

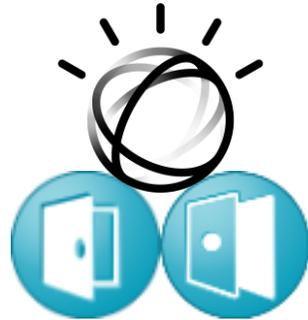
IBM Watson IoT

Requirements Quality Assistant (RQA)

Intelligent Requirements Management with IBM Watson



München, 13.03.2019



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Solution Architect

IBM Engineering

IBM **Watson Internet of Things**



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- Performance is based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput or performance that any user will experience will vary depending upon many factors, including considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve results similar to those stated here.

What do you think of when you hear IBM?

<https://www.youtube.com/watch?v=OTzveEx-rQw>

Agenda

- IBM Watson
- Artificial Intelligence (AI)
- Cognitive Computing and Augmented Intelligence
- Machine Learning (ML)
- Products are getting more complex and capabilities are being added faster
- Engineering knowledge has become big data
- AI is helping companies increase the capacity of their employees through automation and knowledge
- Our vision to inject automation and intelligence throughout the engineering lifecycle
- Challenges and pain points with writing and managing poor quality requirements
- Requirements Quality Assistant (RQA) - our first AI offering for requirements quality
- Roadmap
- Architecture
- Questions & Answers
- Additional Resources

IBM Watson winning against 2 humans at Jeopardy! in 2011



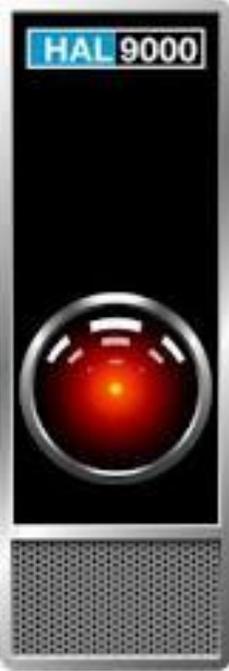
<https://www.youtube.com/watch?v=P18EdAKuC1U>

Watson, IBM's AI System for B2B

- Watson was created as a question answering (QA) computing system that IBM built to apply advanced **natural language processing, information retrieval, knowledge representation, automated reasoning, and machine learning** technologies to the field of open domain question answering.
- Watson was named after **IBM's first CEO**, industrialist **Thomas J. Watson**
- The computer system was **initially developed to answer questions on the quiz show Jeopardy!** and, **in 2011**, the Watson computer system competed on Jeopardy! against legendary champions **Brad Rutter and Ken Jennings**, winning the first place prize of \$1 million for a charity project.
- **Watson is IBM's AI System for Business (B2B)** - Alexa, Siri, Cortana and Co. are rather seen as consumer based (**B2C**)
- The key **difference between QA technology and document search** is that document search takes a **keyword query** and returns a list of documents, ranked in order of relevance to the query (often based on popularity and page ranking), while QA technology takes a question expressed in natural language, **seeks to understand it in much greater detail, and returns a precise answer to the question.**
- When created, IBM stated that, "**more than 100 different techniques are used to analyse natural language**, identify sources, find and **generate hypotheses**, find and **score evidence**, and merge and rank hypotheses."
- In recent years, the Watson capabilities have been extended and the way in which Watson works has been changed to take advantage of new deployment models (Watson on IBM Cloud) and evolved machine learning capabilities and optimised hardware available to developers and researchers. It is no longer purely a question answering (QA) computing system designed from Q&A pairs but can now '**see**', '**hear**', '**read**', '**talk**', '**taste**', '**interpret**', '**learn**' and '**recommend**'.

Artificial Intelligence (AI) / Künstliche Intelligenz (KI)

IBM (letters shifted
by 1 Bit) -> HAL ;)



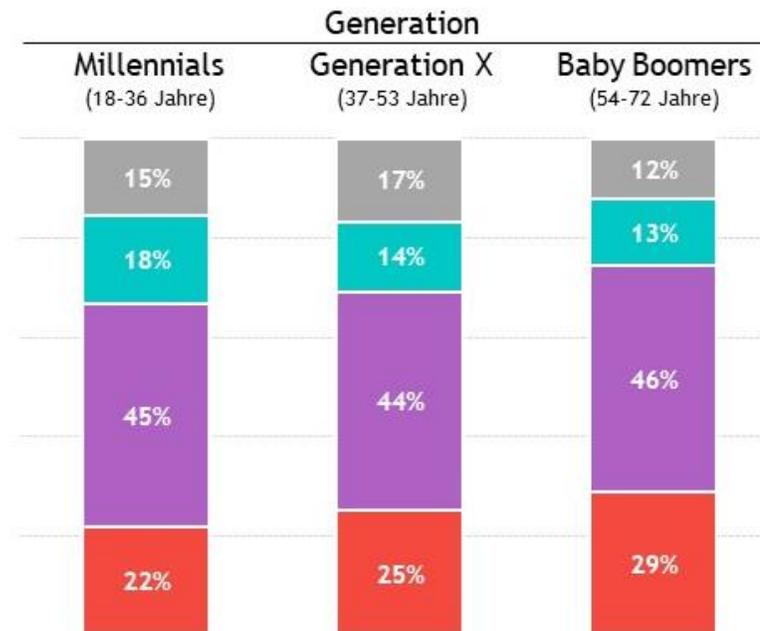
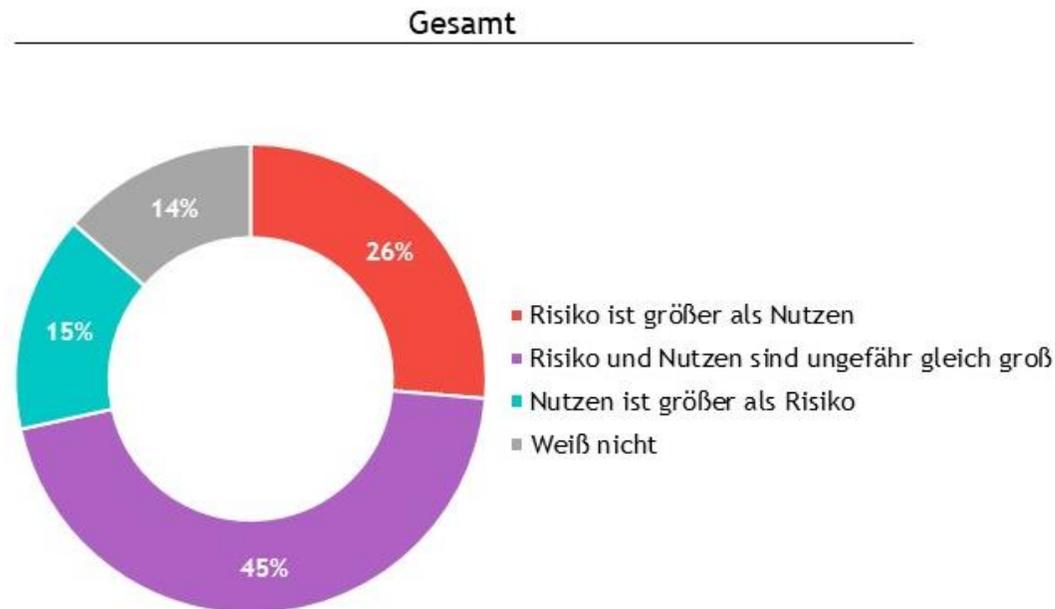
- The term "artificial intelligence" is used to describe **machines that mimic "cognitive" functions** that humans associate with other human minds, such as **"learning" & "problem solving"**.
- The truth is that **AI is hard to define**, because intelligence is hard to define in the first place.
- Our **definition of AI changes**. In fact, John McCarthy, who coined the term “Artificial Intelligence” in 1956, stressed that “as soon as it works, no one calls it AI anymore.”
- Today, many of the **rules- and logic-based systems** that were previously considered Artificial Intelligence are no longer classified as AI. In contrast, **systems that analyse and find patterns in data (machine learning) are becoming the dominant form of AI**.
- Three main categories of AI:
 - **Artificial Narrow/Weak Intelligence (ANI)**
is the only form of Artificial Intelligence that humanity has achieved so far! This is AI that is good at **performing a single task**, such as playing chess or Go, making purchase suggestions, sales predictions and weather forecasts, or even driving a car autonomously.
 - **Artificial General/Strong Intelligence (AGI)**
also known as human-level AI, is the type of Artificial Intelligence that can understand and reason its environment as a human would. We’ve been saying for decades that it’s just around the corner.
 - **Artificial Super Intelligence (ASI)**
when AI becomes much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills. **ASI is even more vague than AGI** at this point.

Deutsche sehen mehr Risiken als Nutzen in der KI / AI

In den letzten Jahren konnten Forscher und Ingenieure große technologische Fortschritte im Bereich künstliche Intelligenz machen. Künstliche Intelligenz wird in immer mehr Produkten und Dienstleistungen eingesetzt. Manche Experten sehen darin einen großen Fortschritt, andere Experten warnen vor möglichen Risiken.

Ist der Einsatz von künstlicher Intelligenz Ihrer Meinung nach im Allgemeinen mit mehr Risiko oder mehr Nutzen verbunden - oder sind Risiko und Nutzen ungefähr gleich groß?

