Alley said. "It's increased our efficiency and enabled us to pursue other forms of tax fraud."

The use of the LexisNexis technology in 2014 has stopped $42 million in refunds being mailed to criminals.

New Jersey Department of Labor & Workforce Development

Approximately 646 instances of attempted identity fraud have been prevented using the LexisNexis® Identity Management solutions.

LexisNexis has helped New Jersey Department of Labor stop $4.4m in unemployment insurance fraud over the past 17 months.

*Tax refund intercept system

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Customer use case: Mississippi National Accuracy Clearinghouse (MS NAC): Solving a key benefits fraud problem

Online government applications for food stamps are at an all-time high
- More than 48m Americans have been on the program for 35 straight months
- Now one in every five Americans are enrolled on the program

Pre-paid / electronic benefit transfer (EBT) cards
- Benefit dollars paid to Pre-paid/EBT Cards has doubled each year to improve turnaround

Every American's identity has already been stolen
- Over 850m names, SSNs and bank accounts stolen in record breaches since 2005

MS NAC
- Set of five US States expressed need to validate that individuals applying for food subsidy benefits in one state were not also applying for benefits in another

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Customer use case: MS NAC solution leverages innovative LNRS technology and analytics

Our program combines customer data from states with our public records data to identify fraudulent patterns, including applications for benefits in multiple states

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Customer use case: MS NAC: contributory data handling and build processing

>96m records ingested per annum

c24m queries processed per annum

>70% reduction in duplicated participants; savings of c$150 million. due to increased identification of fraud
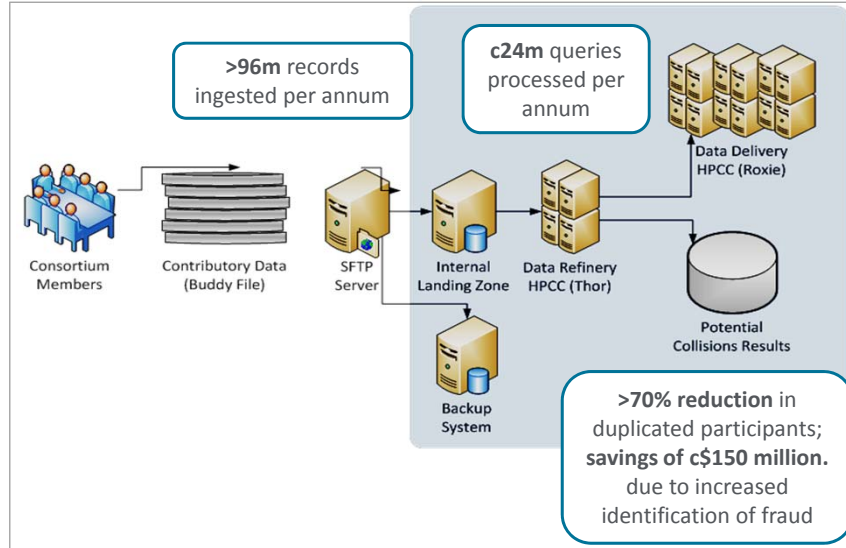
Our longer term vision is to build a Contributory Solution for every Health & Human Services (HHS) segment to solve bigger fraud problems

A "SuperNAC"
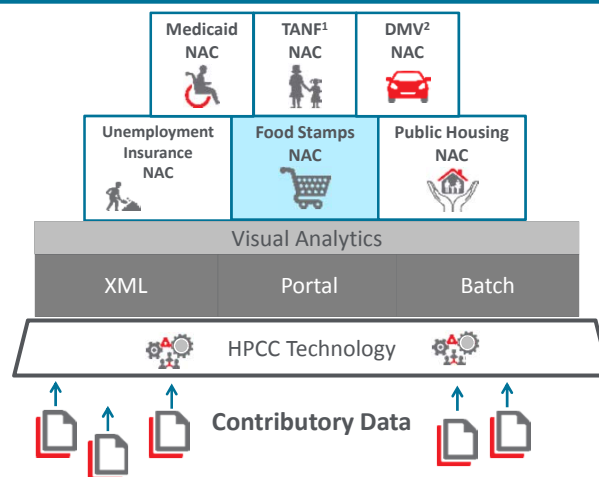
1. TANF: Temporary Assistance for Needy Families
2. DMV: Department of Motor Vehicles

Insurance segment illustration

Bill Madison
Chief Executive Officer, Insurance Data Solutions

LNRS provides vital contributory & external data and analytics to the US insurance industry

Our expertise and product solutions enable carriers to:

- Make better and faster risk underwriting decisions

- Make more accurate policy pricing decisions at issue and renewal

- Reduce claim losses using advanced data & fraud detection analytics

- Streamline the customer application and policy management process

Insurance Solutions growth has been driven by innovation

Deeply embedded at the point of underwriting, we are focused on driving deeper integration across all parts of the carrier workflow

