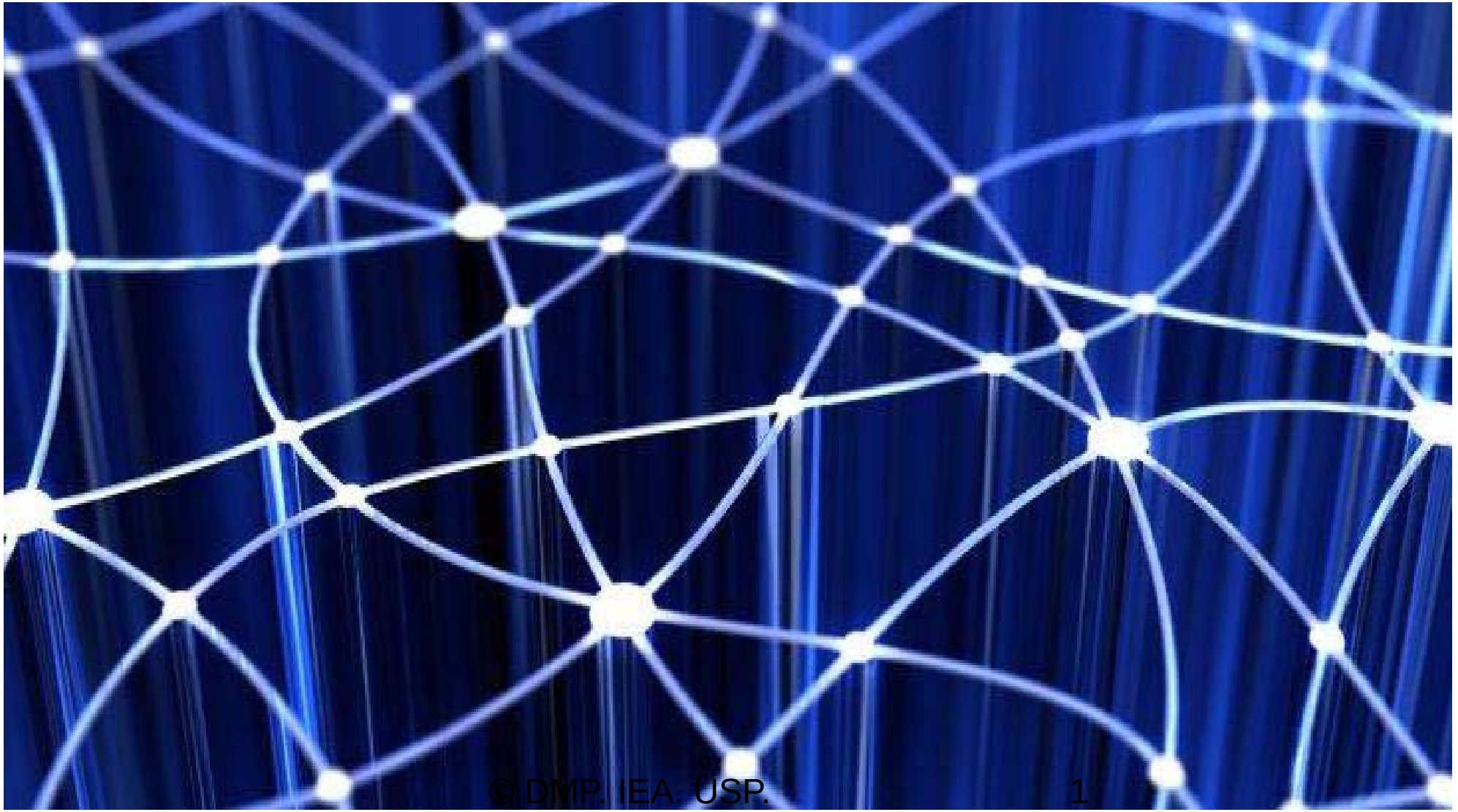
Cognitive Computing

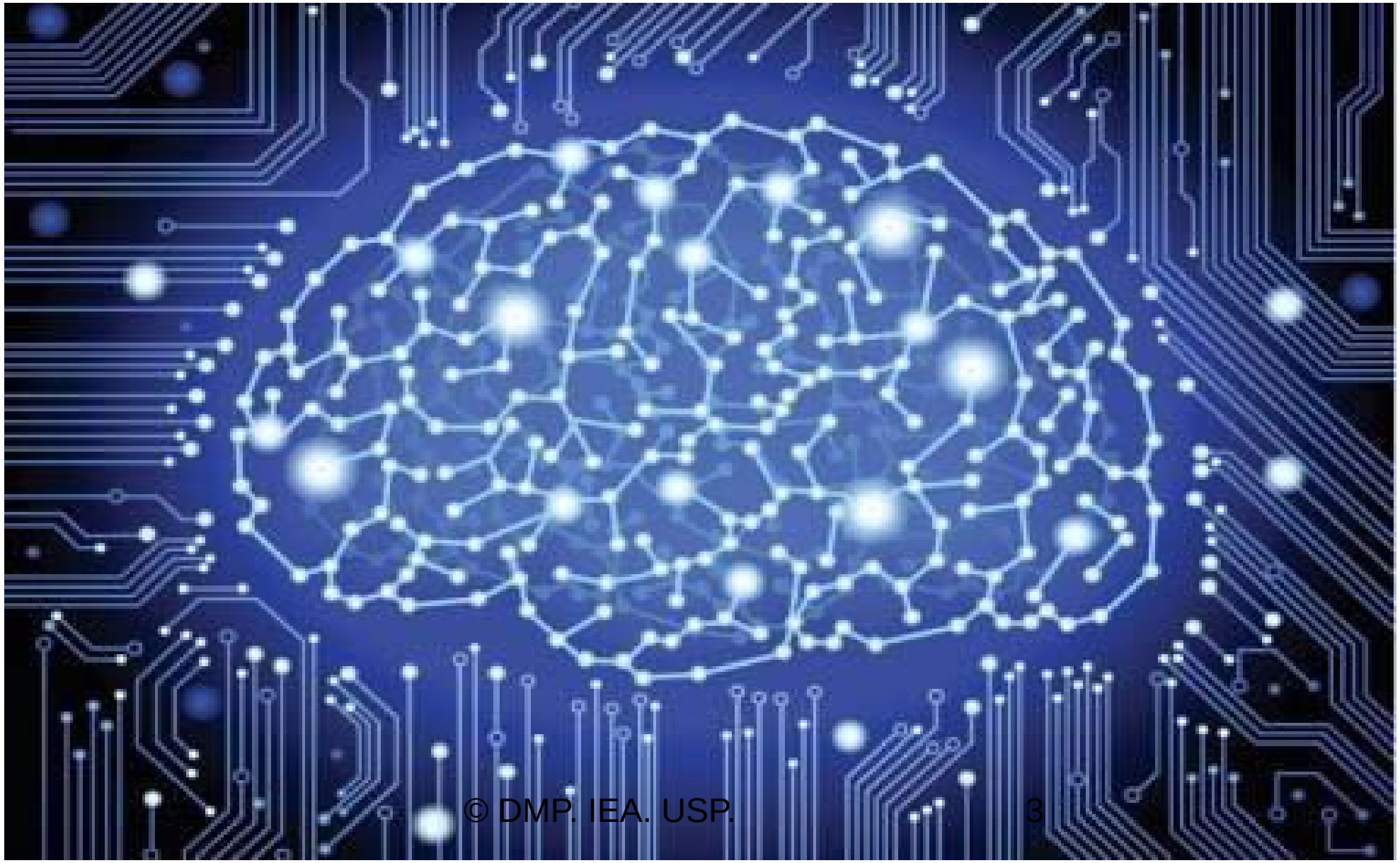
Don Peterson IEA-USP



music [press]

Contents

Augmented Intelligence



The Cognitive Era

Life and work have entered an era of:

- fast change
- mass connectivity and mass data (often indeterminate: uncertain, ambiguous, incomplete, inconsistent, dynamic)
- intelligent technologies which are collaborators rather than tools (e.g. intelligent agents, and humanoid robots).

In terms of systems theory [press] this is an era of more open systems. In terms of information technology, it is Dynamic, Massive, and Cyborg (DMC).

Seen negatively, 'the old ways are gone', and we feel overwhelmed.

Seen positively, this is an **opportunity**, especially using new technology.

This technology is **cognitive computing (CC):** providing **augmented intelligence** for the **cognitive era**.

watch video **[press]**.

CC Definition

Here is part of a definition of CC by the Cognitive Computing Consortium [press]:

Cognitive computing makes a new class of problems computable. It addresses complex situations that are characterized by ambiguity and uncertainty; in other words it handles human kinds of problems. In these dynamic, information-rich, and shifting situations, data tends to change frequently, and it is often conflicting. The goals of users evolve as they learn more and redefine their objectives. To respond to the fluid nature of users' understanding of their problems, the cognitive computing system offers a synthesis not just of information sources but of influences, contexts, and insights. To do this, systems often need to weigh conflicting evidence and suggest an answer that is "best" rather than "right".

CC Basics

Cognitive computing [press] combines:

- natural language processing
- intelligent data-mining
- probabilistic reasoning
- parallel hardware

The result is a paradigm shift in intelligent decision support.

It ingests data from inside and outside the organisation. This may come in large and unstructured data sets --- such as natural language text in journals, books, and social media, or images and sounds.

It supports human reasoning by evaluating data in context and presenting relevant findings along with the evidence that justifies the answers.

It supports context-sensitivity and adaptivity.

CC Sectors

Some application sectors for cognitive computing:

- Education [press, press, press]
- Environment and Sustainability [press, press, press, press, press]
- Fashion [press, press, press, press, press, press]
- Finance & banking [press, press, press, press, press]
- Healthcare [press, press, press, press, press, press]
- Hospitality [press, press, press, press, press, press, press]
- Insurance and Risk [press, press, press, press]
- Law [press, press, press]
- Marketing [press, press, press, press]
- Oil, Gas, Energy [press, press, press]
- Police Work [press, press, press]
- Retail [press, press, press]
- Security [press, press, press]
- Smart Cities [press, press, press, press, press]
- Surveillance [press, press, press, press]
- Travel [press, press, press, press]

The Internet of Things

The Internet of Things (IoT) is a primary application domain for cognitive computing [press].

The IoT is the connected web of sensors and other devices which now provide a vast mass of data.

To utilise this data, cognitive computing is more of a necessity than an option.

In industry, IoT data is used in predictive maintenance (e.g. in oil & gas, roads, railways, subways, and aviation), in safety, and in managing complex systems.

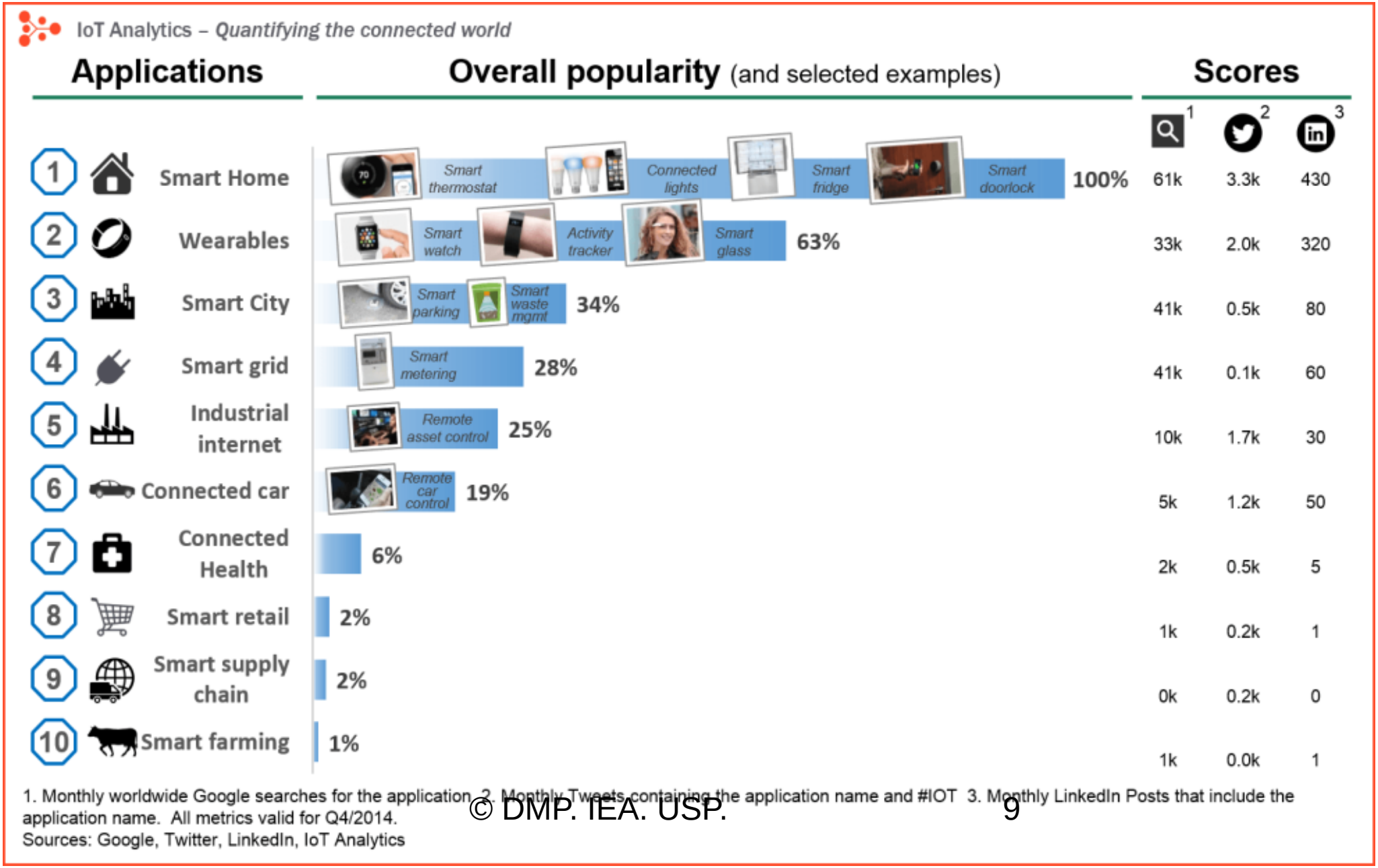
In smart homes, devices and services are connected to each other, to your mobile phone, and to a central home control system.

In smart cities, IoT technology is used to manage public services and provide other benefits.

In healthcare, IoT-enabled wearable devices can send patient data to medical staff, including emergency alerts.

IoT data is a problem for security since 'everything is online' and hacking is made easier.

The Internet of Things



IBM Watson

Watson Basics

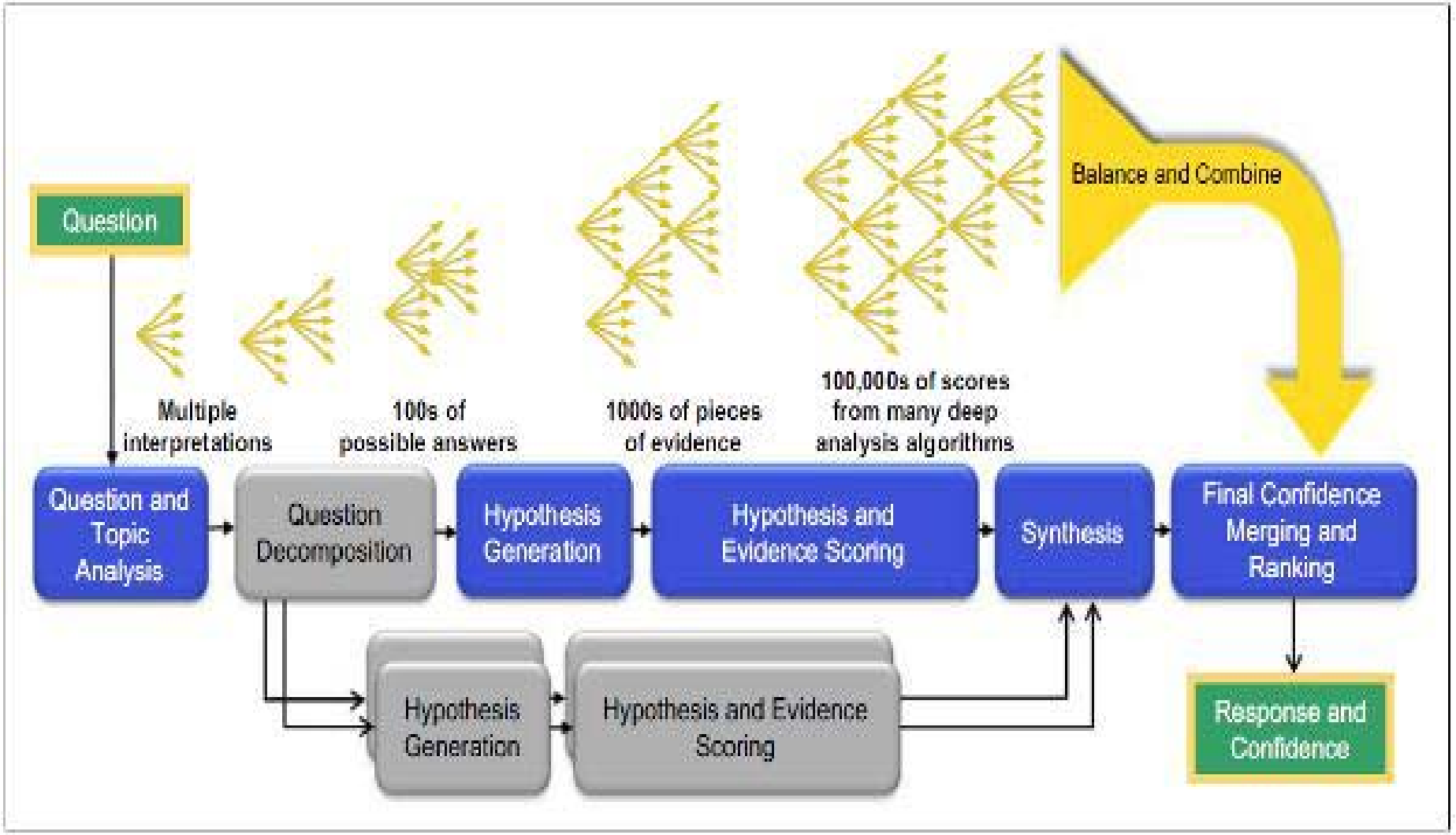
IBM Watson:

- was created as a question answering (QA) computer system suitable for open-domains
- it was initially conceived in the 2000's to play the TV quiz game *Jeopardy!* --- which it won against two human contestants in 2011
- it incorporates natural language processing, information retrieval, knowledge representation, machine learning, and probabilistic reasoning
- it is built using IBM's DeepQA software and the UIMA (Unstructured Information Management Architecture) framework, and uses massively parallel hardware and cloud technology
- its data include encyclopaedias, wikipedia, dictionaries, literature, the client company's internal documents, etc.
- it now goes beyond processing question-answer pairs, and is said to 'see', 'hear', 'read', 'talk', 'taste', 'understand', 'reason', 'interpret', 'learn' and 'recommend'

In developing Watson, IBM has consistently worked closely with industry sectors including healthcare, oil & gas, and several others --- this has given credibility to machine intelligence and moved it out of the research lab and into the real world.