Repräsentative Befragung in Deutschland (ab 18 Jahre), n=2.000 Befragte, Feldzeit: 24. bis 28. August 2018



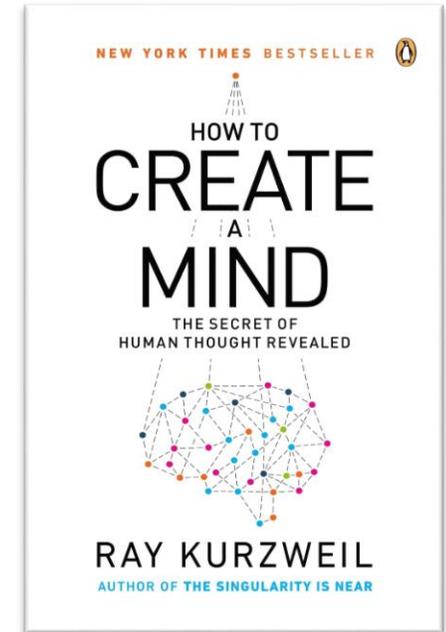
YouGov

„Künstliche Intelligenz (KI) wird zahlreiche Branchen disruptiv verändern. Unternehmen, die sich nicht schnell genug an-passen, laufen Gefahr, von agileren und innovativeren Konkurrenten überrundet zu werden.“, **Christian Kirschniak, PWC**

Künstliche Intelligenz gilt als eines der wichtigsten Themen für die nächsten Jahre. Doch die Bundesregierung geht hier in die falsche Richtung, meint ein renommierter KI-Forscher. **t3n.de, 11.03.2019**

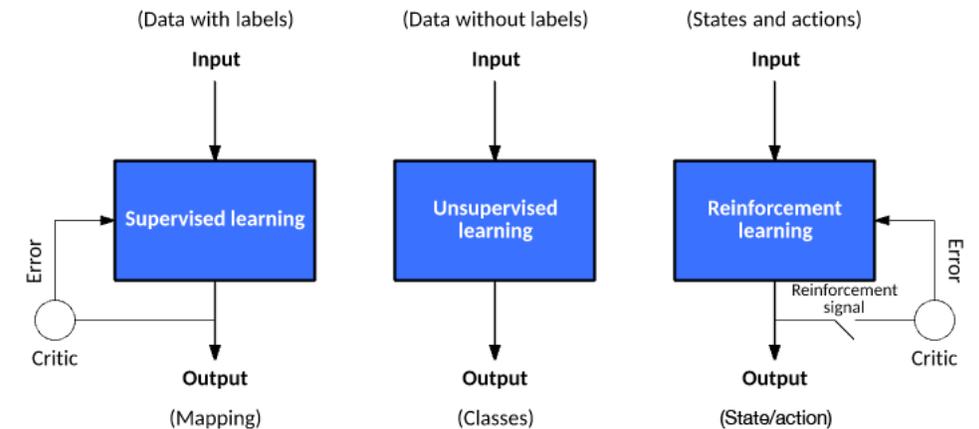
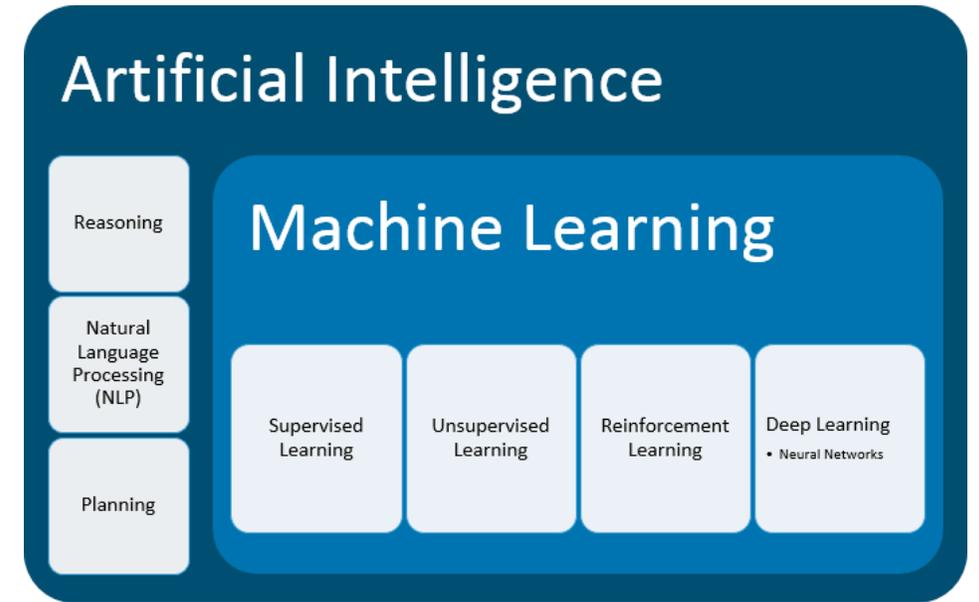
Cognitive Computing and Augmented Intelligence

- Artificial intelligence (AI) has garnered a **negative reputation** as a force that will eventually destroy humanity.
- IBM prefers to speak rather about **Cognitive Computing or Augmented Intelligence** instead of Artificial Intelligence.
- The word *cognition* comes from the Latin verb *cognosco* (*con*, 'with', and *gnōscō*, 'know'), meaning 'I know, perceive', meaning 'to conceptualize' or 'to recognize' (**wissen, erkennen**).
- **Augmented (vermehrte, vergrößerte) Intelligence** should stress the combination of **Man AND Machine!**
- When you hear Cognitive, think **pattern recognition (Mustererkennung)**!
- The book „**How to create a mind**“ from **Ray Kurzweil** describes that the **thinking parts of our brains** are made out of building blocks -> **Neurons and Neuronal Networks**
- The breakthrough in Cognitive Computing has been **the advent of Machine Learning capabilities** with the **vast amount of data (IoT, Mobile) to learn from** and the **massive CPU power & storage capacities of the Cloud**.
- The goal of Cognitive Computing is to **amplify human cognition** and allow people to **make better decisions**.
- Watson is particularly good, when dealing with **large amounts of structured (~20%) & unstructured data (~80%)**
- Today **Watson is a building set (Baukasten) of various KI algorithms** for customers and projects to be used



Machine Learning (ML)

- Machine learning (ML) is the **scientific study of algorithms and statistical models** that computer systems use to effectively perform a specific task without using explicit instructions, **relying on patterns and inference** instead.
- It is seen as a **subset of artificial intelligence**. Machine learning algorithms build a **mathematical model of sample data**, known as "training data", in order to make predictions or decisions **without being explicitly programmed** to perform the task.
- Machine learning algorithms are used in a wide variety of applications, such as **email filtering, detection of network intruders, and computer vision**, where it is infeasible to develop an algorithm of specific instructions for performing the task.
- Arthur Lee Samuels**, an IBM researcher, developed one of the earliest machine learning programs – a self-learning program for playing checkers. In fact, he **coined the term *machine learning***.
- Types of Learning algorithms
 - Supervised Learning
 - Unsupervised Learning
 - Reinforcement Learning
 - Deep Learning



The complexity in product development is driving an explosion of engineering artifacts – it's hard to keep up!



Automotive

150M Lines of code in new Ford F-150 Truck from 155K in 2003

40% of total IT Budget spent on QA and testing by 2019



Electronics

12M lines of code in mobile phone

1.4M lines of code in robotic surgical system



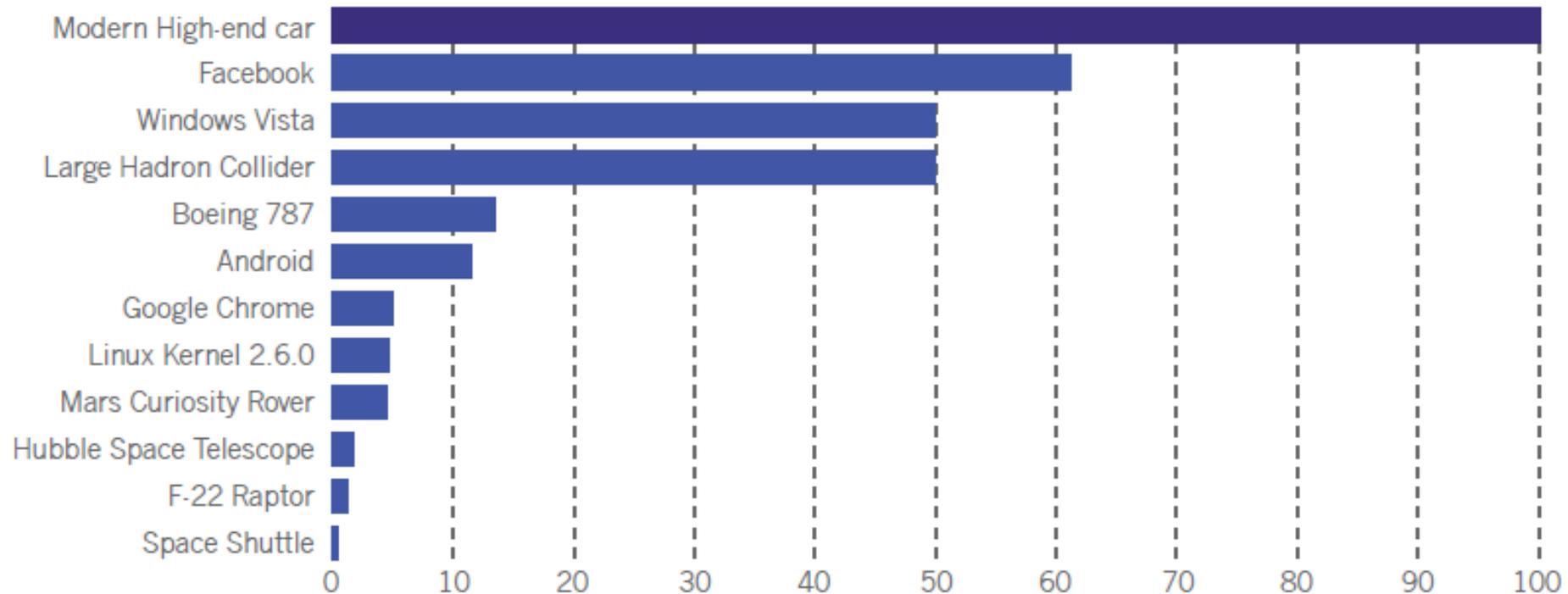
Aerospace & Defense

90% of F-35 fighter jet functionality is software driven

Nowadays cars belong to the most complex systems with the most lines of code. Trends like Autonomous Driving will even push the limit further!