Workflow:

MARKETING → CONTACT → QUOTE → UNDERWRITING → RENEWAL → COMPLIANCE → CLAIM

AUTO: System to system integration level:

Opportunity	Growing	High	High	Growing	Growing	Growing

Growth   Growth

HOME/LIFE/COMMERCIAL: System to system integration level:

Opportunity	Growing	Growing	Growing	Growing	Growing	Opportunity

Growth   Growth

Data assets available across the insurance continuum

MARKETING · CONTACT · QUOTE · UNDERWRITING · RENEWAL · COMPLIANCE · CLAIM

Carrier / agent system

Value added analytics
Overlay additional info to further refine results e.g.,"Insurance Score"

Single point of entry
- standard XML schema

'Pull' on insurance data infrastructure

Output tailored to insurer's systems, pricing and risk criteria

Insurance data infrastructure

Contributory data:
Policy and loss history data

Police reports:
eCrash, CRU and Coplogic

Public records data:
Driver history, vehicle data, bankruptcies, liens, judgments, court records, census data, etc.

Credit bureaux:
Credit bureaux & business information

State gateways:
Motor vehicle reports

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Machine to machine integration: the power of analytics

MARKETING · CONTACT · QUOTE · UNDERWRITING · RENEWAL · COMPLIANCE · CLAIM

- Today LexisNexis manages over 400 models within the infrastructure
  – Industry models and custom models

- Models creates a platform for today's needs and tomorrow's advancement
  – Scores and reason codes
  – Data attributes

- The platform advances and evolves to the needs of the market
  – Signal data sourced models
  – Multi variant decision processes

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The power of data: process and risk assessment

| MARKETING | CONTACT | QUOTE | UNDERWRITING | RENEWAL | COMPLIANCE | CLAIM |

There will always be interest in solutions that provide better risk assessment.

- Motor vehicles records
- Claims history
- Profiles of the household
- Financial history (credit)
- Policy data
- Marketing segmentation
- Driving behaviour
- Telematics

We are constantly adding more data…

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Telematics made real through analytics:

Today we manage:
- Over 1 billion vehicle miles
- 120 earned vehicle years

Why is this important?
- This information provides a baseline of knowledge

- It provides market learnings, not just data.

- By building a database of all posted speed limit information, you can now understand simple things like on ramp / off ramp driving behaviours

- Analytics provides a way to transfer data and market knowledge to actionable intelligence

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The "extended" principle of data

LexisNexis®
RISK SOLUTIONS

Insurance Solutions

RELX Group

Using data to enhance the insurance experience

MARKETING ▸ **CONTACT** ▸ QUOTE ▸ UNDERWRITING ▸ RENEWAL ▸ COMPLIANCE ▸ CLAIM

Industry challenges

- The industry is spending over $6bn a year to "excite consumers"
- The process was more about "data collection"
- Customer experience was poor at best not to mention data errors when entering data into the carrier system, requiring them to revert to the customer

LNRS solutions

- **Auto Data Prefill**: Provides critical household information (drivers, vehicles and existing coverage) needed to quote and underwrite a policy, with minimal input required (name, address and date of birth)

Market Success Stories with Prefill
- Reduce quote time from over 20 minutes to less than 5 minutes
- Improve information product order hit rate by as much as 8%
- Reduction of bad VIN's from 12% to 2% over a 12 month period of time
- Call Centre first time close rate increased by 60% in the first 30 days of launching the service

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Prefill: The next generation
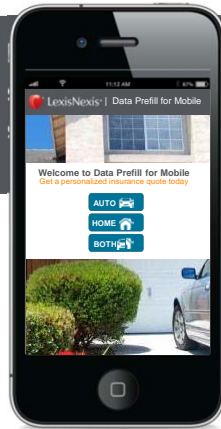
• Mobile Auto Data Prefill

By simply taking a picture of the barcode on the back of a Driver License, LexisNexis can prefill the application components; with no data entry

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Strategic priorities for driving growth

Core markets
- Continuous new product innovation to improve economic outcomes of insurance carriers and intermediaries
- Increase penetration across carrier workflows, from marketing and point of contact through underwriting to claims

Adjacent markets
- Pursue growth in attractive adjacent markets leveraging LNRS' core strengths (e.g. Life, Home, Commercial)

International
- Address international opportunities in selective markets leveraging skills sets, technology, analytics and experience

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Summary

- Combining content & data with analytics & technology is at the core of our strategy

- Decision tools add significant value to our customers and to our business

- We are migrating reference to decision tools across the whole of the RELX Group

Technology teach-in

November 19, 2015

London

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