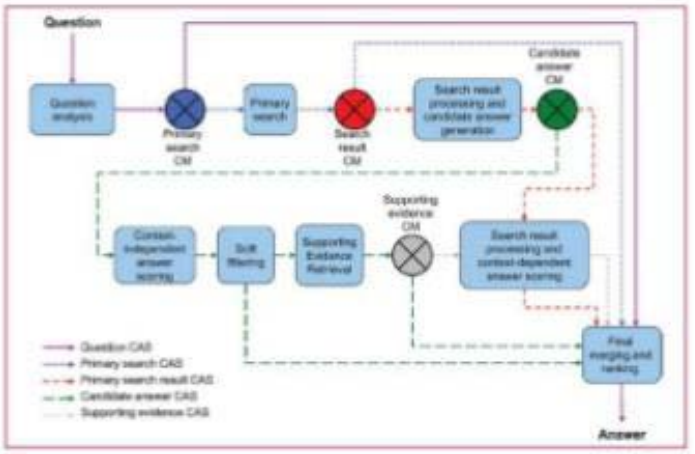
watch video [press]

DeepQA Pipeline

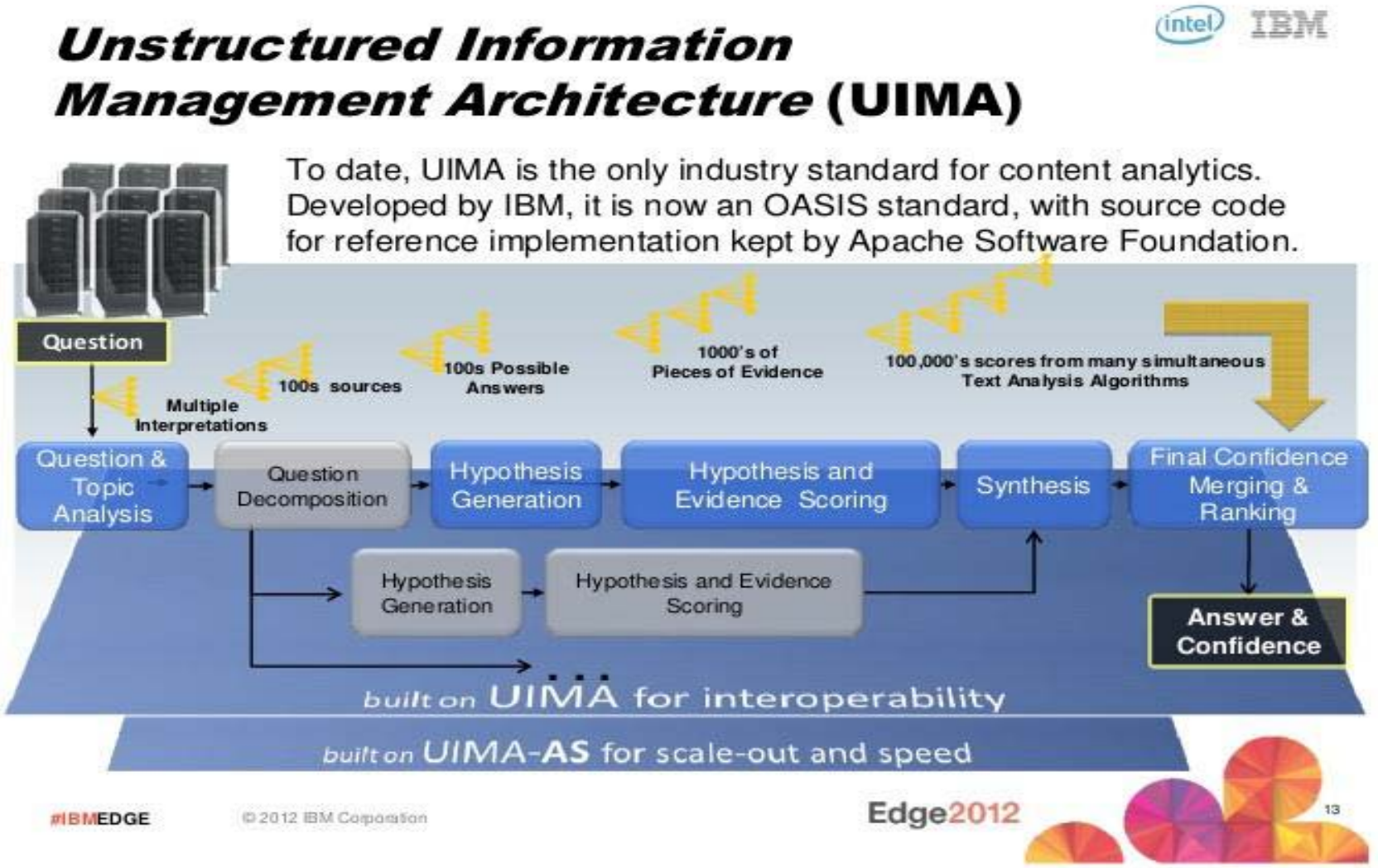


DeepQA Architecture

The DeepQA architecture, which both IBM Watson and RPI MiniDeepQA implement, is a QA (Question Answering) system that answers questions by generating as many potential answers as is practical, then filtering them with multiple evidence scorers in parallel.



UIMA


Unstructured Information Management Architecture (UIMA)
intel
IBM
To date, UIMA is the only industry standard for content analytics. Developed by IBM, it is now an OASIS standard, with source code for reference implementation kept by Apache Software Foundation.
Question
Multiple Interpretations
100s sources
100s Possible Answers
1000's of Pieces of Evidence
100,000's scores from many simultaneous Text Analysis Algorithms
Question & Topic Analysis
Question Decomposition
Hypothesis Generation
Hypothesis and Evidence Scoring
Synthesis
Final Confidence Merging & Ranking
Hypothesis Generation
Hypothesis and Evidence Scoring
Answer & Confidence
built on UIMA for interoperability
built on UIMA-AS for scale-out and speed
#IBMEDGE
© 2012 IBM Corporation
Edge2012
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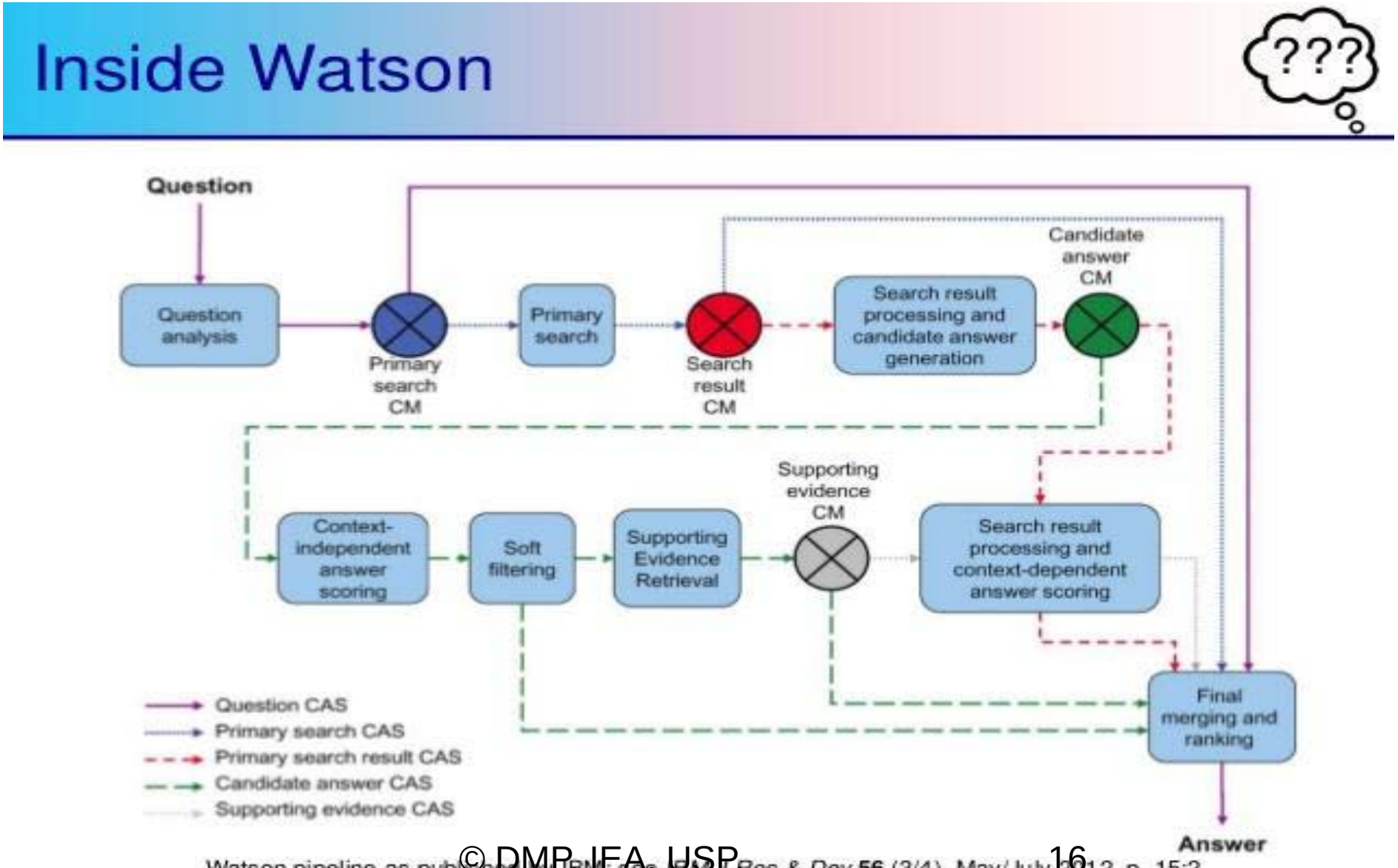
UIMA Architecture

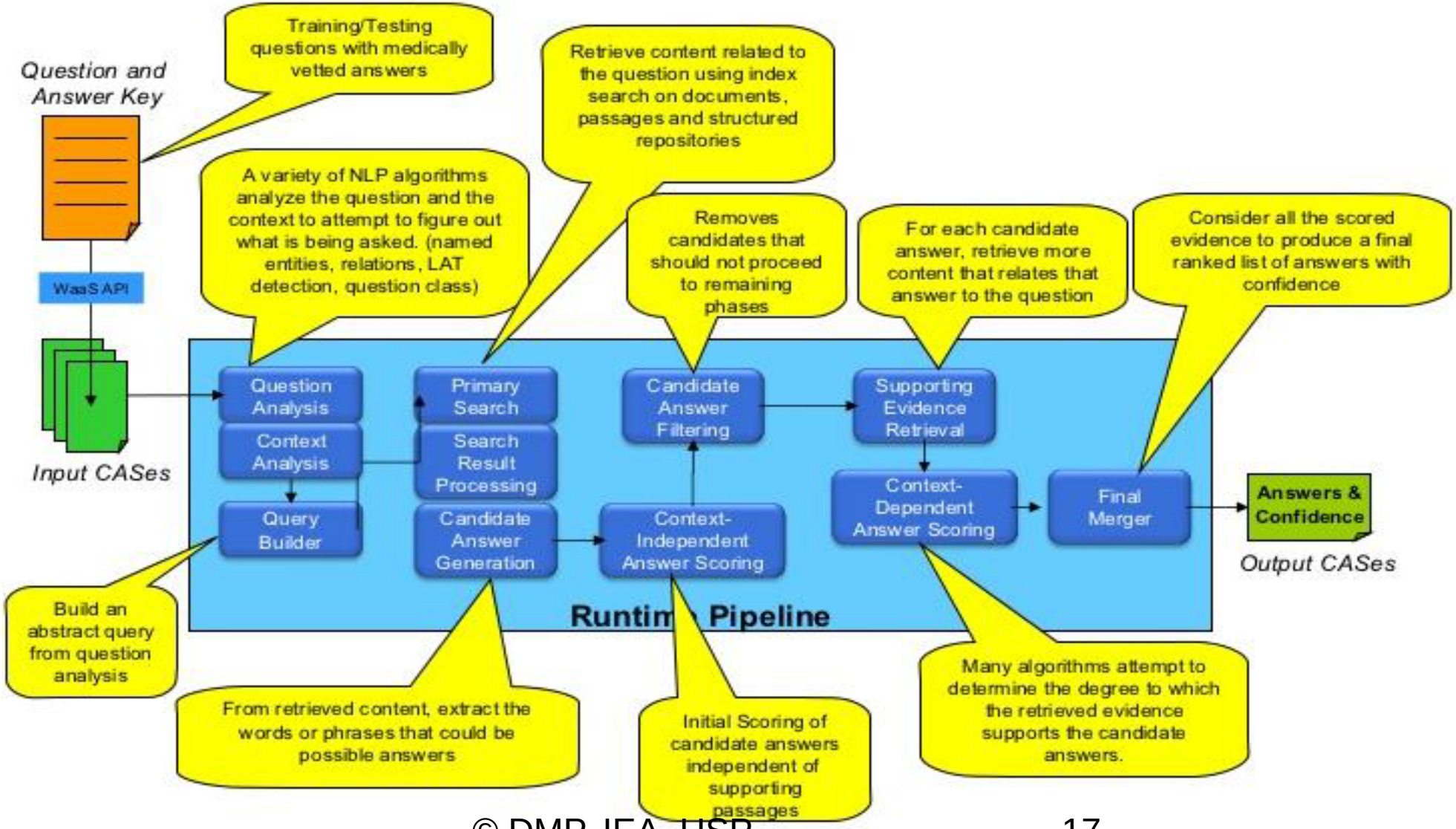
- The DeepQA architecture runs on top of the UIMA architecture.
- A UIMA CAS (Common Analysis Structure) contains a block of data (usually text), and annotations which contain start-and-end indexes into the data (strings, integers, doubles, arrays, annotation references).

Watson Pipeline 1

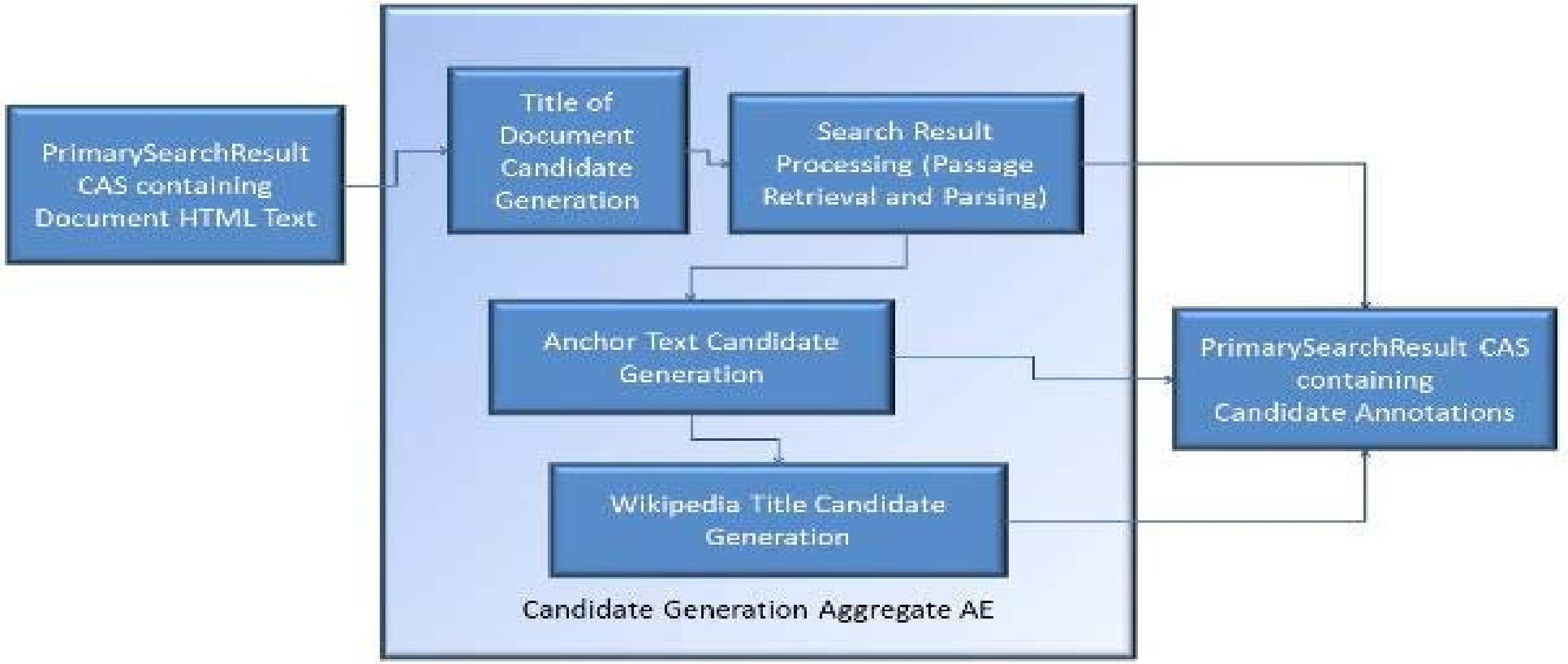


Watson pipeline as published by IBM, see *IBM J Res & Dev* **56** (3/4), May/July 2012, p. 15:2