SOFTWARE SIZE (MILLION LINES OF CODE)

Source: NASA, IEEE, Wired, Boeing, Microsoft, Linux Foundation, Ohio



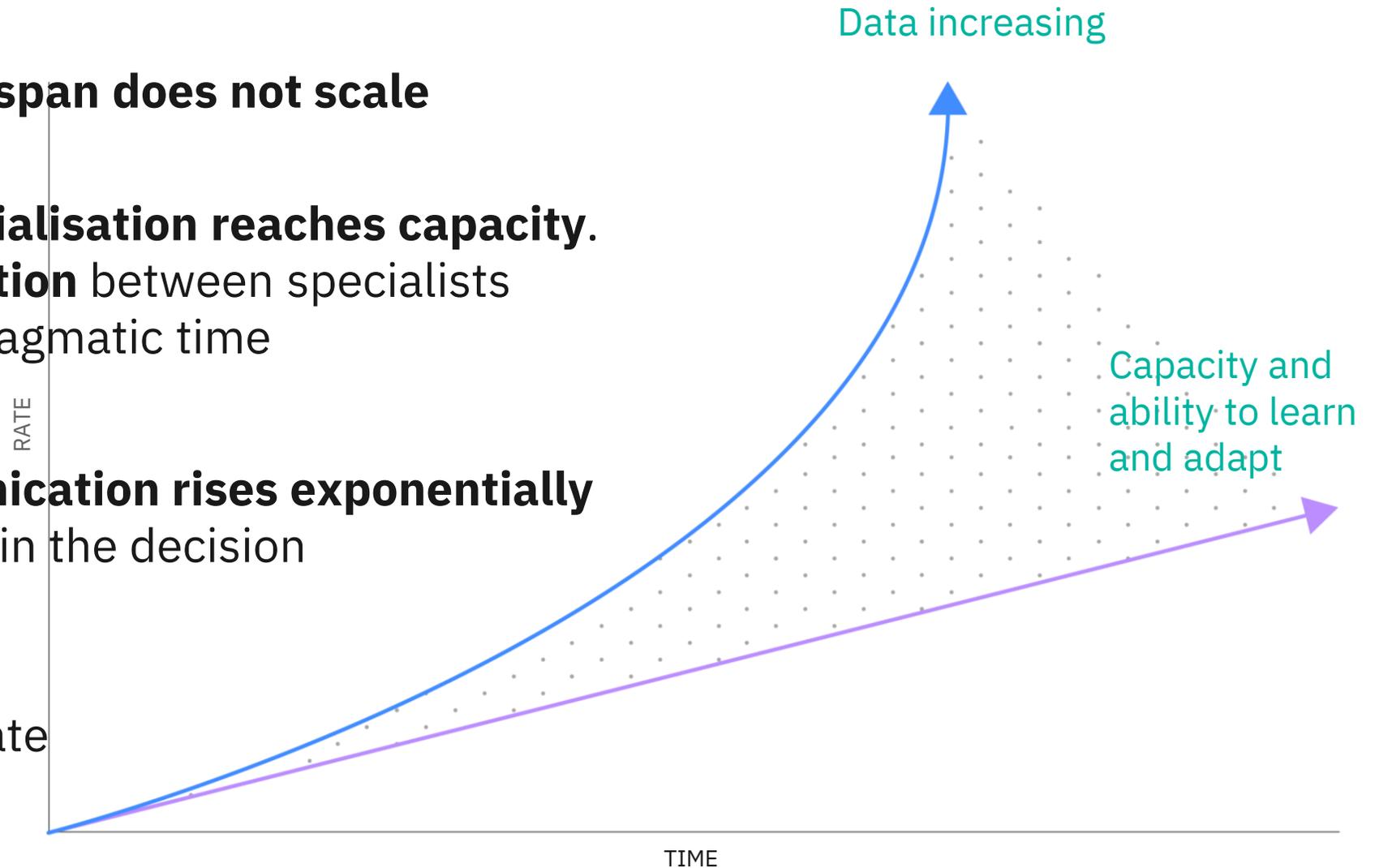
<https://informationisbeautiful.net/visualizations/million-lines-of-code/>

<http://www.visualcapitalist.com/millions-lines-of-code/>

http://bit.ly/KIB_linescode

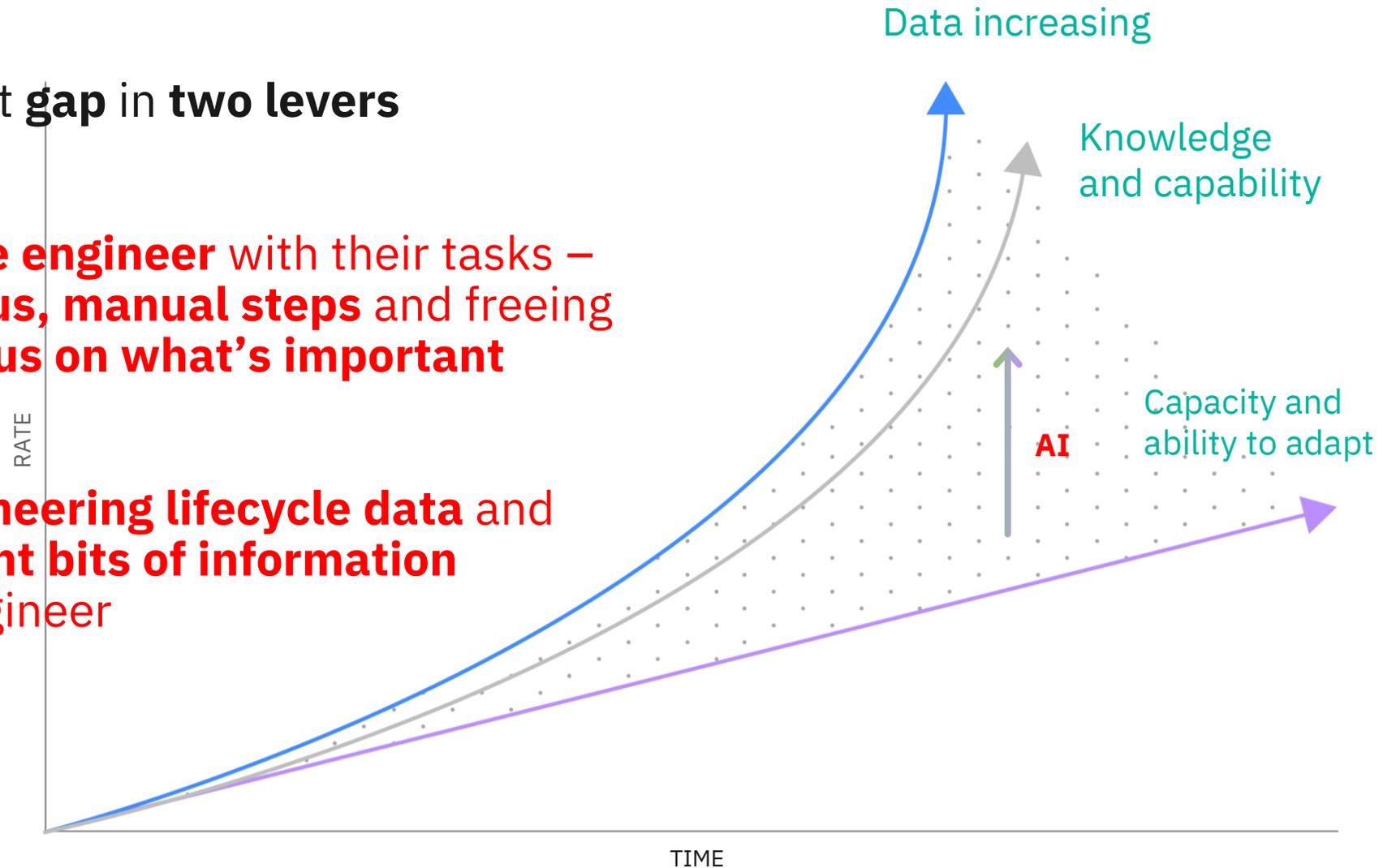
Engineering knowledge has become big data

- **Human brain and life-span does not scale**
- Usual **strategy of specialisation reaches capacity.**
Too much communication between specialists to solve problems in pragmatic time
- **Weight of the communication rises exponentially** with every new person in the decision making process
- Specialization also create **“responsibility gaps”**



AI is the application of knowledge

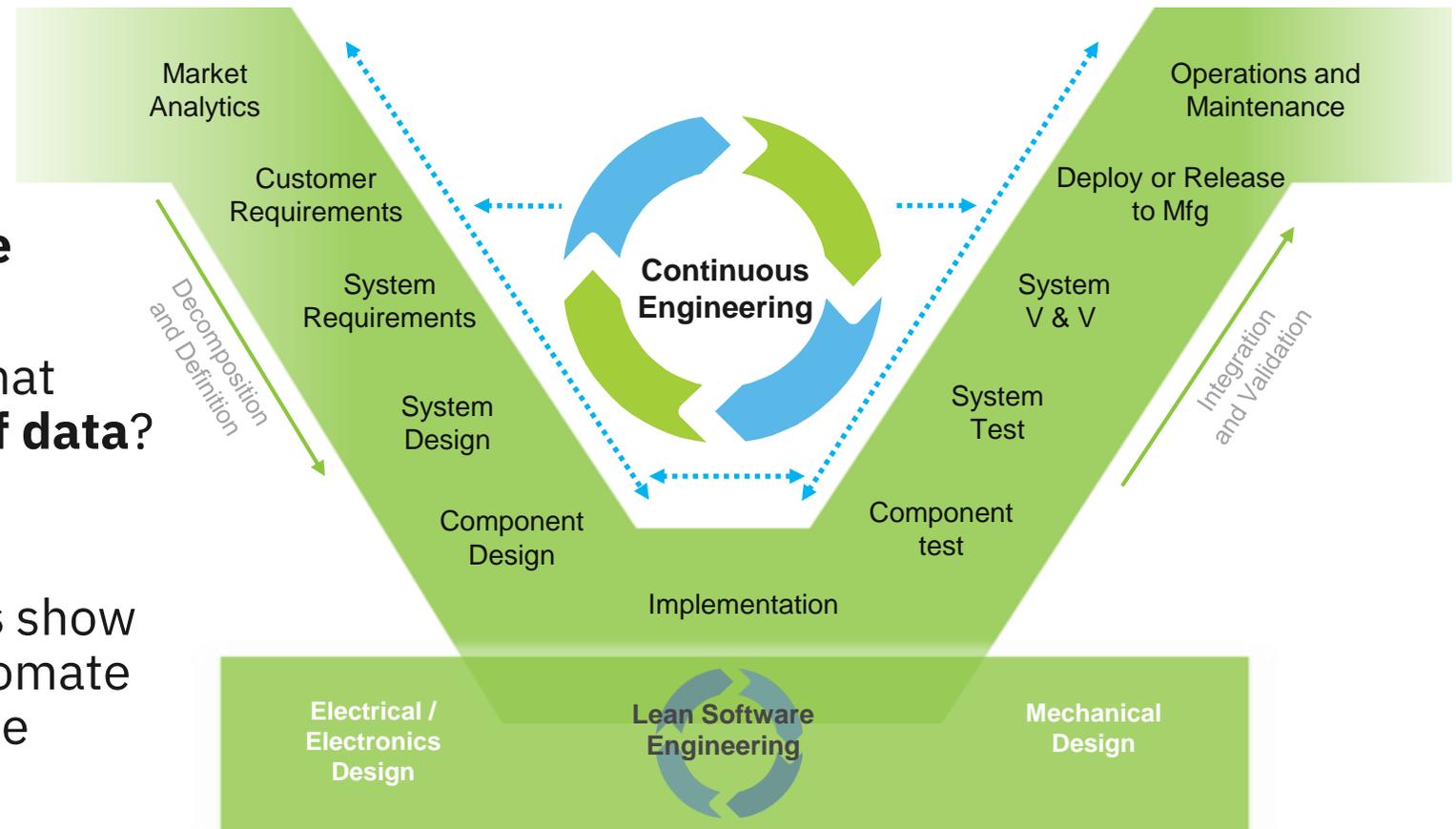
- AI will help **bridge** that **gap** in **two levers**
- **Lever 1 - assisting the engineer** with their tasks – **automating the tedious, manual steps** and freeing up the engineer to **focus on what's important**
- **Lever 2 - mining engineering lifecycle data** and extracting only **relevant bits of information and trends** for the engineer



Helping Engineers to Work Smarter (Vision)

Inject automation and intelligence across the engineering lifecycle

- Use those two levers **across the lifecycle**
- Where in the lifecycle do engineers do **manual, low-value tasks that can be automated?**
- Are there areas in the lifecycle that are experiencing an **explosion of data?** How do we **mine** that **data** and only surface the **relevant bits?**
- **Two successful AI case studies** show where AI helped companies automate some of their processes and mine insights from data ...





Solution:

Autoglass built the world's first automated vehicle body damage assessment and quote generation system. Using the IBM Watson Visual Recognition service, the system analyzes the photos that customers upload when they submit a body damage claim, applying the same classification logic as Belron's highly experienced damage assessment advisors.

“We're able to automate nearly half of our body damage claims assessments using image recognition technology, and we expect that rate to get even higher.”

—Dafydd Hughes, IT Manager at Autoglass BodyRepair



IBM Watson Visual Recognition

- Shortens the claims cycle for certain damage assessments **by more than 95%**
- **Enriches client experience** through personalized conversation flows and real-time answers
- Enables damage assessment advisors to **focus on more complex damage claims**



Solution:

Working with Watson, Woodside Energy built a customized tool that allows its employees to find detailed answers to highly specific questions - even on remote oil and gas facilities.

“It’s helped our engineers get up to speed very quickly on what has already been done and how the projects were managed in the past. We can learn from the past and there’s no need to reinvent the wheel.”

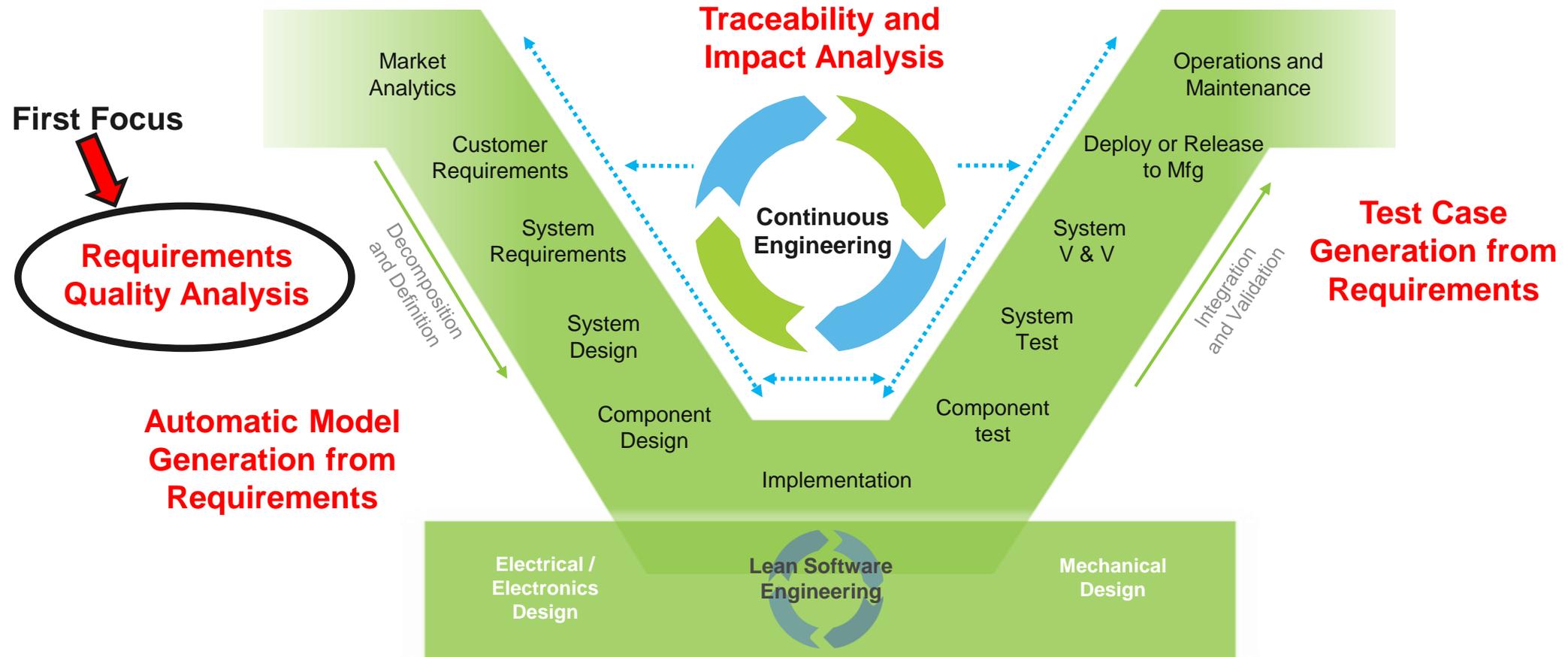
— Caitlin Bushell, Graduate Process Engineer at Woodside