Watson Pipeline 2



Search Result Processing and Candidate Generation

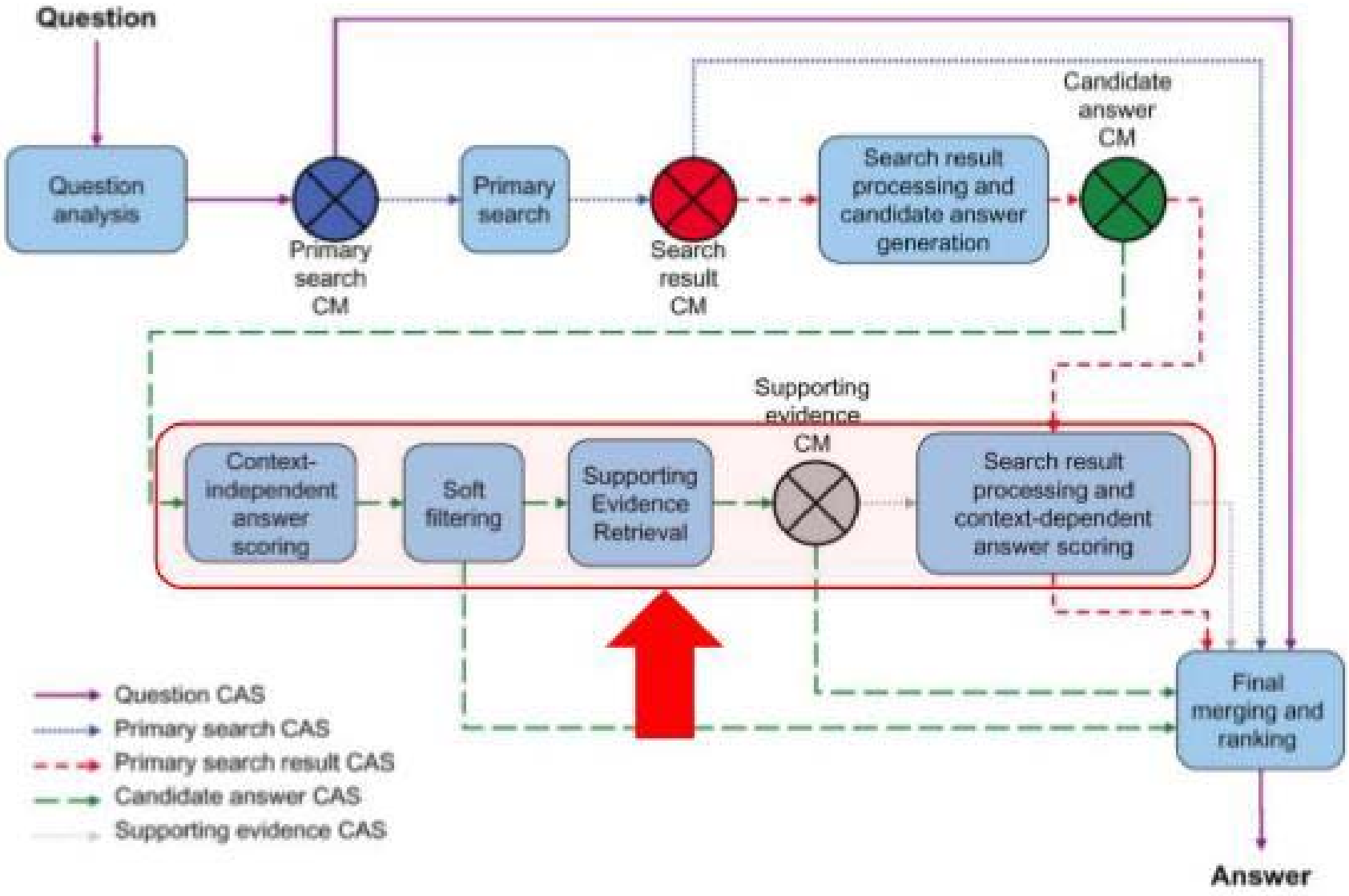


Candidate Generation

From the documents and passages selected by Search Result Processing, candidates are generated using three techniques:

- Title of Document: selects the document's title as a candidate.
- Wikipedia Title Candidate Generation: selects noun phrases in the document/passage that are titles of Wikipedia articles.
- Anchor Text Candidate Generation: uses hyperlinks and metadata in the document to select candidates.

Scoring and Ranking



Scoring Techniques

Passage Term Search

- Extract Question Terms. --- "Where is Paris?"
- Search Passage. --- "Paris is in France"
- Calculate Score. --- Score = IDF(Paris) + IDF(is) --- where IDF = inverse document frequency.

Skip Biagrams

- Construct Graph
  - nodes represent terms
  - edges represent relations
- Extract Skip-Biagrams
  - A skip bigram is a pair of nodes either directly connected or having only one intermediate node.
  - Skip bigrams represent close relationships between terms
- Score based on the number of common skip-bigrams

Data Cache

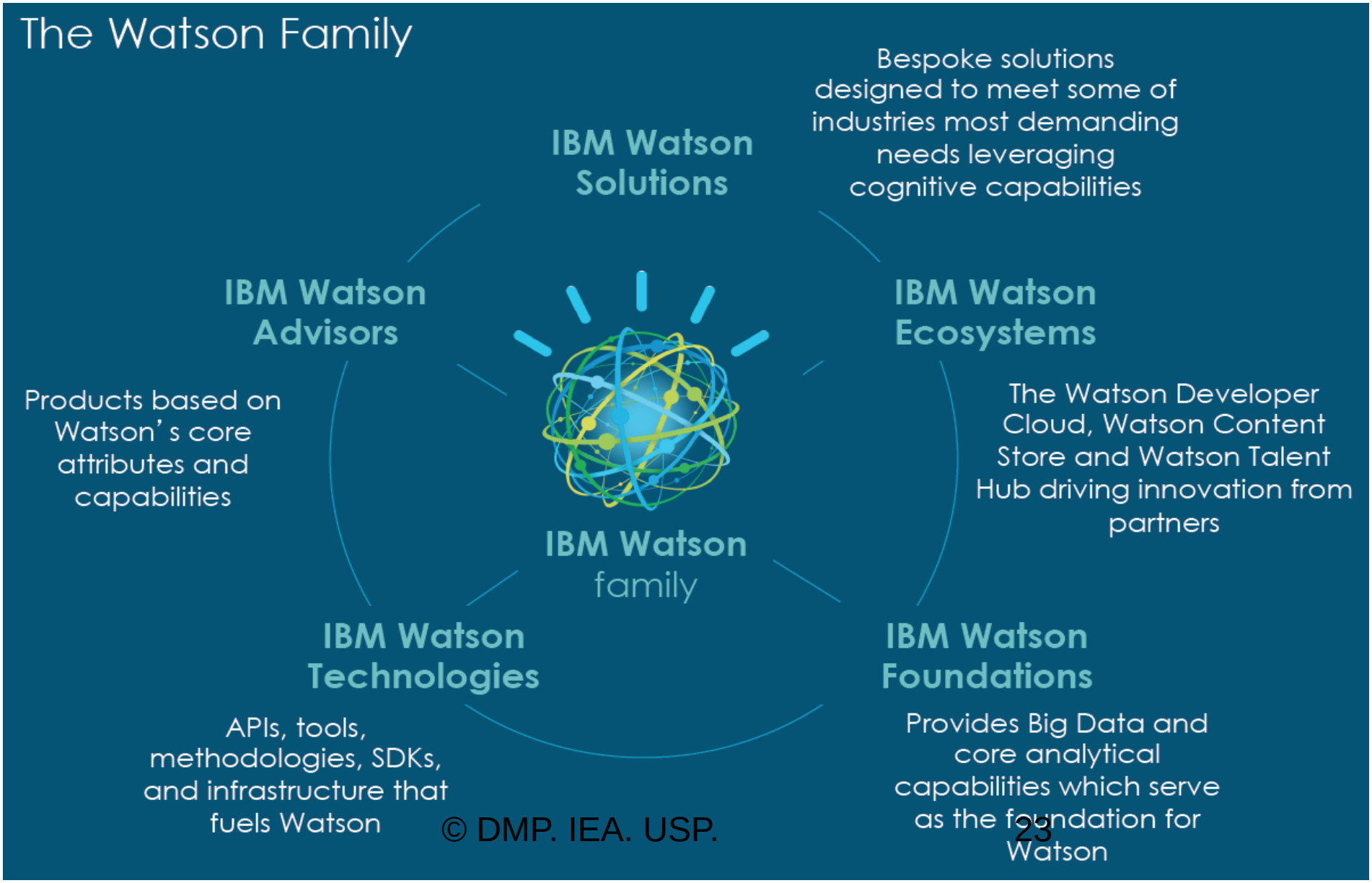
IBM Watson has a pre-processed corpus of information, generated automatically by a subset of the DeepQA pipeline from an enormous volume of raw text, which the remainder of the pipeline uses at question time.

As our system retrieves information from the internet on a per-question basis, it cannot (practically) process the whole corpus in advance.

Since parsing the documents takes a large amount of time, in order to test/demonstrate the system, it is beneficial to store webpages and associated parses locally. This allows a question that has been asked before, and candidates that come up for multiple questions, to be processed faster.

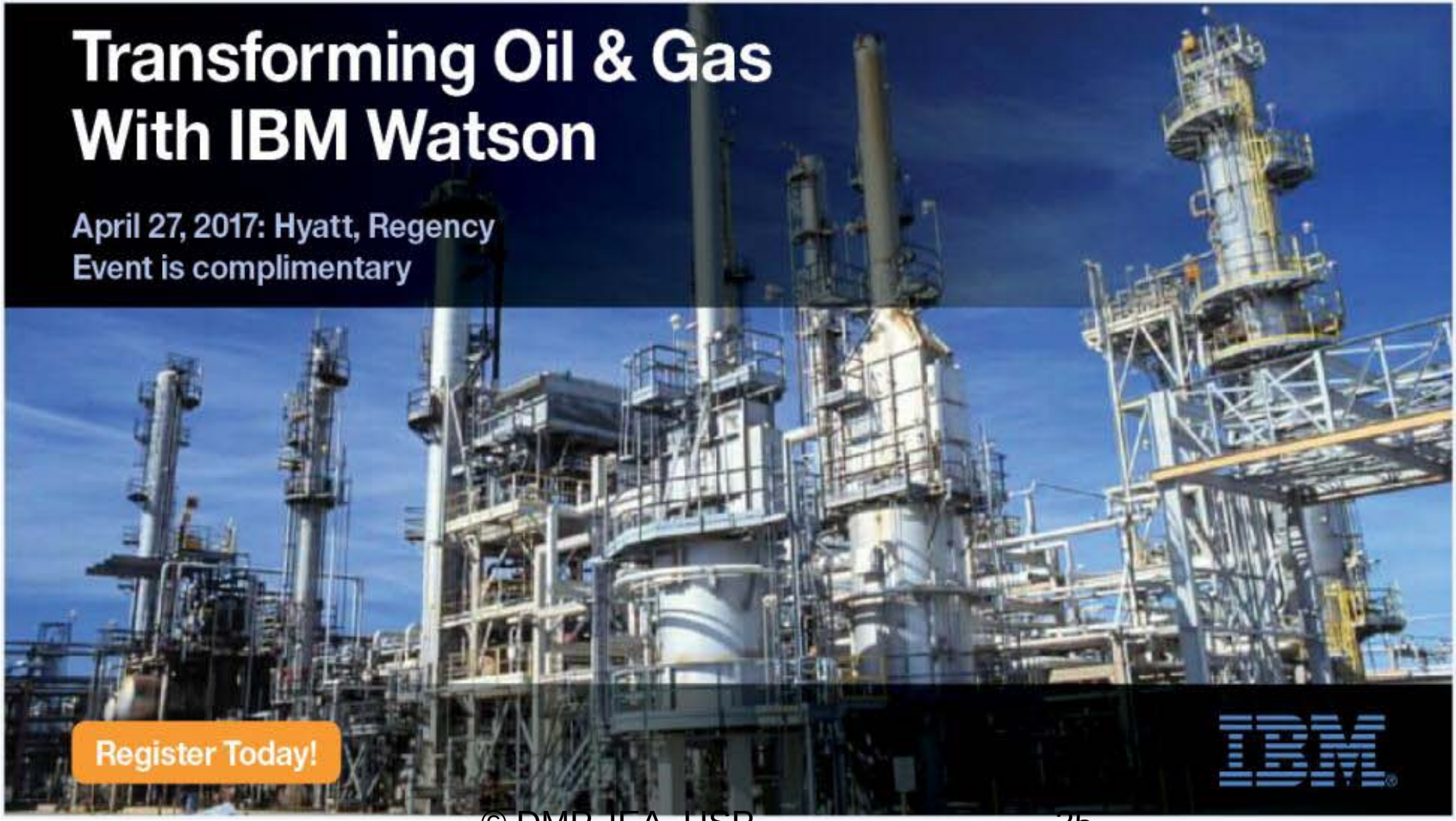
As a side-benefit of the caching, if a website is temporarily down, its data can still be used (if it was not down at some point in the past).

Watson Family



Watson Strategy

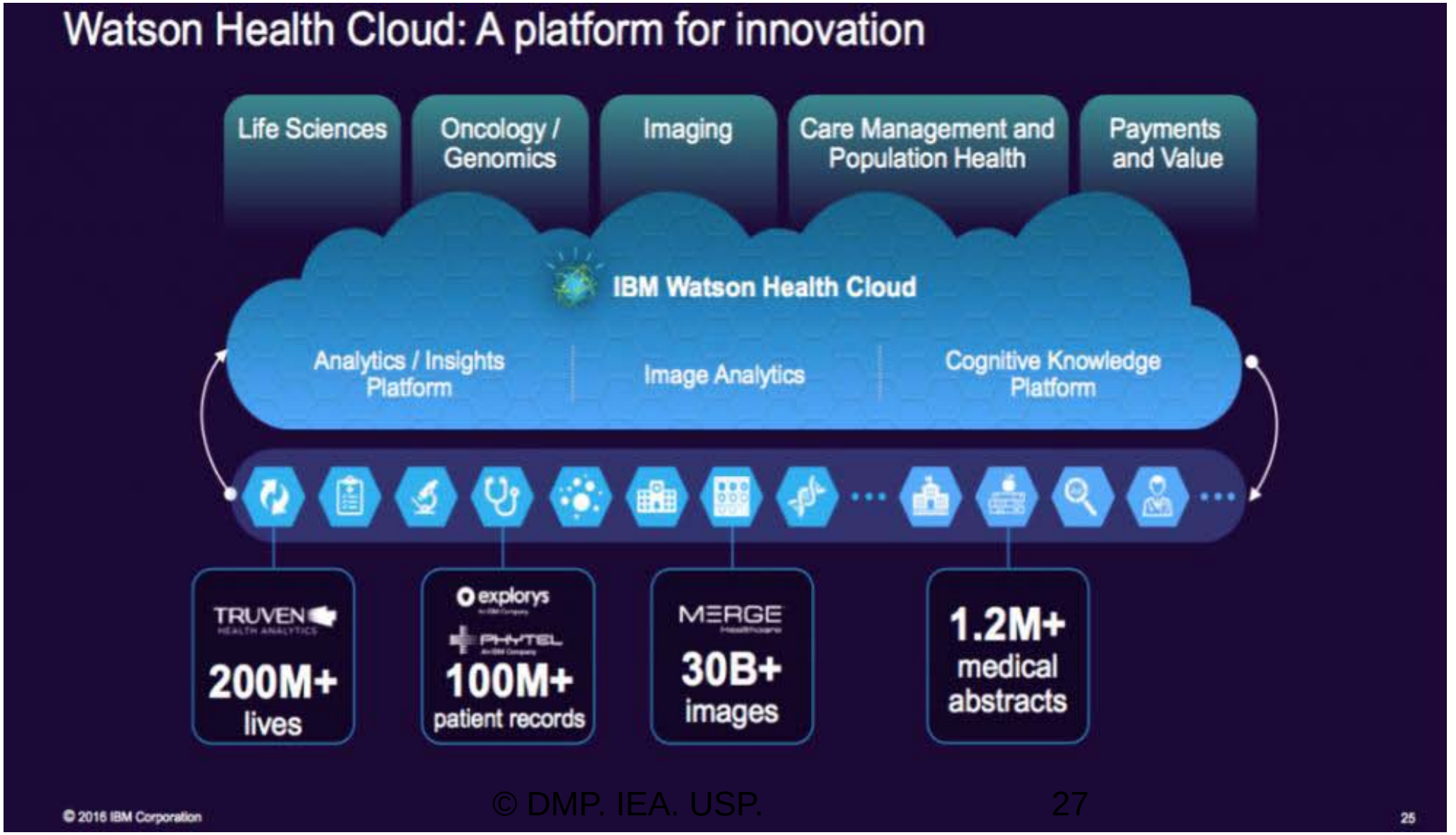
Oil & Gas


Transforming Oil & Gas
With IBM Watson
April 27, 2017: Hyatt, Regency
Event is complimentary
Register Today!
IBM

Oil & Gas


Predictive Futures
Cognitive Analytics
sparkcognition
ARC
Advisory Group
FLOWSERVE

Health


Watson Health Cloud: A platform for innovation
Life Sciences
Oncology / Genomics
Imaging
Care Management and Population Health
Payments and Value
IBM Watson Health Cloud
Analytics / Insights Platform
Image Analytics
Cognitive Knowledge Platform
TRUVEN HEALTH ANALYTICS
200M+ lives
explorys
PHYTEL
100M+ patient records
MERGE
30B+ images
1.2M+ medical abstracts
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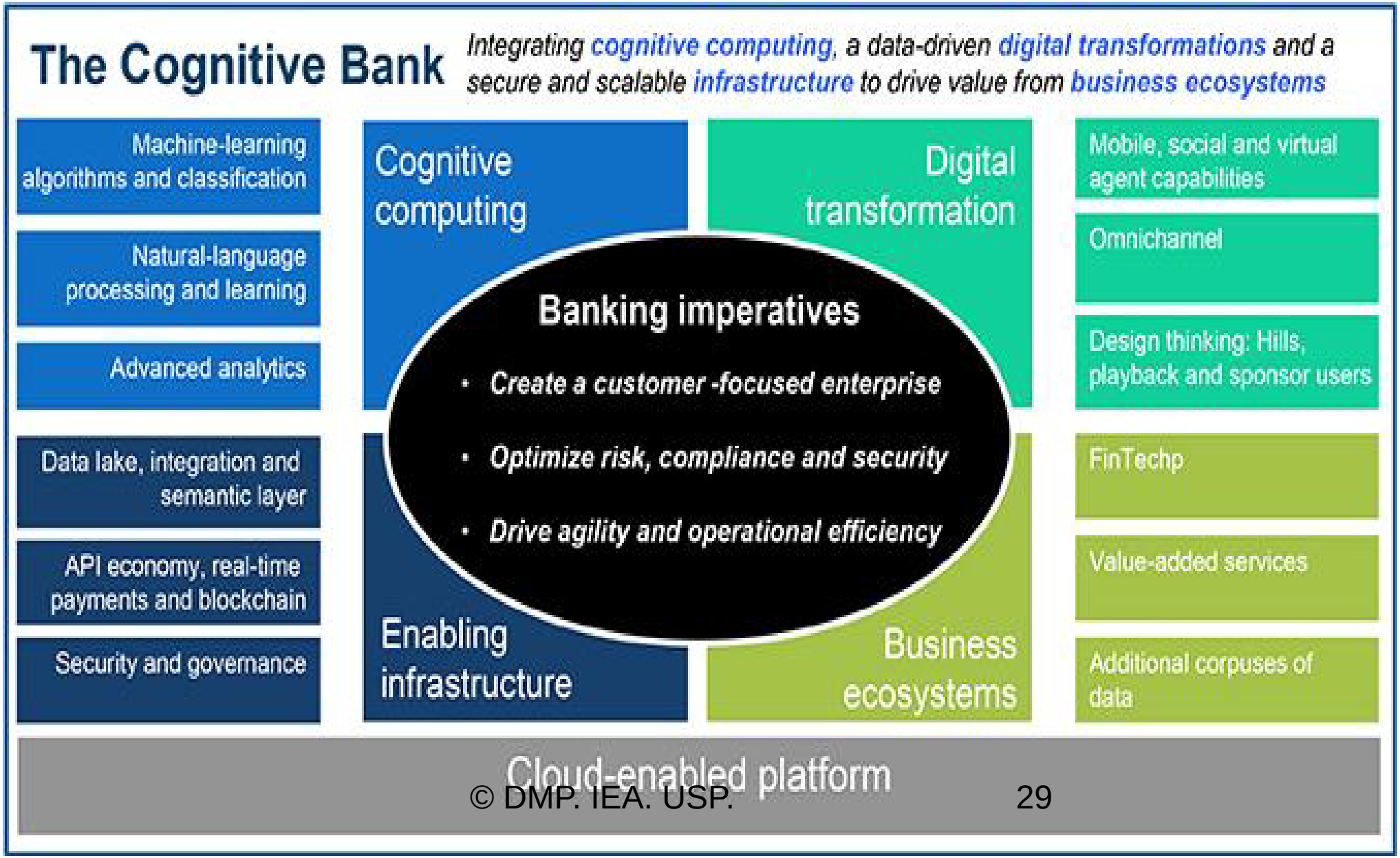
Health

Medical data is expected to double every 73 days by 2020.

Source: University of Iowa, Carver College of Medicine, 2014

IBM Watson Health

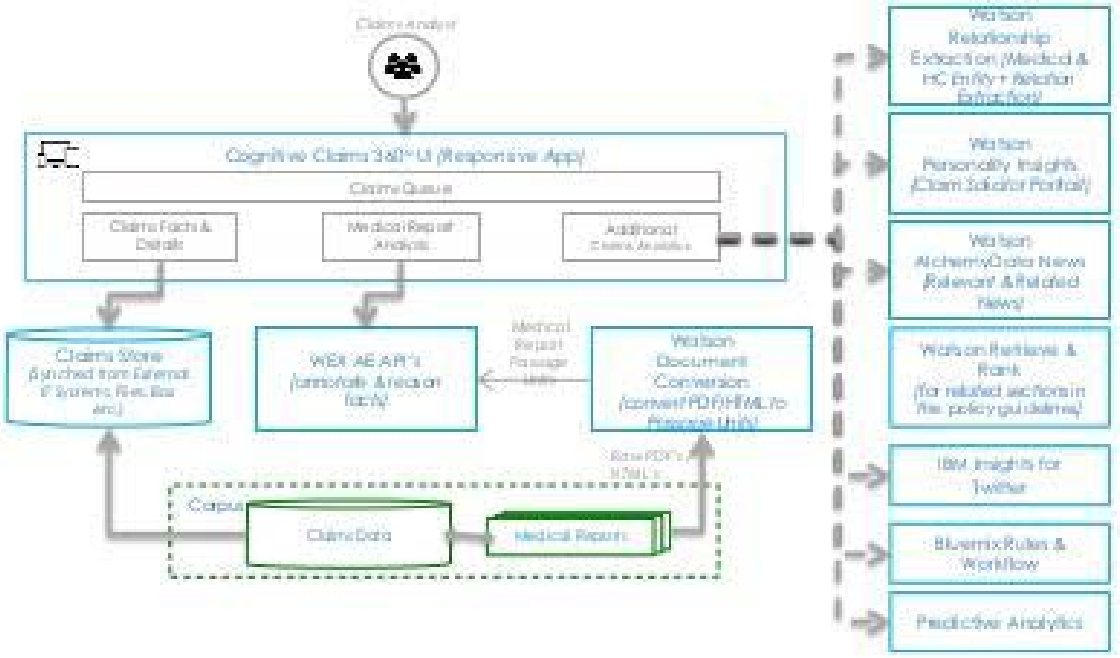
Banking


The Cognitive Bank
Integrating cognitive computing, a data-driven digital transformations and a secure and scalable infrastructure to drive value from business ecosystems
Machine-learning algorithms and classification
Natural-language processing and learning
Advanced analytics
Data lake, integration and semantic layer
API economy, real-time payments and blockchain
Security and governance
Cognitive computing
Digital transformation
Banking imperatives
Create a customer -focused enterprise
Optimize risk, compliance and security
Drive agility and operational efficiency
Enabling infrastructure
Business ecosystems
Mobile, social and virtual agent capabilities
Omnichannel
Design thinking: Hills, playback and sponsor users
FinTechp
Value-added services
Additional corpuses of data
Cloud-enabled platform

Insurance

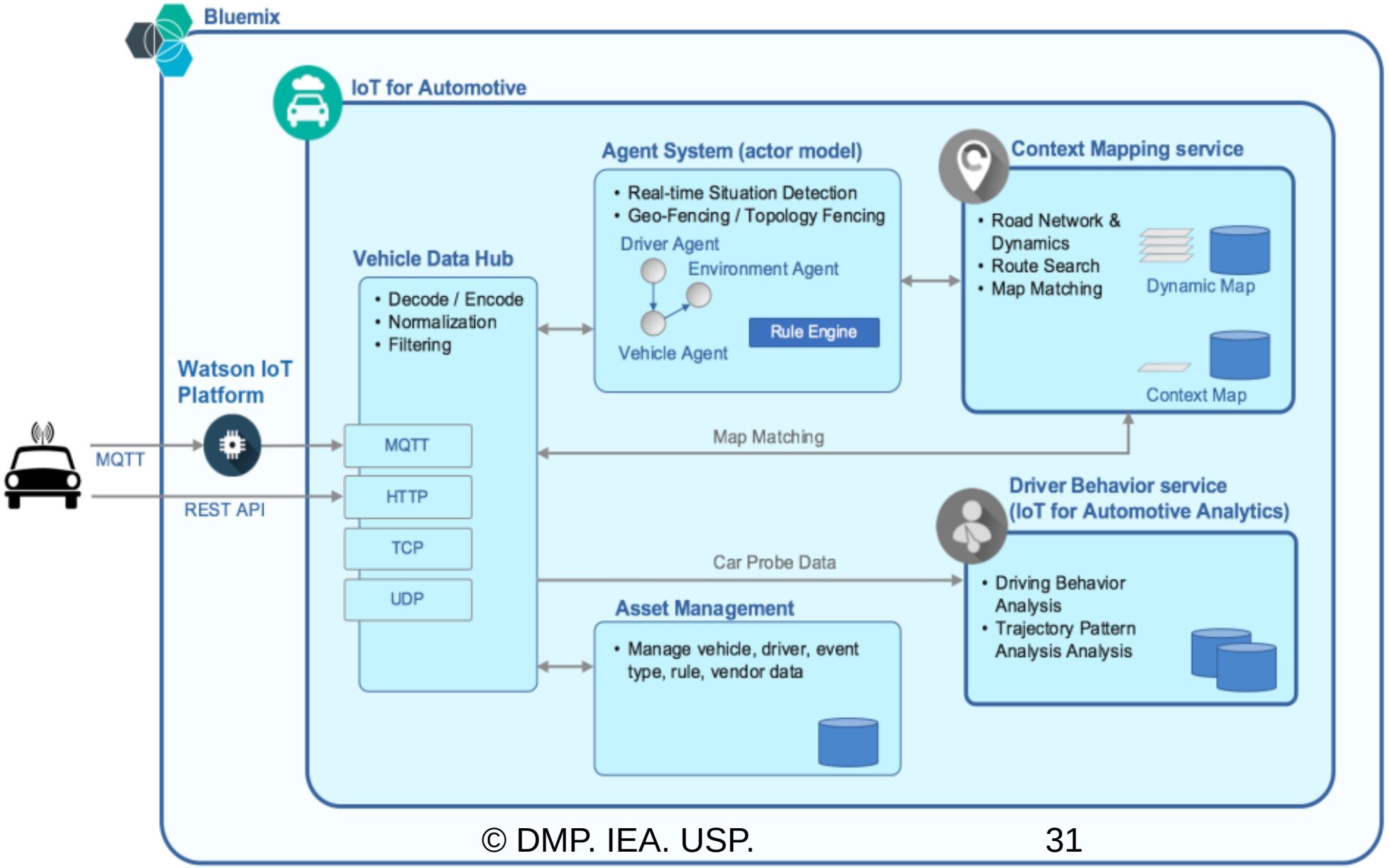
IBM Watson

Watson Claim Advisor Solution Architecture

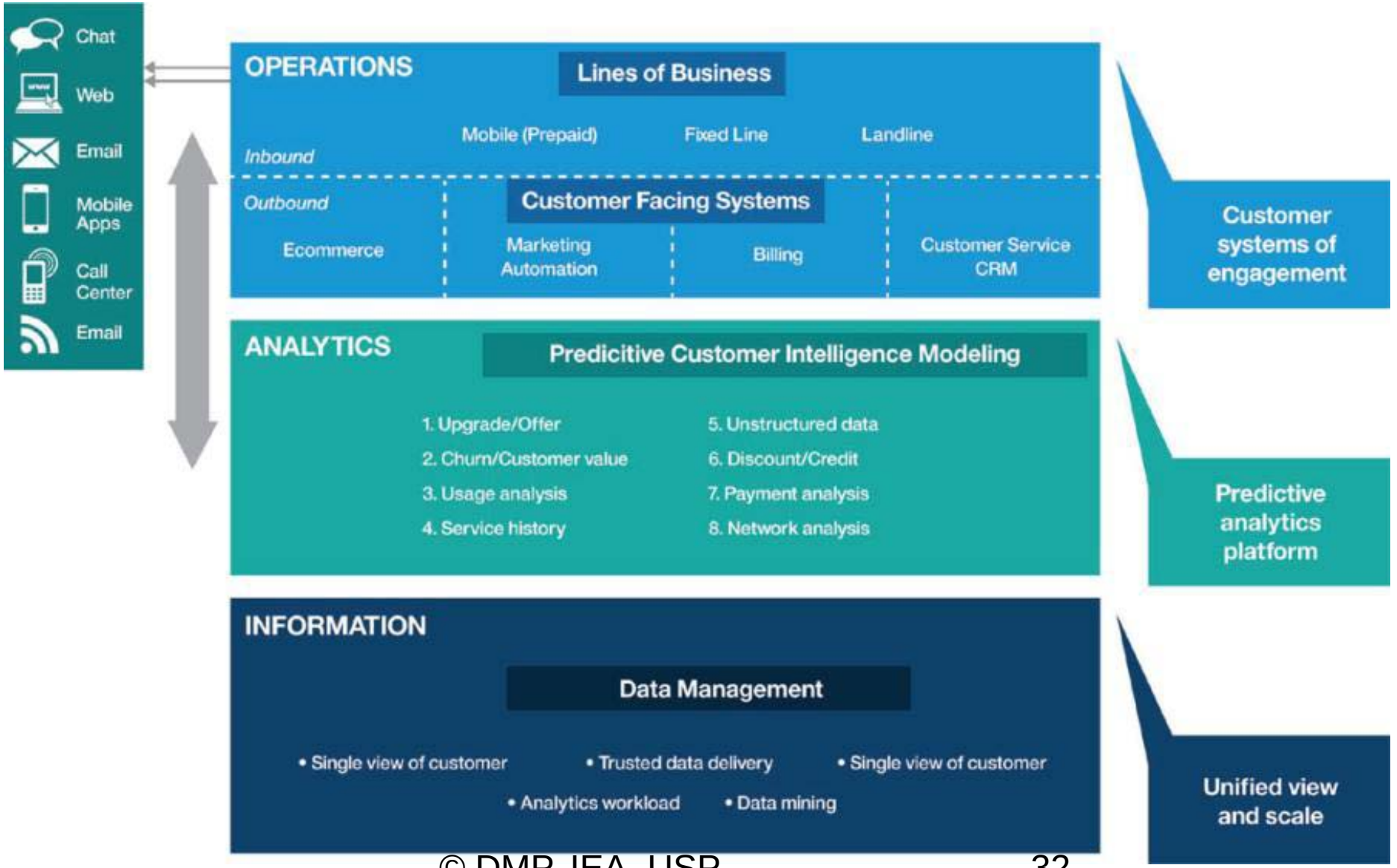


- Watson Explorer v11 AE for Text Analytics incl Entity Extraction
- Watson Document Conversion for converting PDF's/Word's into text
- Watson AlchemyData News for related news articles relevant / related to the claim
- Watson Personality Insights * to create a personality portrait of litigator
- Watson Retrieval & Rank * for fetching related sections in the policy guidelines
- Watson Visual Recognition * to augment claim based on visual info from photos, etc.
- Watson Relationship Extraction with Medical / HC Cartridge

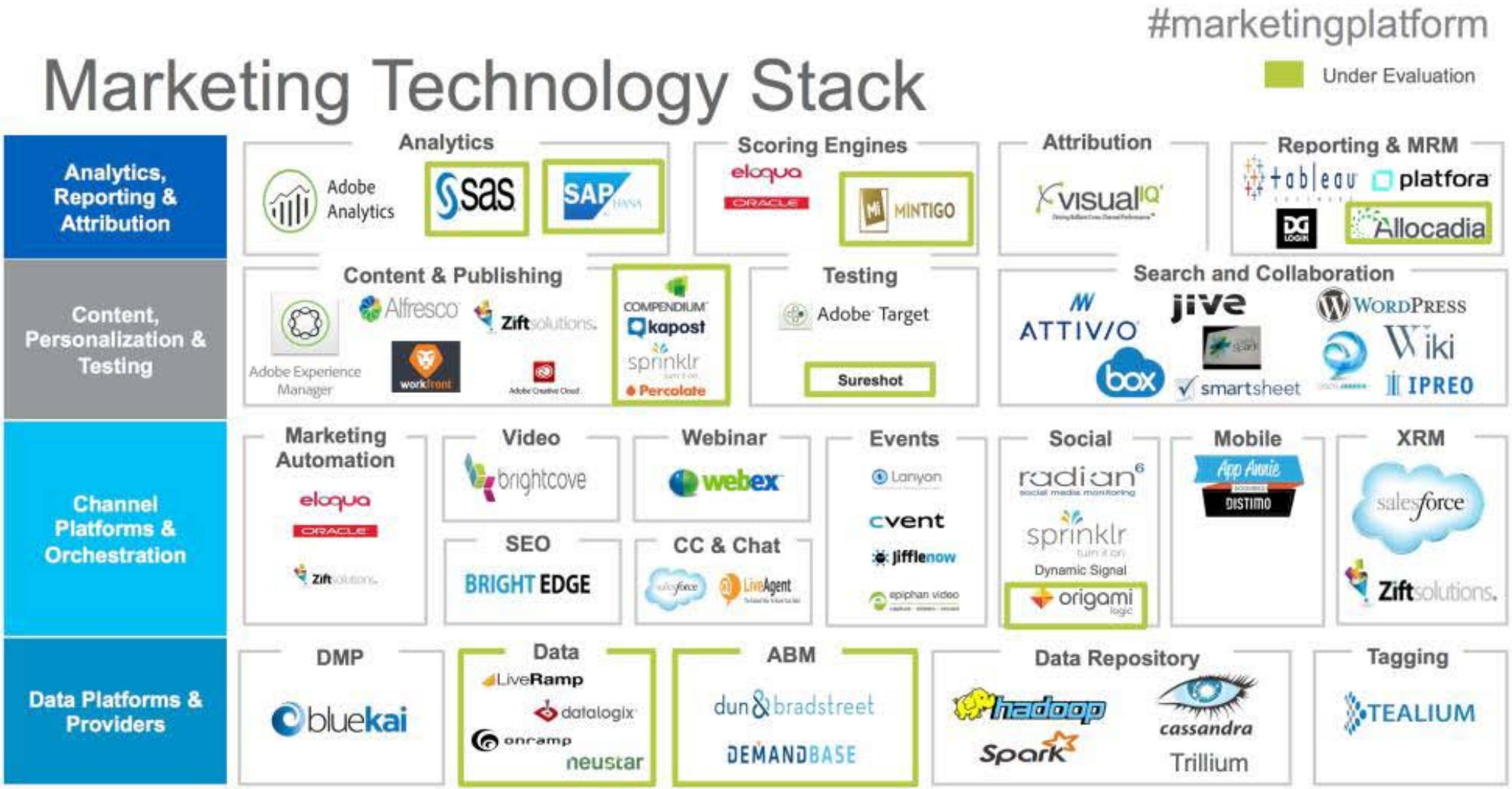
IoT for Road Vehicles



Marketing


Chat
Web
Email
Mobile Apps
Call Center
Email
OPERATIONS
Lines of Business
Mobile (Prepaid)
Fixed Line
Landline
Inbound
Outbound
Customer Facing Systems
Ecommerce
Marketing Automation
Billing
Customer Service CRM
Customer systems of engagement
ANALYTICS
Predicitive Customer Intelligence Modeling
1. Upgrade/Offer
2. Churn/Customer value
3. Usage analysis
4. Service history
5. Unstructured data
6. Discount/Credit
7. Payment analysis
8. Network analysis
Predictive analytics platform
INFORMATION
Data Management
• Single view of customer
• Trusted data delivery
• Single view of customer
• Analytics workload
• Data mining
Unified view and scale

Marketing (MarTech)



The Cube (Queen's University, Toronto)

Jeopardy!