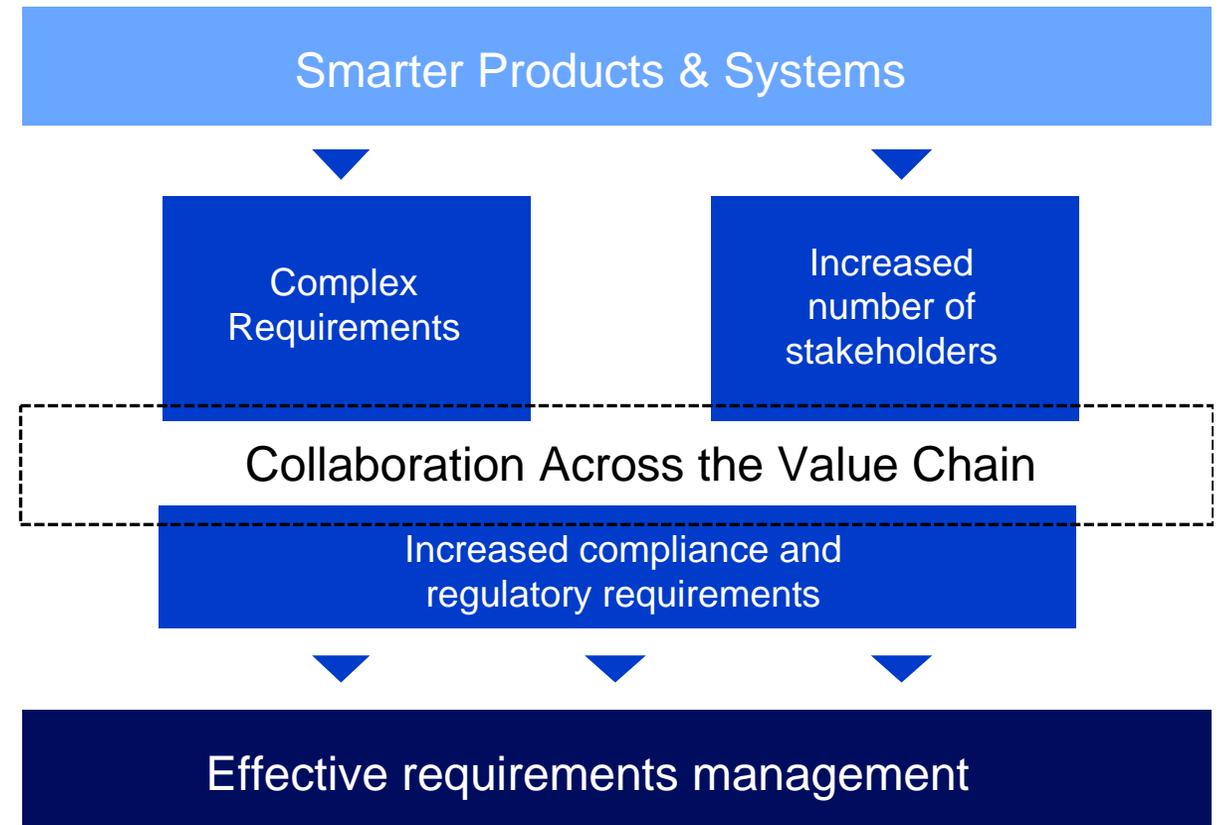
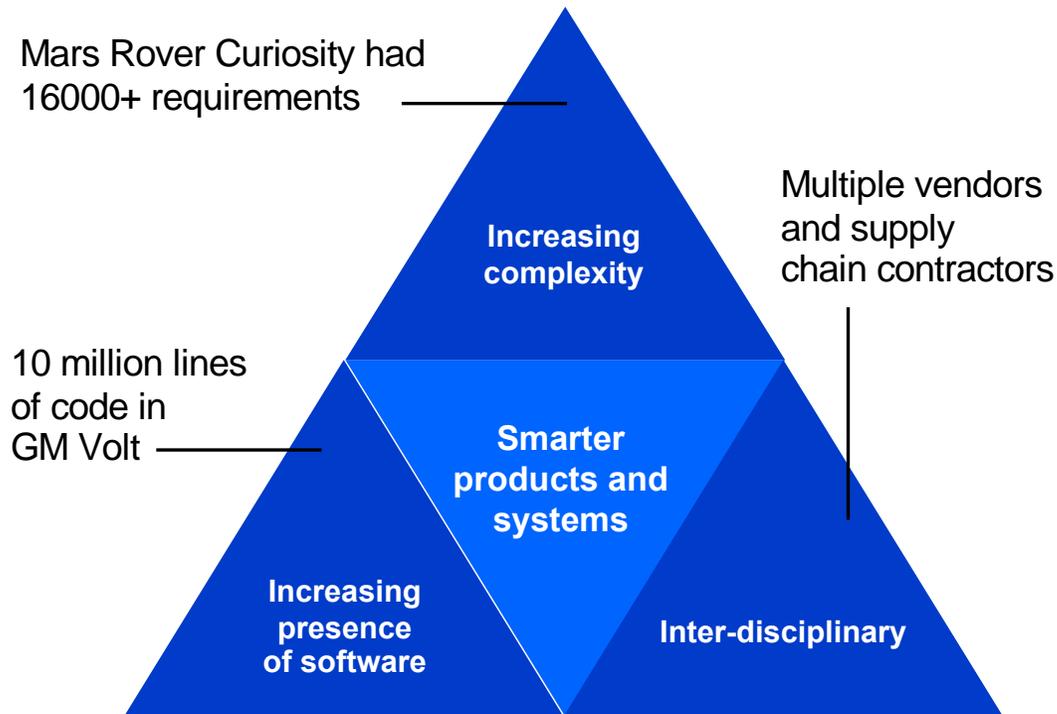
- IBM Watson Knowledge Studio
- IBM Watson Discovery
- IBM Watson Assistant
- IBM Watson Explorer
- IBM Cloud
- **38,000 Woodside documents** were used to train the solution — this would take a human over five years to read
- **30 years of practical engineer experience** at the fingertips of all Woodside employees
- **75% decrease** in time employees spend searching for expert knowledge

Helping Engineers to Work Smarter (areas of interest and focus)

Inject automation and intelligence across the engineering lifecycle



Increased complexity of product development and impact on RM: scale, compliance and multiple stakeholders



Pain points with writing and managing poor quality requirements

Unclear and ambiguous words

“The car shall be fast”

Overly ambitious requirements

“The system shall be 100% reliable”

Difficult to read specifications

“The system shall determine the number of users online at all times and pass the number of users to the system administrator who shall have the ability to disconnect users from the network”

- Manual proofreading of large sets of requirements
- Constant re-work and editing of requirements
- Long meetings to clarify requirements

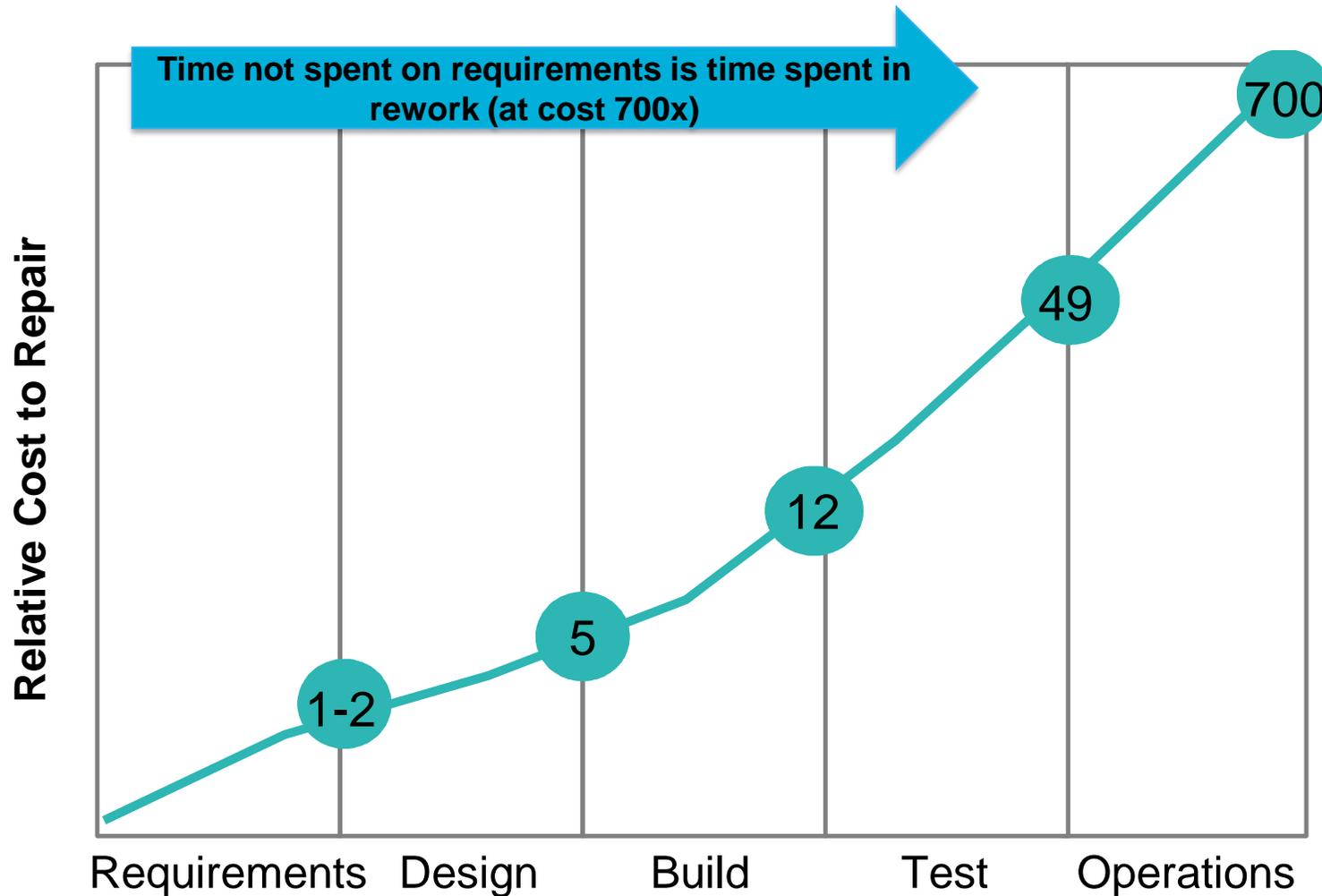
Companies with poor requirements management have **3** project failures for every **1** success