PIENSE
THINK
DENKE
PENSER
$300,000
Who is Stoker?
$1,000
$1,000,000
Who is Bram Stoker?
$ 17,973
$200,000
WHO IS BRAM STOKER?
$5600

Jeopardy!

Jeopardy is an American television game show, in which contestants are given clues in the form of answers, and must reply with a question.

In 2011, IBM Watson took on two successful human players, and won the match, and a $1 million prize [press].

This gave credibility to the claim that IBM's DeepQA architecture is effective in question-answering in open domains with massive unstructured data. The architecture combined:

- Natural Language Processing
- Information Retrieval
- Machine Learning
- Knowledge Representation
- Probabilistic Reasoning
- Massively Parallel Computation.

The Big Picture

Open System Conditions. In general terms, the *Jeopardy!* event was **iconic** of the emerging fact that such systems can provide a **positive response** to modern conditions. These are open system [press] conditions created by the internet, other communications media, globalisation, fast travel, multiculturalism, multilingualism, etc. They are conditions of mass heterogeneous data (e.g. from the IoT), multiple natural languages, uncertainty, incompleteness, inconsistency, instability, a need-for-speed (e.g. provided by parallel hardware), etc. Seen positively, they are conditions of **opportunity** for using artificial intelligence, and the Watson *Jeopardy!* challenge helped to bring this to public attention. This helped to publicise a **paradigm shift** in which we **accentuate the positive** by using augmented cognition to **leverage** open-system conditions

AI Paradigms. Watson has done a lot to bring AI out of the research lab and into the real world. Specifically, it validates a particular paradigm (for both AI and human intelligence) in which a primary factor is the ability to find relevant information in a very large mass of data. This uses keywords, clusters of associations, contextual information, memory, and loosely connected chunks of data. This is called the 'experiential learning' paradigm of intelligence, as opposed to the 'axiomatic' paradigm. It may be that we now need both paradigms.

Oil & Gas

watch video [press]

Situation

The Oil and Gas Industry (O&G) is in a state of **disruption** [press, press]. Low oil prices necessitate greater efficiency.

Big Data Analytics are a major **success lever**: upstream, midstream, and downstream.

Analytics and the use of sensor data are already **well established** in O&G.

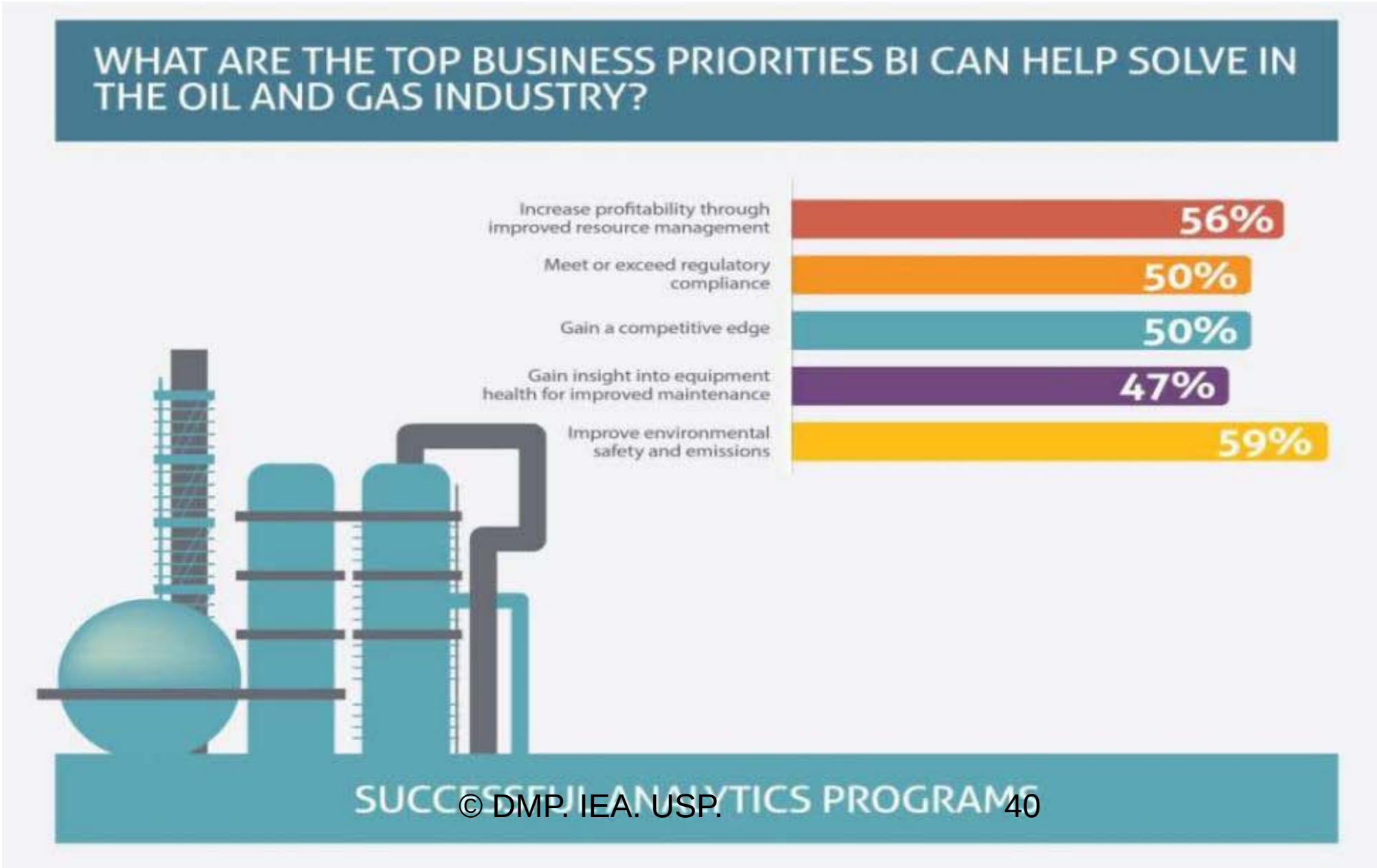
There may, however, be a **legacy problem** with IT systems which have grown over time and now lack agility, functionality, integration (ERP), usability, scalability, or inter-operability. At worst, information may be siloed in one department.

A second digital revolution is now occurring in O&G [press], in which many providers [press, press], including startups [press], promise to enhance safety, efficiency, ROI (return on investment), compliance management, etc., using cognitive analytics.

Here there is emphasis on enterprise systems (where one hub serves various user groups), cloud technology (which supports scalability), human-computer interaction (HCI), and cybersecurity.

Terminology. The terms 'business intelligence (BI)', 'big data analytics', 'IoT', and 'data science' [press] are currently more common in O&G than 'cognitive', though the objective is the same (especially regarding discovery, prediction, mass data, and decision support).

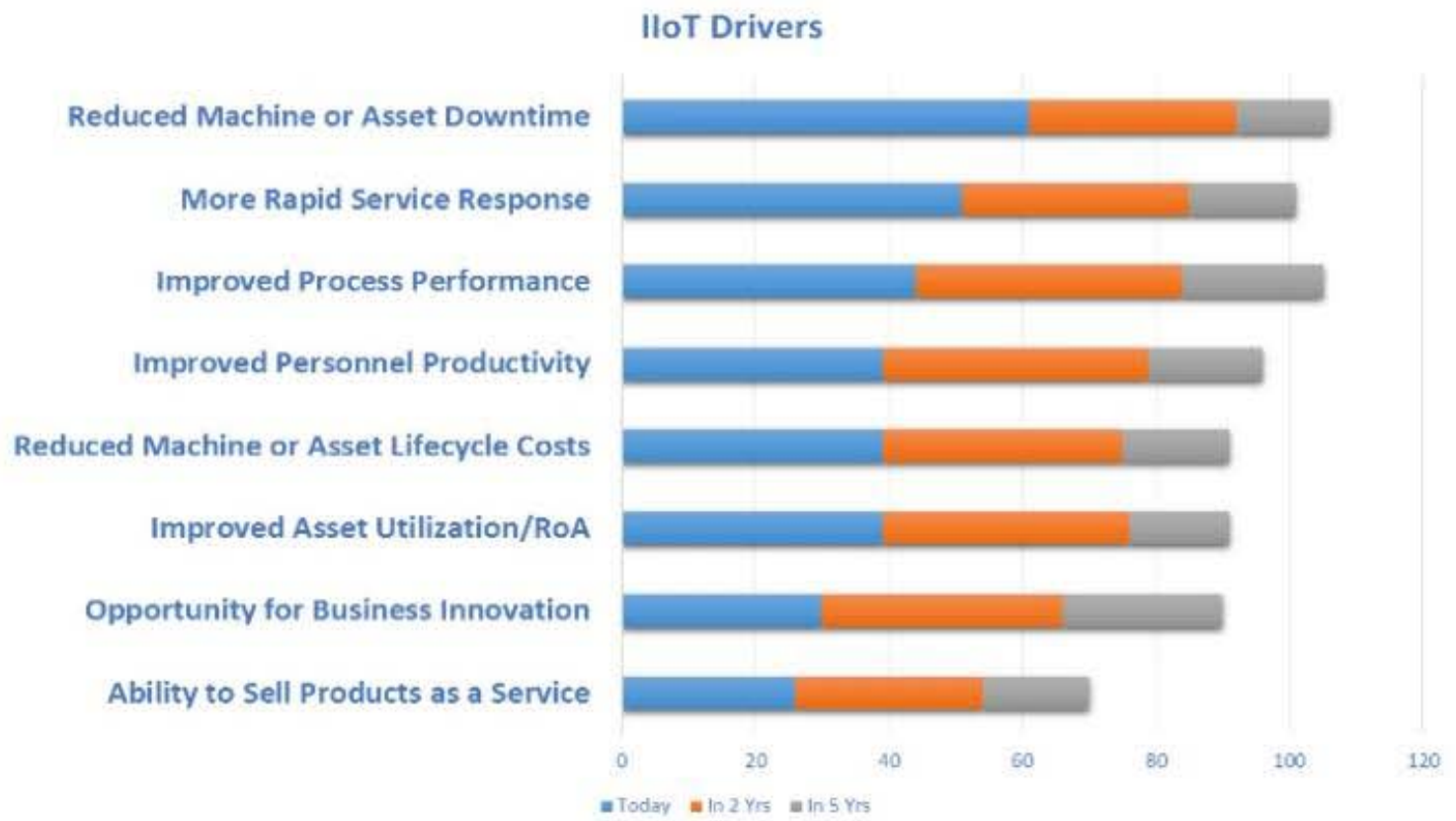
Business Case: BI



Business Case: IoT

IIoT Drivers

Reduced Downtime and Faster Service are Top Drivers Now



Source: ARC Industrial Internet of Things Survey

Business Case: Big Data

MORE BIG DATA

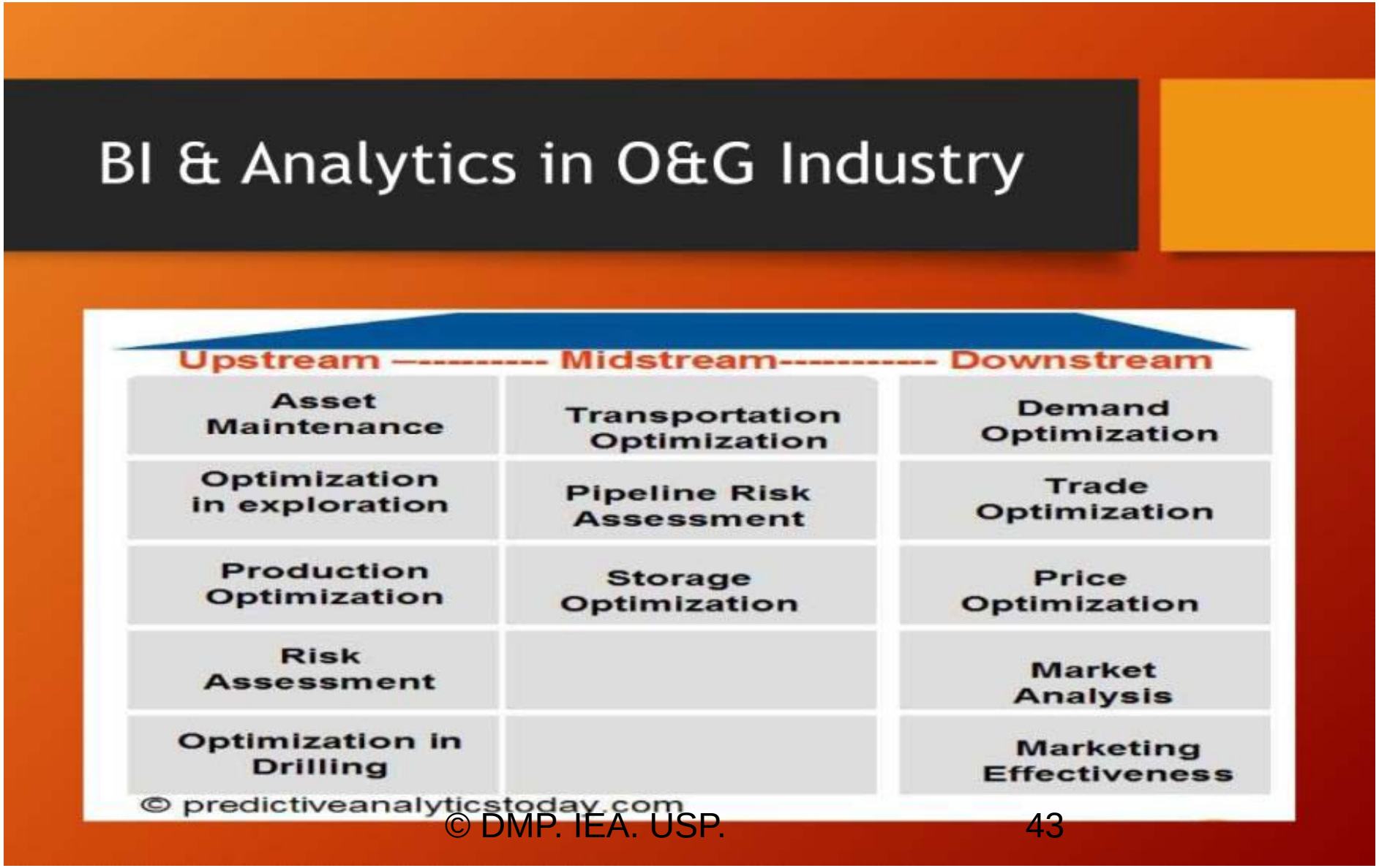
HITACHI
Inspire the Next

VOLUME, VELOCITY AND VARIETY

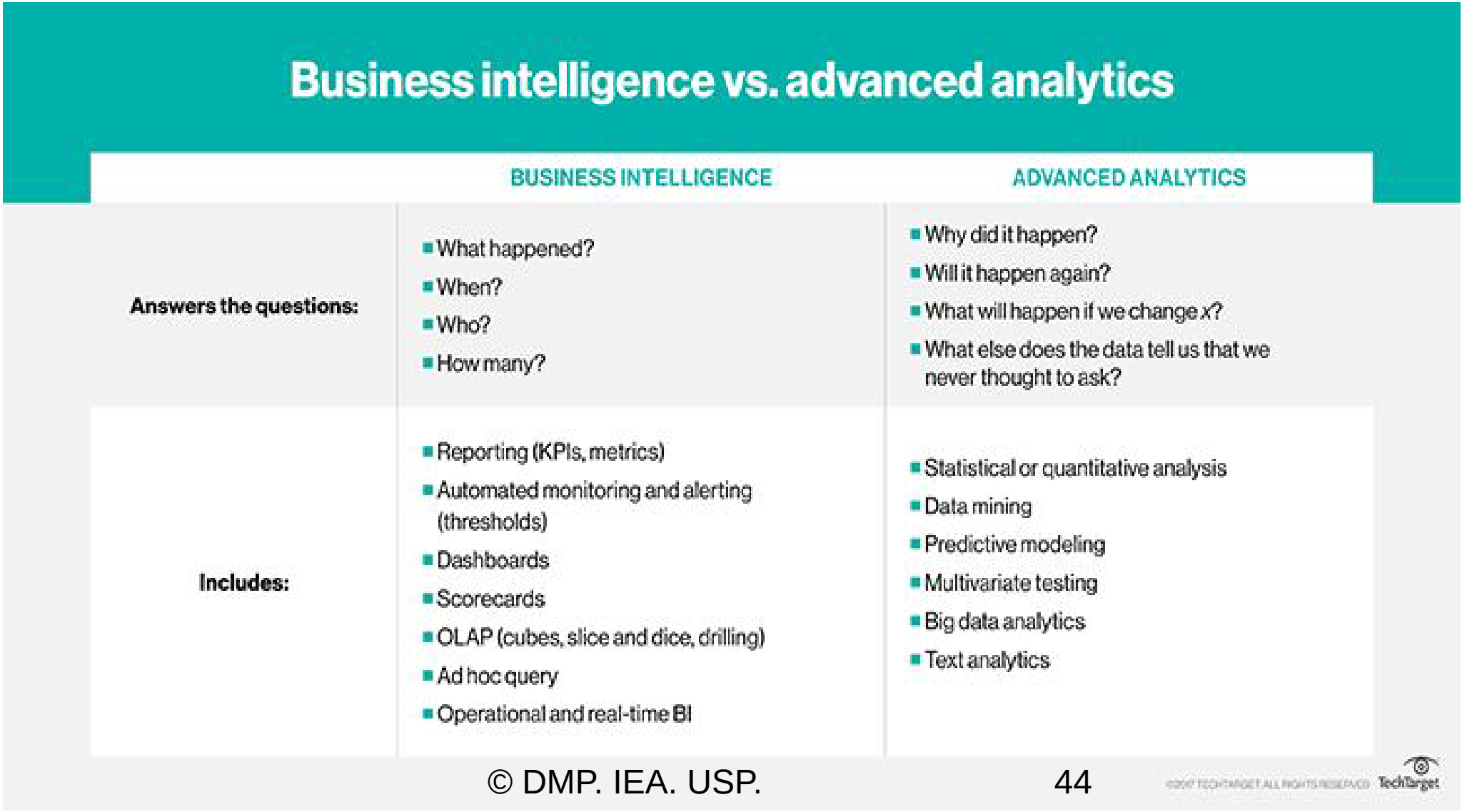
- More Volume
  - New sensor and acquisition technology: Isometrix, WAZ
  - More data being integrated: Drilling, Production
- More Velocity
  - Real time data from operations, sensors
  - Streaming vs batch processing
- More Variety
  - Structured, Unstructured, semi-structured
  - Complexity involving multiple disciplines
- Potential Value
  - Clearer view, better understanding by combining data sources
  - Capitalizing on opportunities
  - Lower risk for failures

8

Analytics


BI & Analytics in O&G Industry
Upstream ---------- Midstream---------- Downstream
Asset Maintenance
Transportation Optimization
Demand Optimization
Optimization in exploration
Pipeline Risk Assessment
Trade Optimization
Production Optimization
Storage Optimization
Price Optimization
Risk Assessment
Market Analysis
Optimization in Drilling
Marketing Effectiveness
© predictiveanalyticstoday.com

Analytics


Business intelligence vs. advanced analytics
BUSINESS INTELLIGENCE
ADVANCED ANALYTICS
Answers the questions:
What happened?
When?
Who?
How many?
Why did it happen?
Will it happen again?
What will happen if we change x?
What else does the data tell us that we never thought to ask?
Includes:
Reporting (KPIs, metrics)
Automated monitoring and alerting (thresholds)
Dashboards
Scorecards
OLAP (cubes, slice and dice, drilling)
Ad hoc query
Operational and real-time BI
Statistical or quantitative analysis
Data mining
Predictive modeling
Multivariate testing
Big data analytics
Text analytics
TechTarget

CC for O&G

In response to the current state of disruption, a new wave of AI-based systems is on the rise.

This is cognitive computing (or cognitive analytics) for O&G.

Some projected features of CC in O&G are:

- advanced interfaces (using gesture, voice, facial recognition, multiplenatural language translation)
- ambient analytics (multimodal background employee surveillance)
- cobots (robots collaborating with humans)
- extended IoT sensor types (wearables, employee location tracking)
- simulation
- virtual assistants
- virtual reality.

The objective is to leverage efficiency, profitability, and safety by providing intelligent decision support based on analysis of real-time and historical data.

Change is expected to be gradual, but to have high leverage and advantage.

IBM has already collaborated in CC for O&G with Repsol [press], Woodside [press], and Flotek [press].

CC Applications in O&G

Discovery. Integration of historical and real-time data: geological, geophysical, seismic. Minimisation of risk. Integration across technical experts.

Drilling. Planning, real-time risk and optimization, real time direction and speed, frictional drag estimation, well cleaning, rate of penetration (ROP), well integrity, operational troubleshooting, equipment condition, seismic vibrations, thermal gradients, strata permeability, pressure differentials, equipment failure e.g. semi-submersible pumps, downtime, collaborative robotics

Drones. Cognitive drones (2013-) for land surveying and mapping, well and pipeline inspection, methane leak detection, discovery, security, offshore delivery

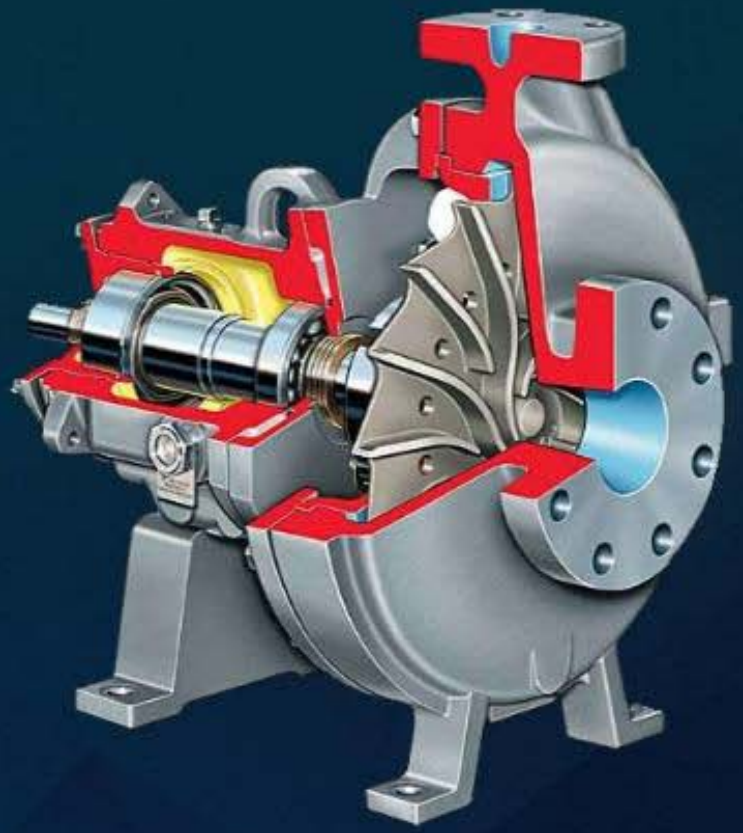
Planning and Forecasting. Macroeconomic trends, hydrocarbon extraction costs, investment decisions, weather patterns

Reservoir Management. Characterization, modeling, field surveillance, field development, field life, production costs, recovery yield, predictive maintenance, security, spill and fire detection.

Use Case: FlowServe & Spark

Pump Monitoring Application Trial

- Desired Results
  - Predict failures with 1 day advanced notice
  - Zero or minimal false positives
  - "Dummy Light" output
- Data Provided
  - 3 years of historical data
  - Pre-filtered FFT data from production assets
  - 10 second time resolution
  - Major component failure logs



Use Case: FlowServe and Spark

Trial Outcome

- Predicted failures 5 to 6 days in advance (20x improvement)
- Previous method predicted only 3-6 hours in advance
- Completed with less than 2% false positive rates

Renewable Energy

Situation

The clean energy sector is renewable and 'green' --- but, like O&G, it also needs to be efficient and profitable [press].

This is true in the Middle East [press, press] and elsewhere.

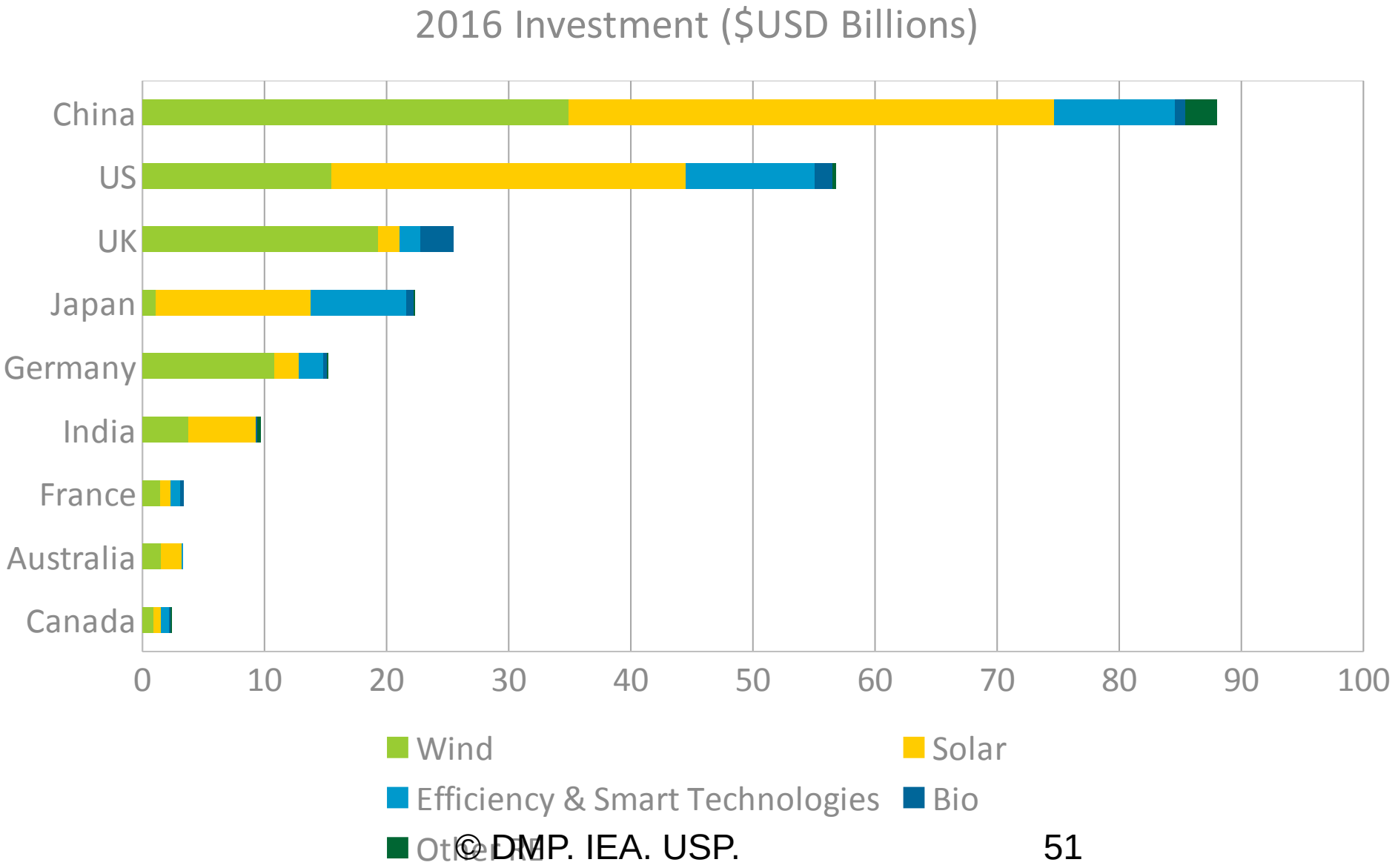
Renewable Energy Analytics are essential to leverage productivity, performance, efficiency, integration, maintenance, and profitability in the renewable energy sector.

IoT sensor data, weather conditions, and grid conditions are analysed at high granularity to make and support real-time decisions (e.g. on blade-tilt in turbines), providing performance-optimisation.

This data also supports predictive maintenance, in which real-time data is matched against historical data, supporting decisions on adjustments and replacements, and reducing downtime.

There is industry and academic consensus on the need for Big Data Analytics for renewable energy and green technology [press], and several providers are committed [press, press, press, press].

Renewable Energy Investment



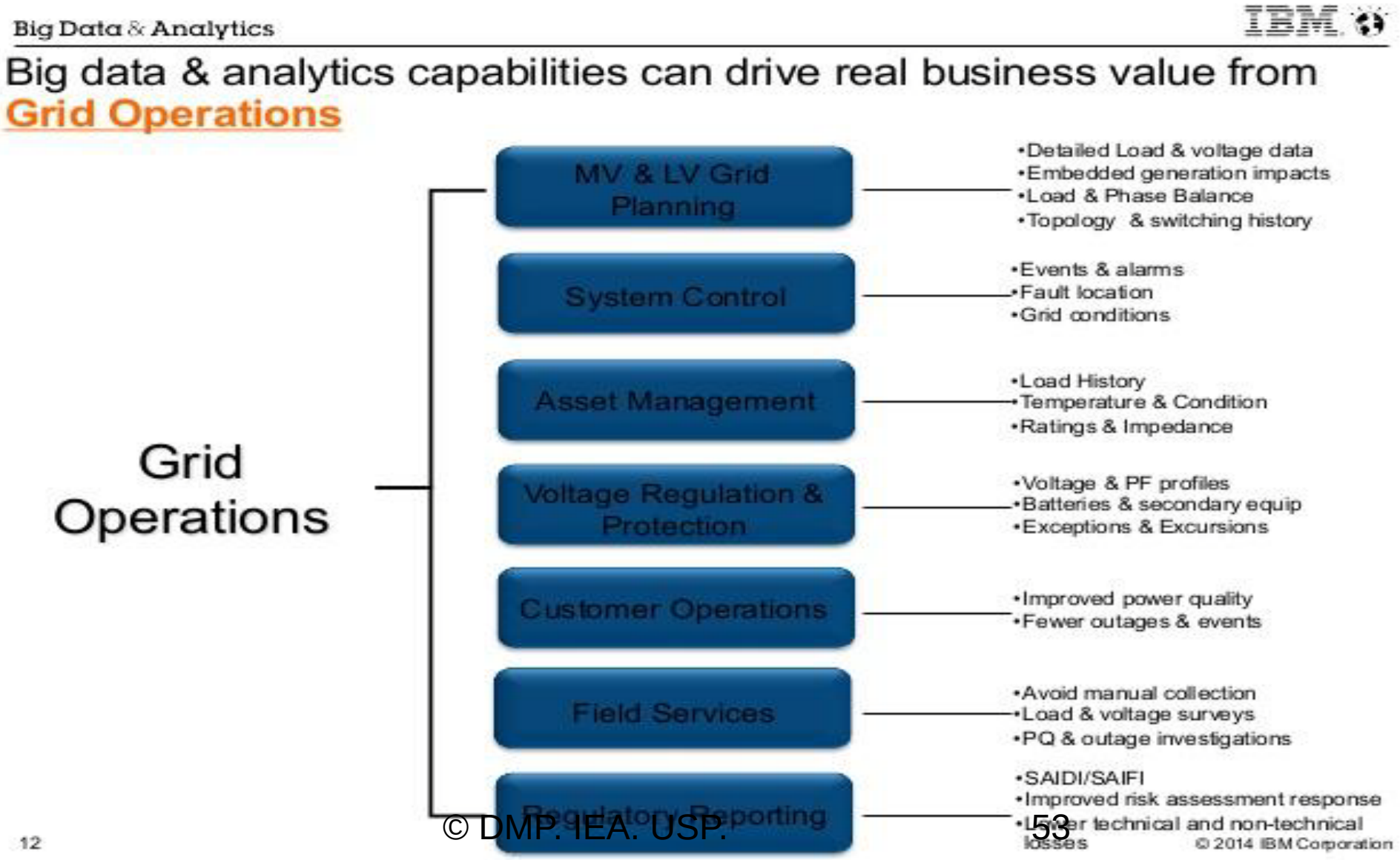
Business Case: Analytics

“Digitalisation is an essential part of the future energy landscape, and turning big data into smart data will enable us to be more reliable, energy efficient, and cost effective.

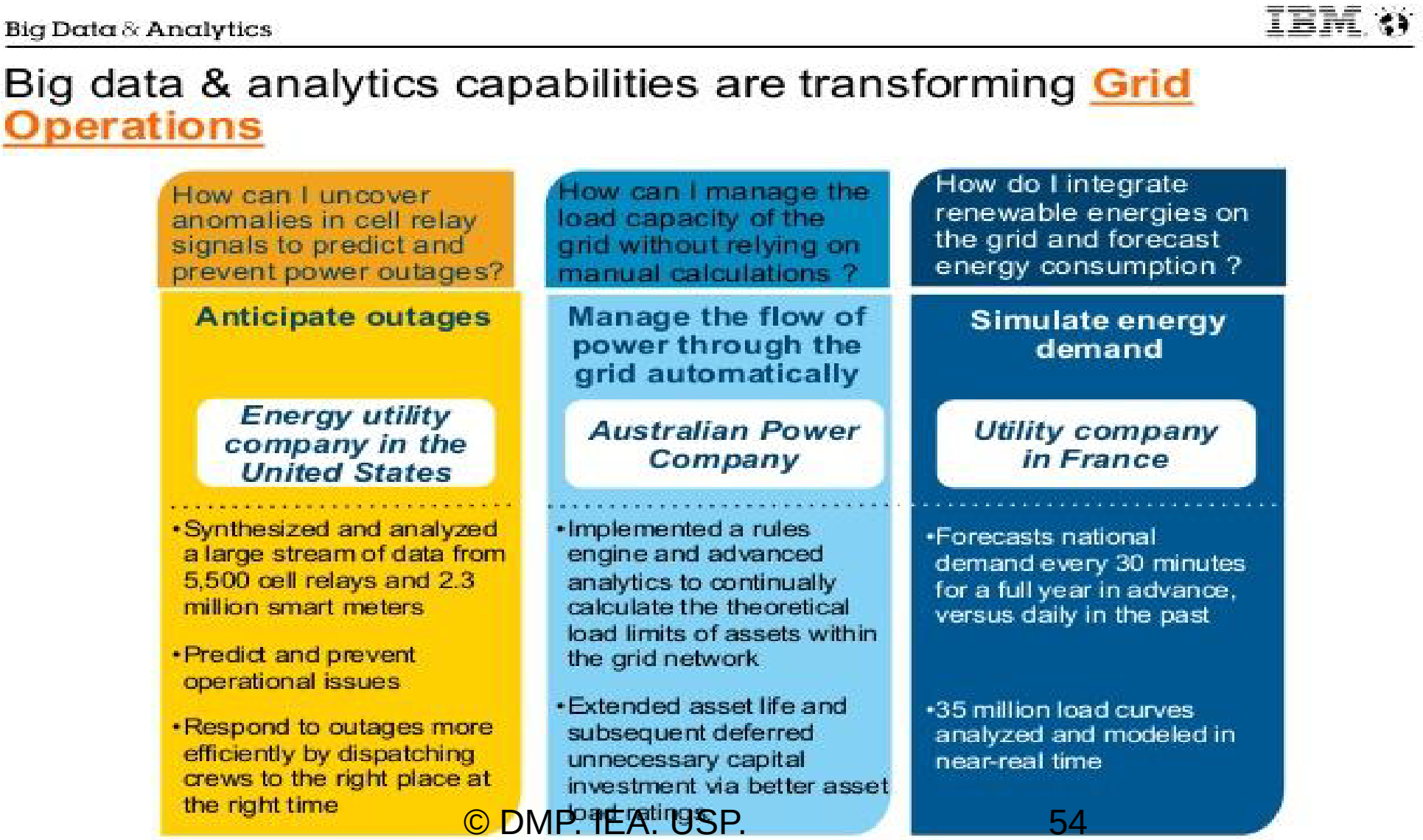
However, we must remember that with greater interconnectivity, use of data analytics, and cloud technologies comes greater exposure to cyber security threats so organizations need to be well prepared.”