Companies with poor requirements management, on average, spend **\$2.24 million more** per project



The cost to fix software defects rises exponentially with each successive phase of the project life cycle



(2004) NASA Publication

Current solutions ... and why they can miss errors

- **Rules engines**

- Simple key word searches cannot understand words in context
 - Ex. of “clear”
 - Ambiguous: “The GPS system shall provide a clear perspective of the road”
 - Not ambiguous: “The GPS System shall clear the display on transition to power off mode”

- **Peer review**

- Difficult to enforce across teams
- Manual, tedious review of long documents

- **Checklists**

- Limited capacity to keep track of all quality indicators (cognitive span is 7 +/- 2 things)

High quality requirements are critical for a project's success

Completeness

Unfinished requirements lead to preventable confusion and delays

Consistency

The more consistent requirements are the fewer opportunities there are for errors

Accuracy

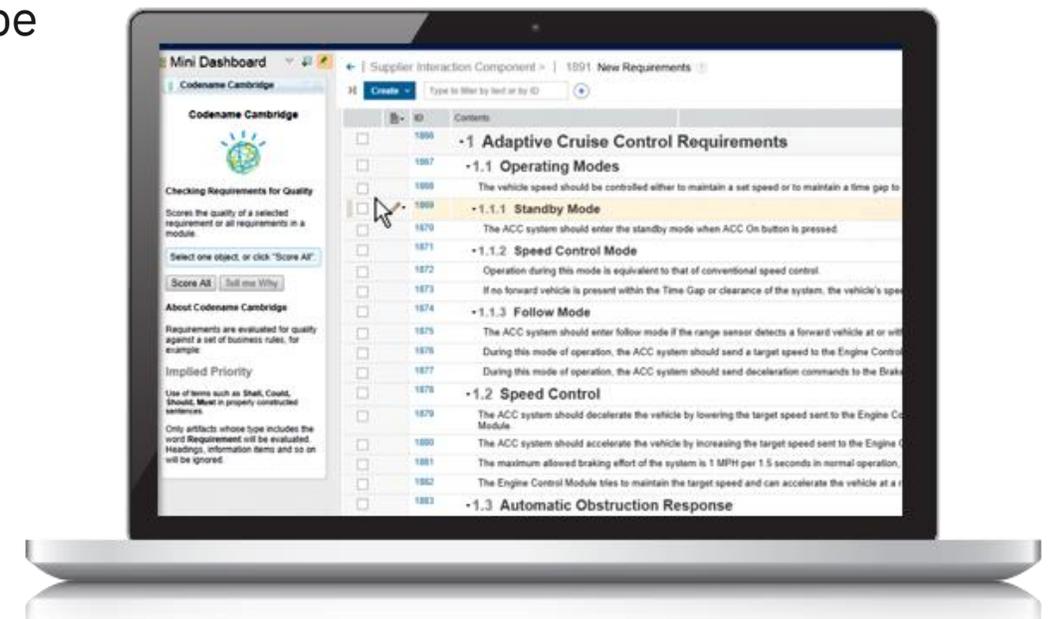
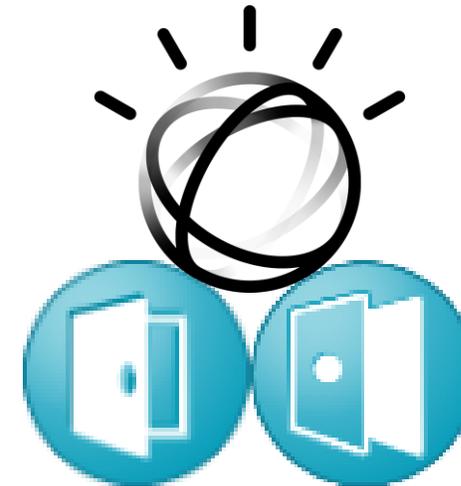
Accurate requirements reliably articulate the objectives of stakeholders



IBM Requirements Quality Assistant (RQA)

<https://www.ibm.com/us-en/marketplace/requirements-quality-assistant>

- **New Watson capability** embedded inside **DNG** and **DOORS** ...
- **Removes risk and ambiguity** in the requirements authoring phase **out-of-the-box** by using **AI** (Watson Natural Language Understanding)
- **Pre-trained** to detect **key quality indicators** designed to be consistent with the **INCOSE Guidelines** for Writing Good Requirements
- Authors **receive coaching** from Watson to **improve the quality of the requirement** as it is being written
- Enterprise benefits (**400 engineers example**)
 - Reduce the cost of defects by **60%** to save **\$3.9M**
 - Reduce cost of manual reviews by **25%**
 - Retain engineering **expertise for junior engineers**



Grading and quality issues

The screenshot shows the Project Cambridge interface. On the left, a 'Mini Dashboard' displays a 'Welcome Watson to your Requirements Team' message and a 'Quality Scores: 0-100' section. Two requirements are highlighted with red circles and a score of 70:

- 415: The GPS System shall show a clear perspective of the upcoming junction. Ambiguous Term. Look for: clear perspective. View details. Teach Watson.
- 418: The GPS System shall use minimum power. Unspecific quantity. Look for: minimum power. View details. Teach Watson.

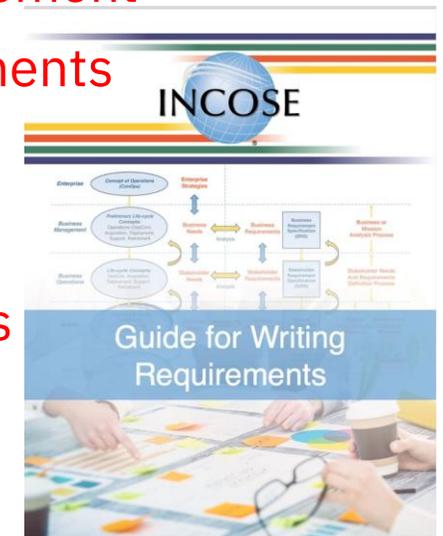
The main content area shows a list of requirements with checkboxes and IDs. The requirements are:

ID	Contents
413	The GPS System shall clear the display and reduce current draw to less than 2 mA on transition to power off mode.
414	The GPS System shall show a clear perspective of the upcoming junction.
415	The GPS system shall show a clear perspective of the upcoming junction.
416	The GPS System shall maintain the displayed user location for at least 500 milliseconds.
417	The GPS System shall update the user location at least every 100 milliseconds.
418	The GPS system shall use minimum power.

– **Grades requirements** against a criteria that was designed to be consistent with the **INCOSE Guidelines** for Writing Good Requirements

– **Pre-trained** to detect 10 quality issues

1. Unclear actor or user
2. Compound requirement
3. Negative requirements
4. Escape clause
5. Missing units
6. Missing tolerances
7. Ambiguity
8. Passive
9. Incomplete requirements
10. Unspecific quantities



Identification and reasoning

The screenshot displays the Project Cambridge interface. On the left, a 'Mini Dashboard' widget provides a 'Welcome Watson to your Requirements Team' message and a 'Start over' button. Below this, 'Quality Scores: 0-100' are shown for two artifacts. The first artifact, '415: The GPS System shall show ...', has a score of 70 and is marked as 'Ambiguous Term' with the reasoning 'Look for: clear perspective'. The second artifact, '418: The GPS System shall use ...', also has a score of 70 and is marked as 'Unspecific quantity' with the reasoning 'Look for: minimum power'. The main panel shows a list of requirements, with items 415 and 418 highlighted in orange and checked. The background shows a detailed view of requirement 2103, '1.2.3 Follow Mode', which describes the ACC system's behavior when a forward vehicle is detected within a clearance distance.