(Dietmar Siersdorfer, Siemens Middle East.)

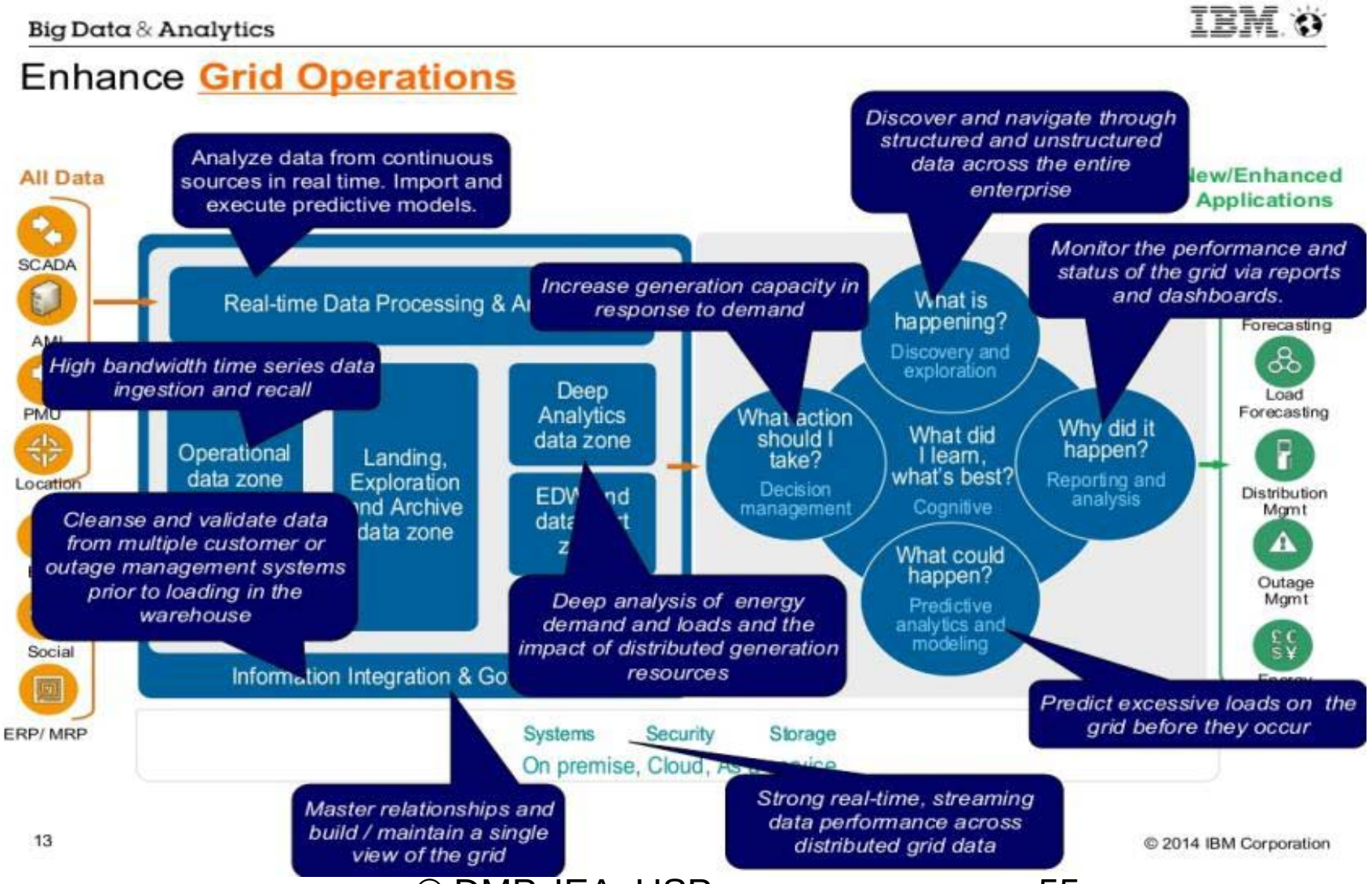
Grid Operations



Grid Operations



Grid Operations



Shagaya Renewable Energy Park

Solar: CSP (Concentrated Solar Power, parabolic trough) [press, press]

Solar: PV (PhotoVoltaic, solar panels) [press]

Wind.

Storage. Molten salt thermal energy storage

Technology Mix. [press]

Supply: national grid during peak periods, e.g. summer time.

Location. 100 km west of Kuwait City

Developer. Kuwait Institute for Scientific Research (KISR) [press]

Contractor. TSK [press]

Master Plan. [press]

Kuwait Times. [press]

Banking & Finance

Situation

Banking and Finance are facing disruption due to several factors:

- economic, societal, and industry change
- compressed margins
- regulatory requirements
- security threats
- empowered, multi-lingual, multi-cultural consumers
- competition from non-traditional players [press]
- crypto-currencies
- mass, heterogeneous, multi-source data.

Paradigm Shift

- It is normal in banking and finance to need quality decision making (fast, customer-centred, context-aware, agile, and accurate)
- It is now normal to have access to mass data (internal & external, structured & unstructured, static & dynamic).

- The question is how to put the two together.
- The answer is **cognitive computing**! [press, press, press, press, press].

Objectives

- quality of service
- customer experience
- efficiency
- profitability.

Strategy

Holistics. An ERP (Enterprise Resource Planning) approach is best, as in other sectors. Create a robust ecosystem which supports enterprise-wide visibility and collaboration. (No silos!)

Culture. Create a culture of collaboration between number cruncher's data science, and decision maker's data science. The two overlap, and depend on each other. (This is not just an IT project!)

Stakeholder Loop. Identify CC's customer service value, and business value for the organisation. Establish a *CC Vision* and *CC Roadmap*. Maintain a review and feedback loop with executives, customers, staff, and other stakeholders. (Everyone should benefit!)

Technologies

Biometric Authentication. Provides convenient security checking. E.g. face, retina, palm, voice, typing rhythm, gait.

Blockchain. Shared immutable ledgers (transaction histories) enhance transparancy and trust, and reduce workload and friction.

Chatbots. Provide 24/7 service in several natural languages.

Cloud Infrastructure. Facilitates scalability.

Virtual Personal Assistants. Provide personalised advice and service based on customer data and history.

Robots. Mitsubishi Bank Tokyo have started to use the Nao robot as bank personnel [press].

Functions

- Anomaly Detection. E.g. fraud, money laudering, financing of terrorism, employee irregularity.
- Automated Trading. E.g. hedge funds.
- CFO (Chief Financial Officer) Support. Support for real-time pattern-extraction from mass and unstructured data, to support fast-response decision making.
- CRM (Customer Relationship Management). Customer-sensitivity. Personalised, history and evidence backed customer-interaction.
- Flexibility. E.g. 24/7 service, any user-end device, voice interaction in multiple languages.
- Forecasting. Increase forecasting accuracy, investment optimisation and revenue growth. Help CFOs identify hidden opportunities and risks.
- Personalisation. E.g. targeted marketing (based on customer preferences, data, and history). Customer-tailored recommendations which are contextualised and evidence-backed.
- Regulatory Compliance. Cross-enterprise ERP approach.
- Risk Detection. Through prediction and pattern detection.
- Security. Cyber-threat detection.

Nao at the Bank (Mitsubishi, Tokyo)

Health

Situation

This is a time of opportunity for the use of cognitive and IoT technologies in healthcare.

Success is reported in oncology (cancer), and technology for augmented reality and visualisation is being developed for surgery.

Medical data is increasing exponentially, thus inviting pattern-extraction from large data sets.

Wearable devices offer the possibilities of biometric data collection, remote monitoring, and provision of information to patients.

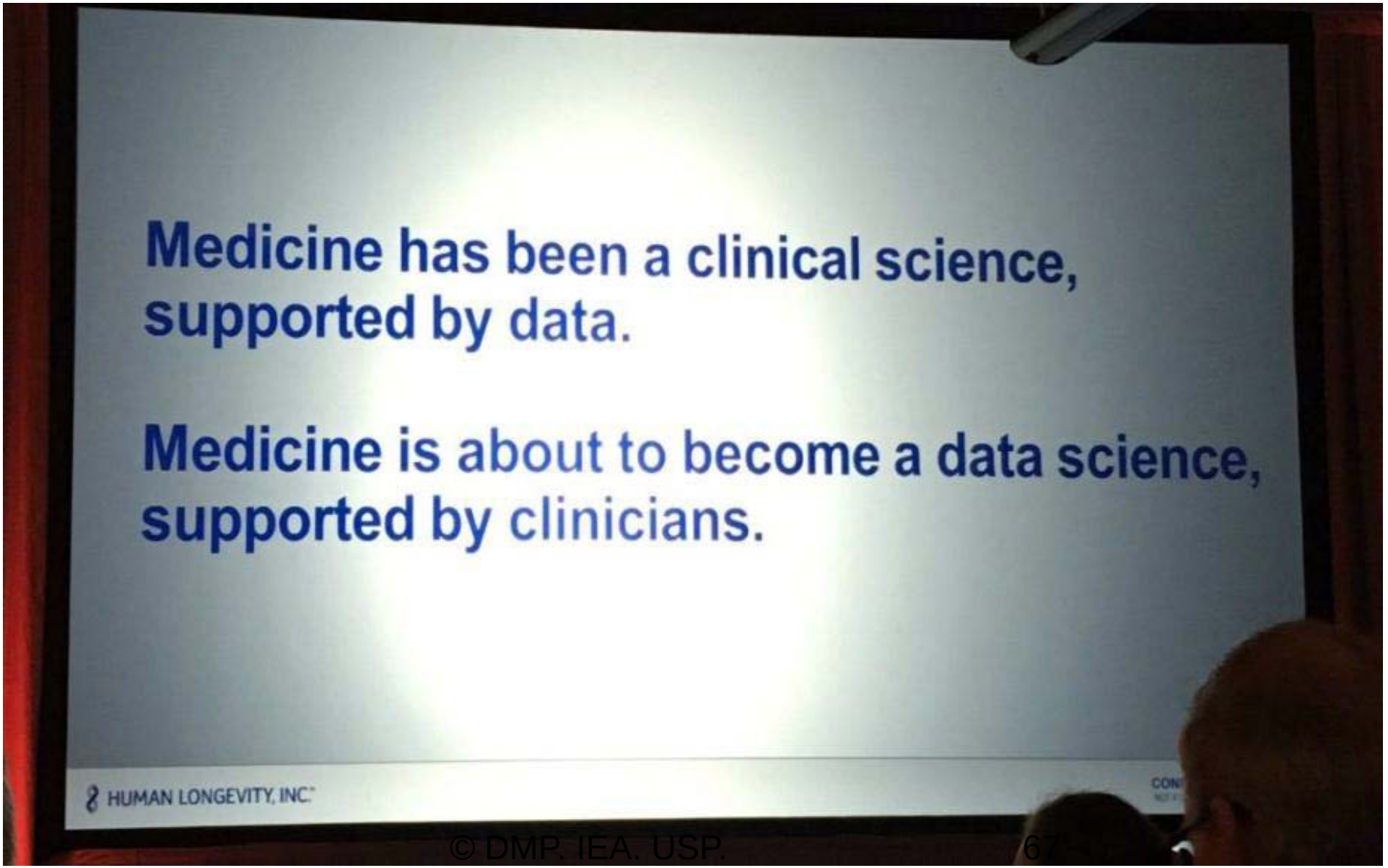
Natural language processing invites convenient remote patient interaction with systems and intelligent agents.

Cognitive systems tolerate ambiguity and uncertainty, which is suitable for patient interaction in medical contexts.

On the side of caution, some issues are: cost, security, training, standards, trust, and safety.

On the side of optimism, some say that medicine is becoming “a data science supported by clinicians” [press].

Medicine and Data Science



Diabetes

Diabetes is a growing public health problem with multiple complications.

Today, 415 million adults worldwide (8.3% of population) have Type I or Type II diabetes, and the number is predicted to rise to 600 million by 2040 .

Some factors influencing diabetes are obesity, diet (which should be low-sugar, low-fat, and high-fiber), tobacco use, exercise, stress, and urbanisation. These factors may be non-optimal in modern lifestyle.

Type II diabetes is characterised by insulin resistance (lowered response to insulin) as well as by under-production of insulin. Systemic inflammation is held to be a precipitating factor, and duodenal switch surgery is held to produce remission.

Dasman Diabetes Institute

DDI

In Kuwait City, the Dasman Diabetes Institute (DDI) conducts research, treatment, and education in Type I and Type II diabetes [press].

The DDI's Health Informatics Unit concentrates on the use of computers and health information technology tools for patient care, education, and research.

Medtronic

Medtronic

Medtronic (Minneapolis, USA) is among the world's largest medical equipment development companies [press].

Medtronic has Diabetes Centers in Northridge, California, and San Antonio, Texas, USA [press], and produces devices and systems for diabetes support [press].

Sugar.IQ

IBM is collaborating with the American Diabetes Association (ADA) to supply Watson with 66 years worth of data from medical journals and its extensive collection of educational materials. The objective is to discover hidden patterns in diabetes data, to “translate big data into big insights”.

IBM is also collaborating with Medtronic to produce **Sugar.IQ**. This is a cognitive mobile personal assistant app to support daily diabetes management by providing real-time actionable glucose insights and predictions.

The IBM contribution involves IBM Streams (streaming analytics) [press], and Watson Health [press].

The system uses wearable technology to capture biometric data and display recommendations and predictions. Factors such as food, sleep, and stress are to be included [press, press, press, press, press, press, press, press].

Sugar.IQ

University of Glasgow

SenseAble

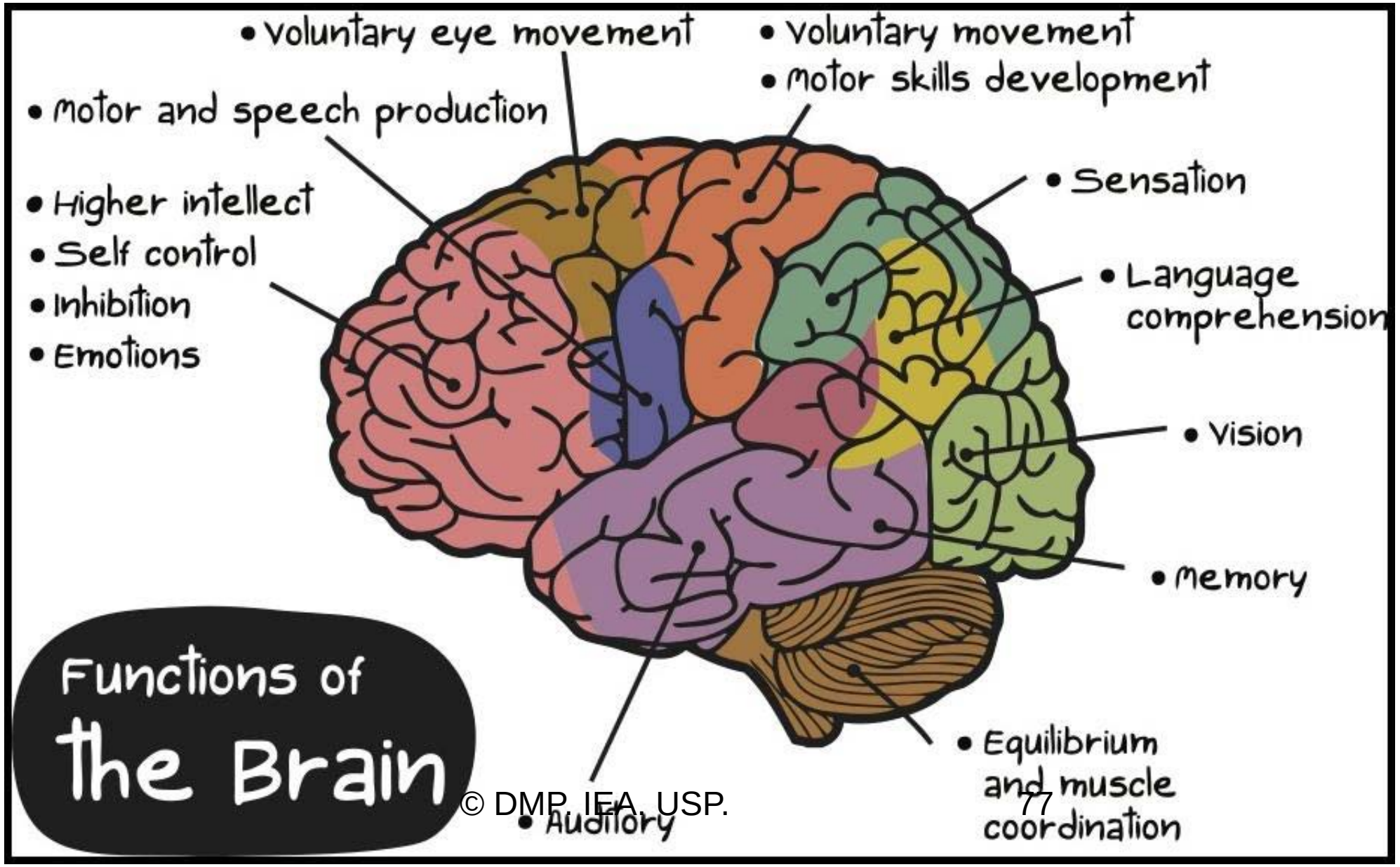
At Glasgow University's School of Engineering, the Bendable Electronics and Sensing Technologies (BEST) Group [press] has developed a wearable sensor system which collects and transmits biometric data from the user's sweat [press, press, press, press, press].

A flexible/stretchable patch on the skin is made from a graphite-polyurethane composite and measures about one square centimetre. This transmits to a mobile phone app called 'SenseAble': wirelessly, and without external power, using near-field communication.

The system currently measures pH, and will be extended to measure glucose, ammonia, and urea.