ID	Contents
413	The GPS System shall clear the display and reduce current draw to less than 2 mA on transition to power off mode.
414	The GPS System shall show a clear perspective of the upcoming junction.
415	The GPS system shall show a clear perspective of the upcoming junction
416	The GPS System shall maintain the displayed user location for at least 500 milliseconds.
417	The GPS System shall update the user location at least every 100 milliseconds.
418	The GPS system shall use minimum power

- **Identifies exactly what's wrong** with the requirement
- **Displays the issue** to the requirements engineer

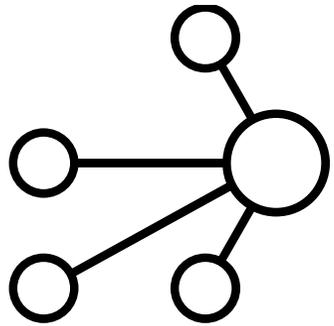
Learning and improving

The screenshot displays the Project Cambridge Mini Dashboard. On the left, a sidebar contains a welcome message, a 'Start over' button, and a 'Quality Scores: 0-100' section. Two artifacts are listed: '415: The GPS System shall show ...' with a score of 70 and '418: The GPS System shall use ...' with a score of 70. Both artifacts have a 'Teach Watson' button circled in red. The main area shows a table of artifacts with columns for ID and Contents. The table lists artifacts 413 through 418, with 415 and 418 checked. Below the table, a detailed view of artifact 415 is shown, including its ID (2098) and content: 'The GPS system shall show a clear perspective of the upcoming junction'. The interface also includes a navigation bar at the top with 'Project Dashboard', 'Artifacts', 'Reviews', and 'Reports'.

- **RQA learns** from the requirements engineer
- Becomes **“smarter” over time**
- But also the requirements engineer **learns from RQA** and becomes better in writing good requirements over time!

Our approach

Watson Services



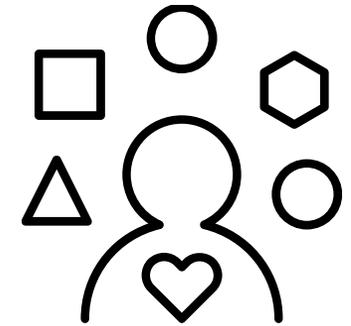
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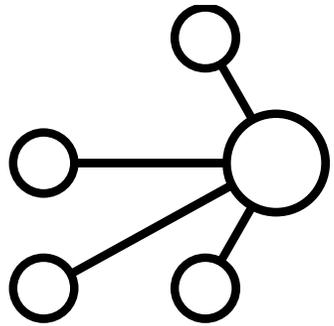


Customer Solution

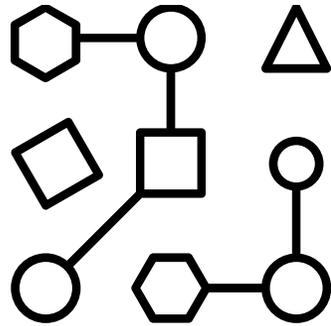


Our approach: *Pre-train Watson for you*

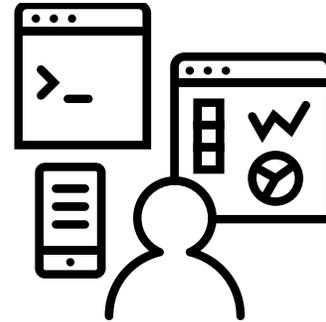
Watson Services



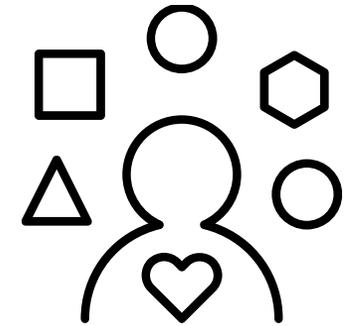
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Customer Solution



Watson Natural
Language
Understanding

Architecture and
pre-built NLP model

Requirements
Public Domain Data

IBM Requirements
Quality Assistant

DEMONSTRATION

Mini Dashboard

Project Cambridge

Welcome Watson to Your Requirements Team

When's the last time you didn't use spellcheck? Check the quality of 100's of requirements within seconds. Let Project Cambridge be the tool you don't know how you lived without.

Quality Scores (0 - 100)

All 5 artifacts checked

Check Again **Start Over**

- ▶ 420: On transition to power off mo 70
- ▶ 421: The System shall show a clear 80
- ▶ 422: The GPS System shall display t 100
- ▶ 423: The GPS System shall maintain 100
- ▶ 424: The GPS System shall updat... 100

← | Project Cambridge Demos > | 419 System Requirements ?

> | **Create** ▾ | Type to filter by text or by ID +

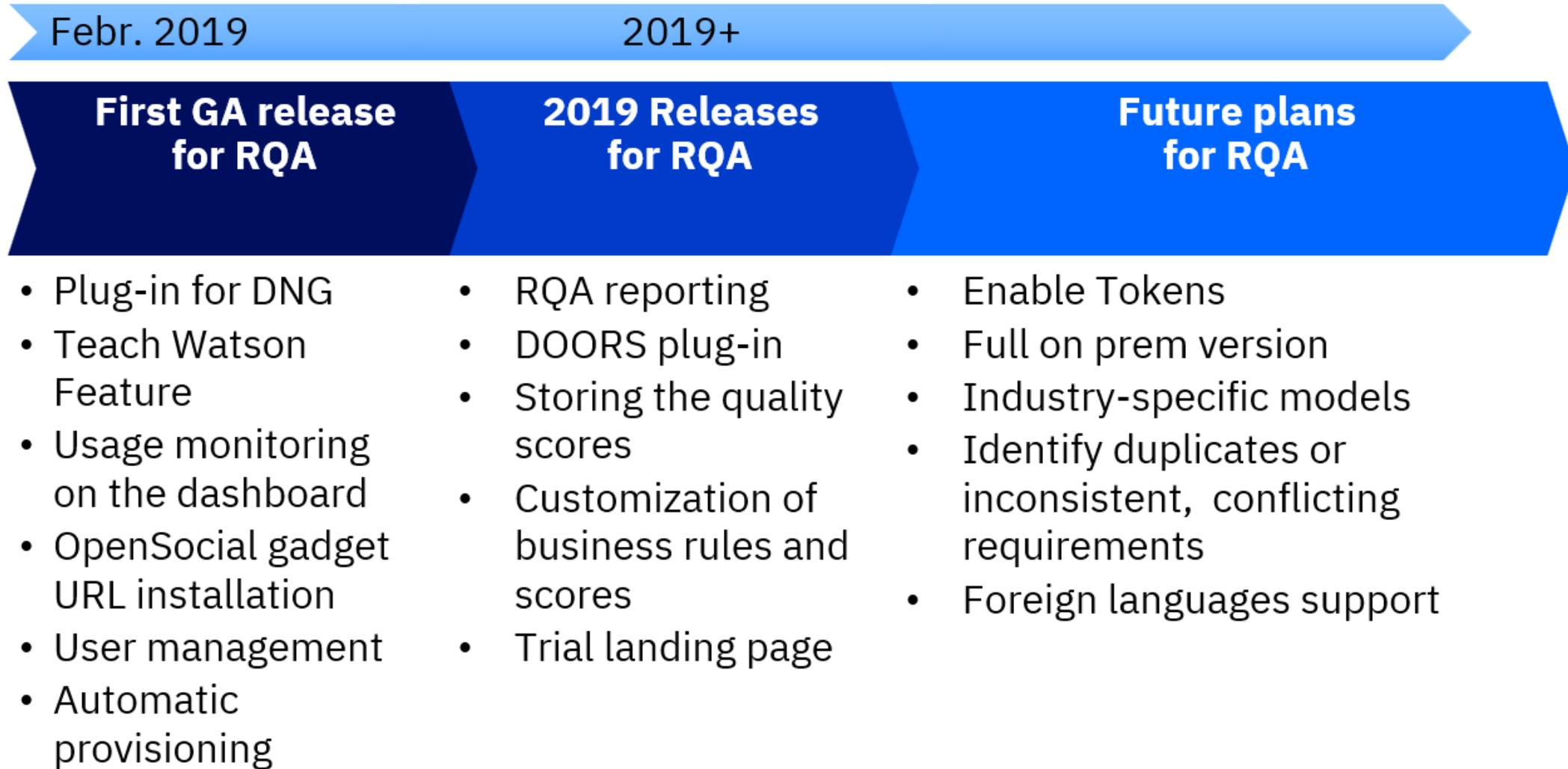
	ID	Contents
<input type="checkbox"/>	420	On transition to power off mode, the GPS System shall clear the display and reduce current draw to less than 2 mA
<input type="checkbox"/>	421	The System shall show a clear perspective of the upcoming junction.
<input type="checkbox"/>	422	The GPS System shall display the user location.
<input type="checkbox"/>	423	The GPS System shall maintain the displayed user location for at least 500 milliseconds.
<input type="checkbox"/>	424	The GPS System shall update the user location at least every 100 milliseconds.



<https://www.youtube.com/watch?v=RcKVxWjWFF8>

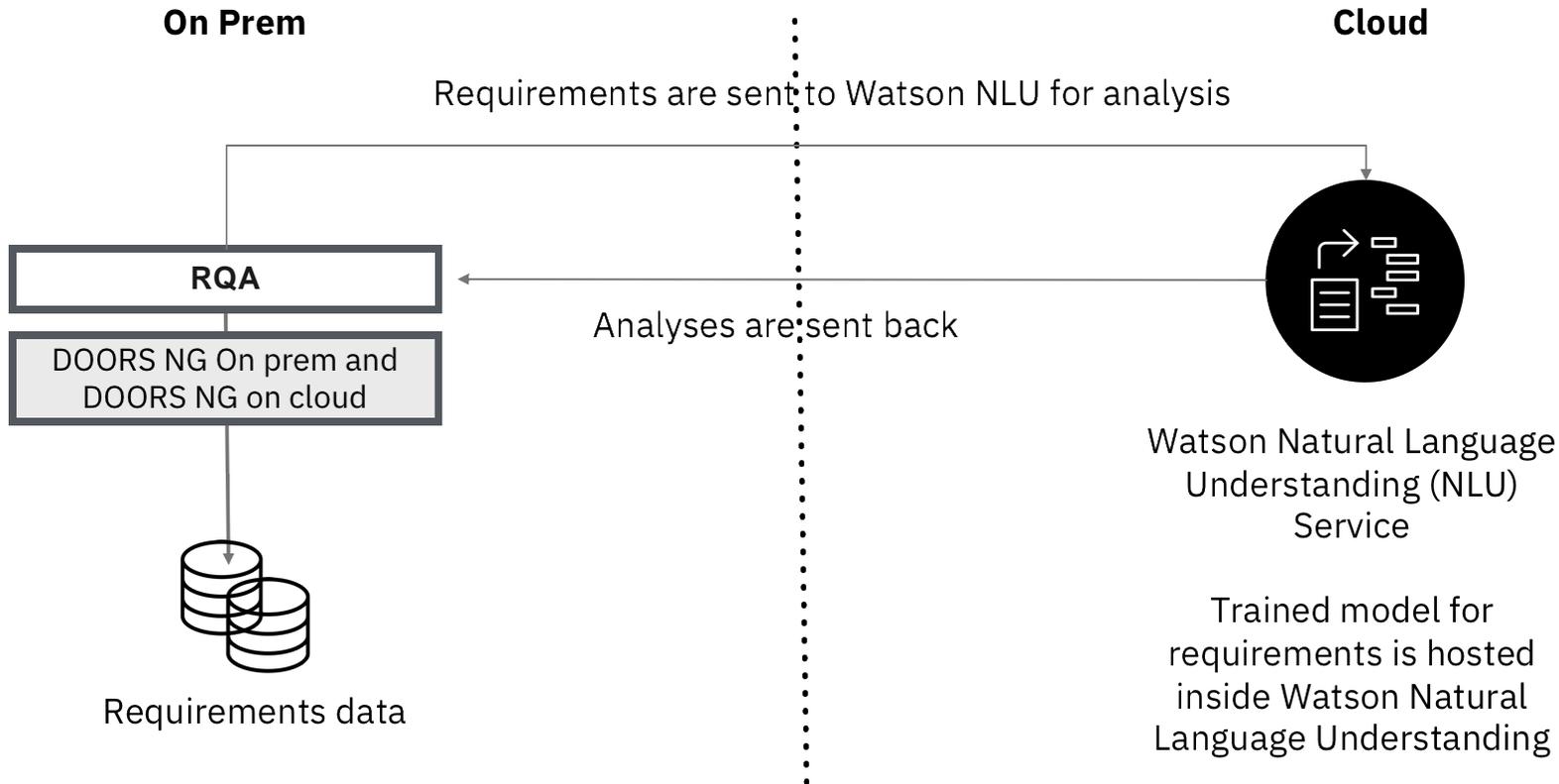
ROADMAP

RQA Roadmap



ARCHITECTURE

Current simplified architecture (Hybrid)



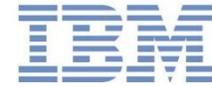
- ✓ Offering works with DOORS NG on prem **and** DOORS NG on cloud
- ✓ Plugin is installed locally and is the customer's channel to the cloud components
- ✓ Requirements are passed through Watson NLU... **not stored in the cloud (Stateless)**

QUESTIONS ?

FRAGEN ?

Contact

Danke für Ihre
Aufmerksamkeit!



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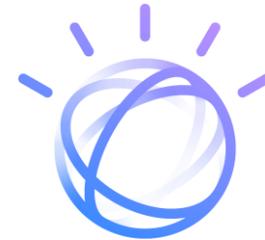


Code reader download (recom. Android: QR Droid, BeeTagg / iPhone: Qrafter, i-nigma)
Code scanning, contact store directly

Thank you, for
your attention!

Additional Resources 1/2:

- **IBM Requirements Quality Assistant (RQA)**
 - <https://www.ibm.com/us-en/marketplace/requirements-quality-assistant>
 - <https://www-01.ibm.com/common/ssi/cgi-bin/ssialias?infotype=an&subtype=ca&appname=gpateam&supplier=897&letternum=ENUS218-353>
 - http://www-01.ibm.com/common/ssi/ShowDoc.wss?docURL=/common/ssi/rep_sm/2/649/ENUS5900-A32/index.html&lang=en&request_locale=en
 - Video: <https://www.youtube.com/watch?v=RcKVxWjWFF8>
 - Documentation: https://www.ibm.com/support/knowledgecenter/SS3UPN/com.ibm.help.rm.assist.doc/helpindex_rm_assistant.html
- **IBM Watson**
 - <https://www.ibm.com/watson/>
 - <https://www.ibm.com/watson/de-de/>
 - <https://www.youtube.com/watch?v=Xcmh1LOB9I>
 - <https://www.youtube.com/watch?v=P18EdAKuC1U>
 - <https://www.industry-of-things.de/was-watson-kann-und-was-nicht-a-672872/>
 - [https://en.wikipedia.org/wiki/Watson_\(computer\)](https://en.wikipedia.org/wiki/Watson_(computer))
 - [https://de.wikipedia.org/wiki/Watson_\(K%C3%BCnstliche_Intelligenz\)](https://de.wikipedia.org/wiki/Watson_(K%C3%BCnstliche_Intelligenz))
- **This is AI, presented by IBM - Discovery Channel Videos (Part 1-4) on YouTube:**
 - <https://www.youtube.com/watch?v=H3P87qCdqk4>
 - <https://www.youtube.com/watch?v=Krqy-Eso3a8>
 - <https://www.youtube.com/watch?v=EOuehCrPMIU>
 - <https://www.youtube.com/watch?v=EJEvwghTJw>
- **Don't fear superintelligent AI - Grady Booch (IBM)**
 - <https://www.youtube.com/watch?v=z0HsPBKfhoI>
- **IBM DOORS Next Generation**
 - <https://jazz.net/products/rational-doors-next-generation/>
- **IBM Continuous Engineering Webinars (free)**
 - <https://www.gotostage.com/channel/ibm>
- **IBM Continuous Engineering Product Previews (free)**
 - <https://jazz.net/previews/>
- **IBM Continuous Engineering**
 - <https://jazz.net/products/continuous-engineering-solution/>
 - <https://www.ibm.com/internet-of-things/learn/continuous-engineering-IoT/>
 - <https://www.ibm.com/internet-of-things/solutions/systems-engineering>
 - <https://www.ibm.com/us-en/marketplace/engineering-solutions-on-cloud>



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Additional Resources 2/2:

- **Cognitive Computing / Augmented Intelligence**
 - <https://www.youtube.com/watch?v=j98rY3vhPhE>
 - <https://www.youtube.com/watch?v=wuvBMAyNqeQ>
- **Studie bzgl. Einschätzung von Künstlicher Intelligenz in Deutschland**
 - <https://yougov.de/news/2018/09/11/kunstliche-intelligenz-deutsche-sehen-eher-die-ris/>
 - <https://www.heise.de/newsticker/meldung/Kuenstliche-Intelligenz-Deutsche-sehen-mehrheitlich-Risiken-4160306.html>
- **Zwischen Alarmismus und Utopie. Von der Zukunft der Arbeit im Zeitalter der Digitalisierung, BR2 Podcast**
 - <https://www.br.de/mediathek/podcast/radioreportage/zwischen-alarmismus-und-utopie-von-der-zukunft-der-arbeit-im-zeitalter-der-digitalisierung-1/1388240>
- **Künstliche Intelligenz: Wie Deutschland seinen Wohlstand aufs Spiel setzt, report München, Doku**
 - <https://www.youtube.com/watch?v=mlk5qGFLri8>
- **Doku über künstliche Intelligenz - Frag deinen Kühlschrank, ARD-alpha, 21.01.2019, 20:15 Uhr, 44 Min.**
 - <https://www.br.de/mediathek/video/doku-ueber-kuenstliche-intelligenz-frag-deinen-kuehlschrank-av:5c0824160383f0001c0fa1ec>
- **Wie Künstliche Intelligenz deutsche Unternehmen prägt, 11.03.2019**
 - <https://www.ibusiness.de/aktuell/db/292804SUR.html>
- **KI Strategie der Bundesregierung**
 - <https://www.bundesregierung.de/breg-de/themen/digital-made-in-de/ki-als-markenzeichen-fuer-deutschland-1549732>
 - <https://t3n.de/news/laut-ki-forscher-setzt-die-bundesregierung-auf-veraltete-konzepte-1149442/>
 - <https://www.boell.de/de/2019/01/28/kuenstliche-intelligenz-schlusslicht-oder-weltspitze-der-ki-standort-deutschland>

IBM „For Dummies“ eBooks (free download):