This has potential to provide non-invasive and remote real-time monitoring of diabetes and other conditions.

Cognitive Science



CC and the Brain

Cognitive science studies the functions of the human brain.

In the brain:

performance = **schemas** + **executive function**

In CC:

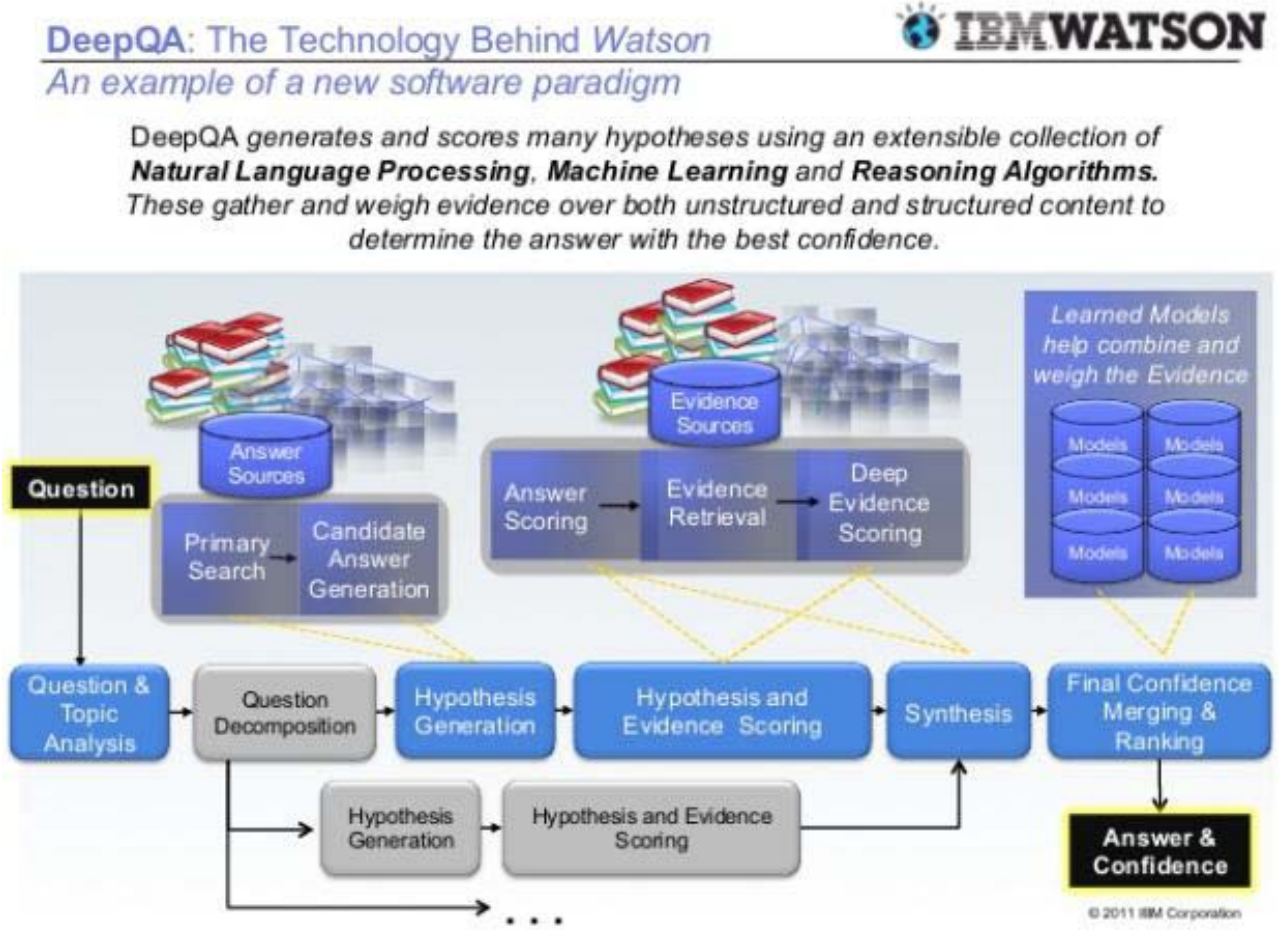
performance = **candidate generation** + **scoring and ranking.**

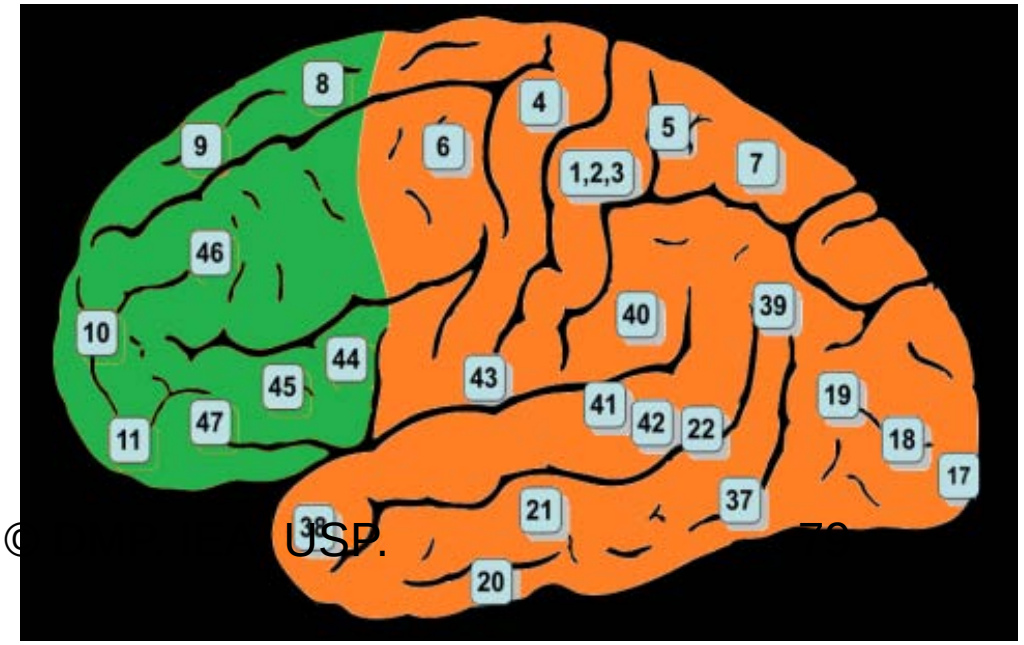
The correspondence is:

- schemas are units of knowledge
- candidates are hypothetical knowledge
- executive function (EF) controls the selection and enactment of schemas
- scoring and ranking (S&R) controls the selection and presentation of candidates.

Thus CC sytems 'think like a brain', and can augment the brain.

CC and the Brain





Work Together

Cognitive science tells us how the brain makes decisions. CC augments these processes [press].

A primary brain operation is executive function [press, press, press]. This is associated with the pre-frontal cortex, and controls the enactment of schemas.

In the diagram above, this is the green part. (This is a functional diagram, and in the physical brain many parts are involved and inter-connected.)

The three primary executive functions are:

- **Selection** (working memory)
- **Scheduling** (go, stop, suspend, juggle, etc.)
- **Steerage** (adapting the details of enactment).

These three functions support adaptation to context, circumstances, and goals.

They provide us with agile decision making in a fast changing, uncertain world.

Some sources of information about executive function in the brain are:

- the psychiatric syndrome of autism (where EF is diminished)
- brain damage (where EF is diminished)
- fMRI (functional Magnetic Resonance Imaging).

Cognitive Agility

In **business**, for success and survival, CEOs, teams, and whole organisations need **agility** in decision making.

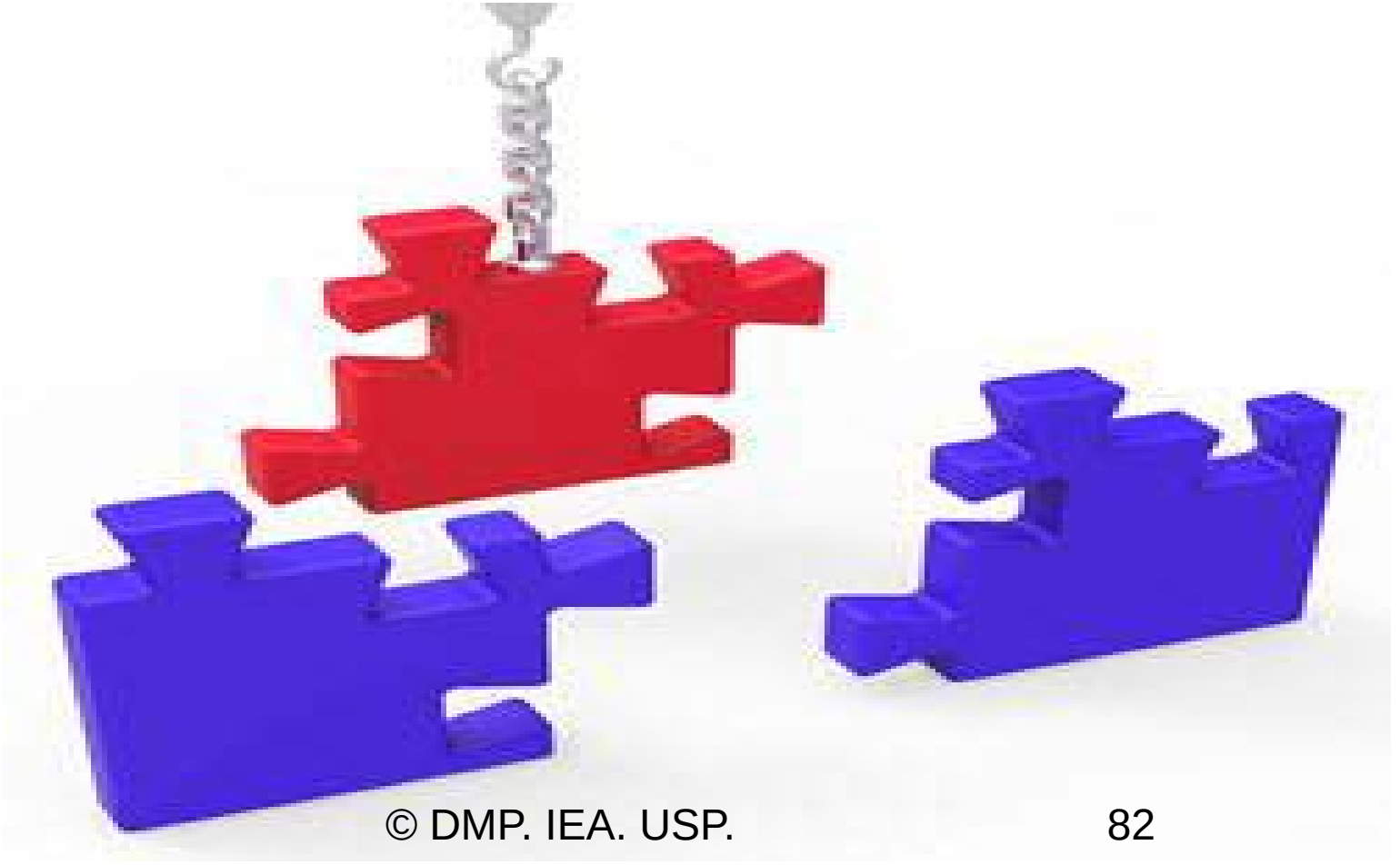
They need to **adapt** to changing circumstances, contexts, and goals [press, press, press, press].

So cognitive science, business decision making, and cognitive computing overlap in a useful way.

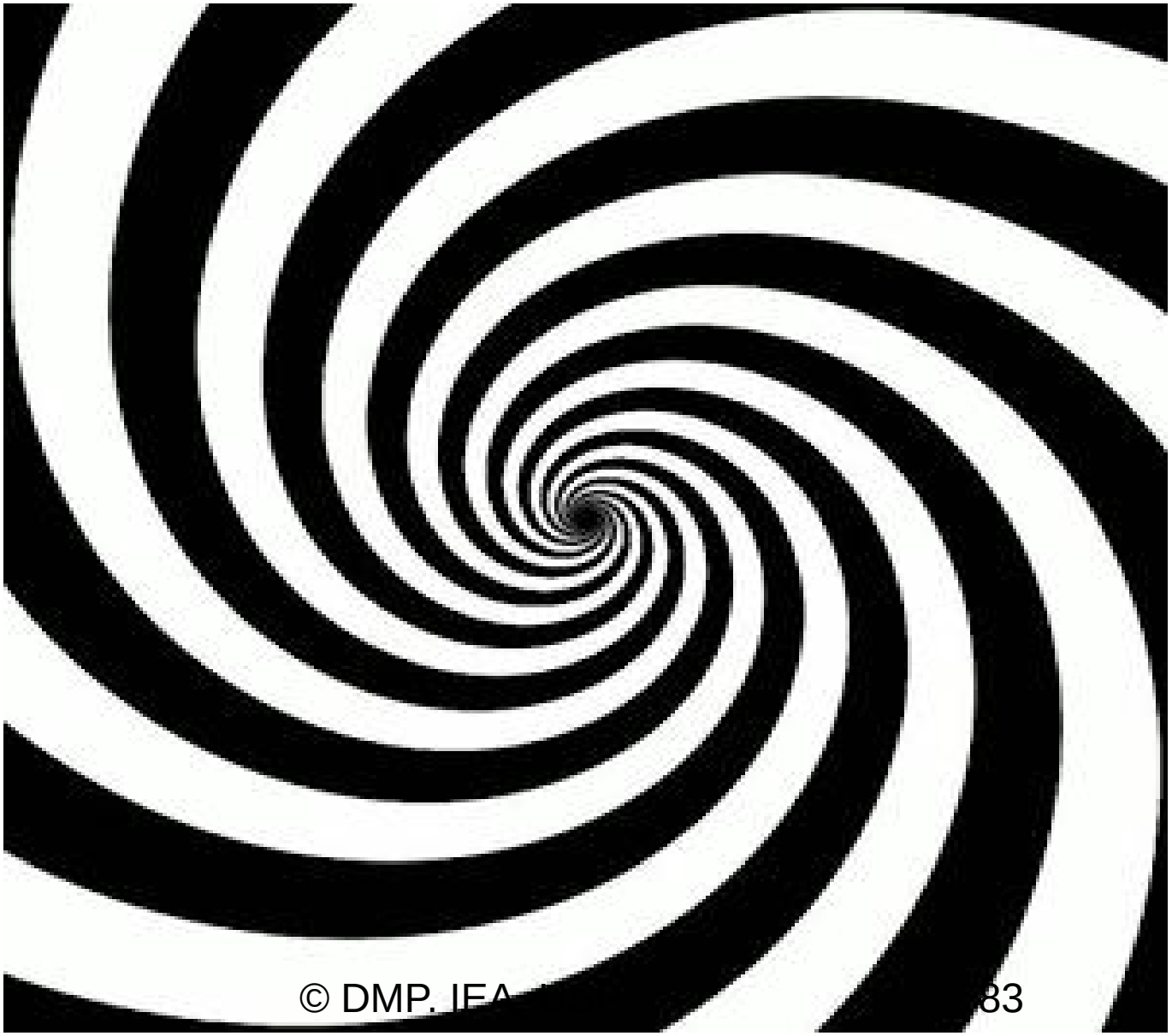
We call this the **Cognitive Agility SPOT** (Single Point of Truth).

The Cognitive Agility SPOT

At the Cognitive Agility SPOT (Single Point of Truth), **cognitive science**, **modern business**, and **cognitive computing** fit together like a jigsaw – and support each other in the new era.



Roundup



Review of Course

Augmented Intelligence

IBM Watson

Oil & Gas

Renewable Energy

Banking & Finance

Health

Cognitive Science.

Appendix

References

Books

- Cognitive Computing and Big Data Analytics, J. Hurwitz, M. Kaufman, and A. Bowles. Wiley. 2015 [press, press]
- Big-Data Analytics for Cloud, IoT and Cognitive Computing. K. Hwang and M. Chen. 2017. [press]

Journals

- Big Data and Cognitive Computing. Online journal. ISSN 2504-2289. [press].
- Industrial Marketing Management. Journal Special Issue. ISSN 0019-8501. [press]
- Cognitive Systems Research. Journal. ISSN: 1389-0417. [press]

Technical Topics

Development Environments. IBM's Bluemix cloud service, Google's TensorFlow library

Fundamentals 1. Knowledge-Based AI, Semantic Nets, Generate and Test

Fundamentals 2. Means-Ends Analysis, Production Systems, Frames, Case-Based Learning and Reasoning

Learning. Concept Formation, Classification, Planning, Understanding, Common Sense Reasoning, Scripts

Reasoning. Explanation and Learning, Analogical Reasoning, Version Spaces, Constraint Propagation, Diagnosis, Meta-Reasoning

Design. Machine Learning, Hypothesis Generation and Scoring, Natural Language Processing, Knowledge Representation, Ontologies and Taxonomies

Analytics. Predictive Analytics, Text Analytics, Image Analytics, Speech Analytics

IBM Watson. DeepQA Architecture, Unstructured Information Management Architecture (UIMA), Structured and Unstructured Knowledge.

Links

Providers
Amazon Machine Learning [press, press]
Cognite Ventures startup list [press]
Google Cloud [press]
IBM Watson [press]
Microsoft Azure [press]
SAS [press, press, press]
SparkCognition [press]
comparison article [press]

Countries
China [press]
India [press, press]
Russia [press]
UAE [press]

Reports
Decision Support and Business Intelligence [press]
IBM Cognitive Advantage Report [press]
IDC Predictions of growth in cognitive computing [press]
Intel report [press]
SAS Executive Guide [press]

Organisations
Cognitive Computing Consortium [press]
Cognitive Science Society [press]
IEEE SMC Cognitive Computing Society [press]
MUST Research Club (India) [press]
Kaggle [press]

Energy
O&G [press, press, press, press, press, press, press]
O&G Analytics Market [press, press]
Renewable [press, press, press, press, press]
Security [press]
Transformation [press, press, press, press, press, press, press, press, press, press]

General
Accenture [press, press]
AI? [press, press, press]
Cognitive Science and Business [press, press, press, press, press, press, press].
Cognitive Science and Agility [press, press, press, press, press].
Future of work [press, press, press]
IoT [press, press, press, press, press, press, press, press, press].

Motto: “When the wind changes, so must the sails of the ship”.