Auswirkungen der Digitalisierung auf Betriebspersonale und betriebliche Regelwerke

RENATO RODRIGUES
CAPGEMINI ENGINEERING

CAPGEMINI GROUP
&
CAPGEMINI ENGINEERING

CAPGEMINI PROVIDES END-TO-END CONSULTING, IT, ENGINEERING AND OPERATIONS SERVICES WITH ~360,000 EXPERTS GLOBALLY

KEY FINANCIALS (2022)

Revenue	Operating Margin	Manufacturing Sector Revenue
€22 billion	12.9%	25%
▲ +15.1% YoY	▲ +1.0pt YoY	▲ +25.0% YoY

GLOBAL PRESENCE

Headcount
(58% Offshore)
360,000
▲ +20% YoY

Europe
110.305

North America
24.753

Latin America
12.306

Asia-Pacific
205.317

Middle East and Africa
5.360
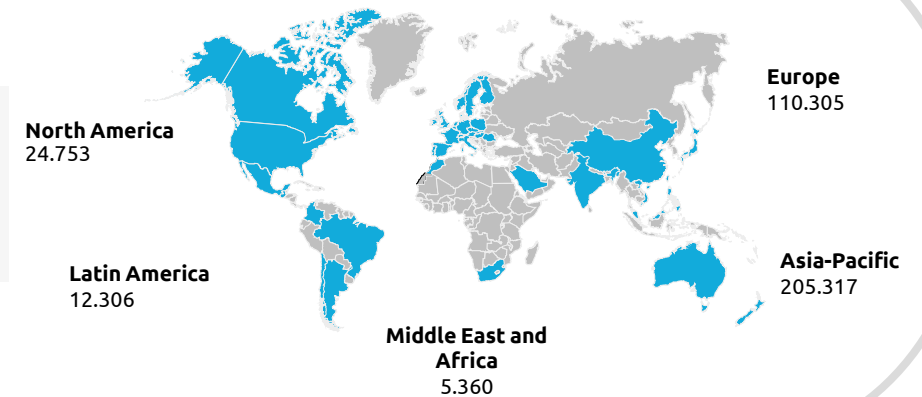
2022 REVENUE BY BUSINESS

7%
31%
62%
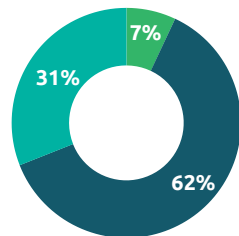
- ■ Application and Technology
- ■ Operations and Engineering Services
- ■ Strategy and Transformation

2022 REVENUE BY REGION

8%
31%
11%
21%
29%
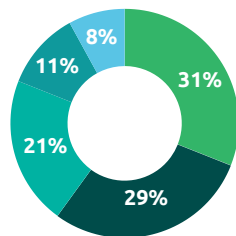
- ■ UK and Ireland
- ■ France
- ■ North America
- ■ Rest of Europe
- ■ APAC and LATAM

3 playing fields

1
2
3 Customer First
4 Intelligent Industry
5 Enterprise Management

Data
Cloud

2 pillars
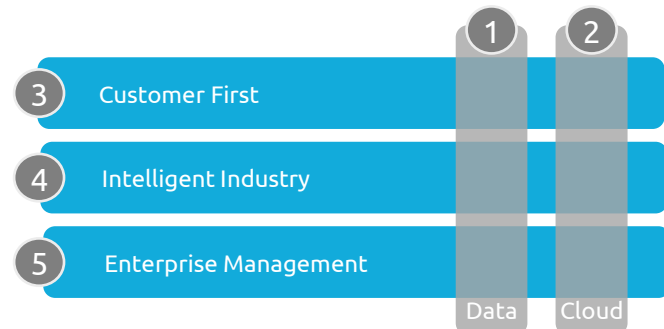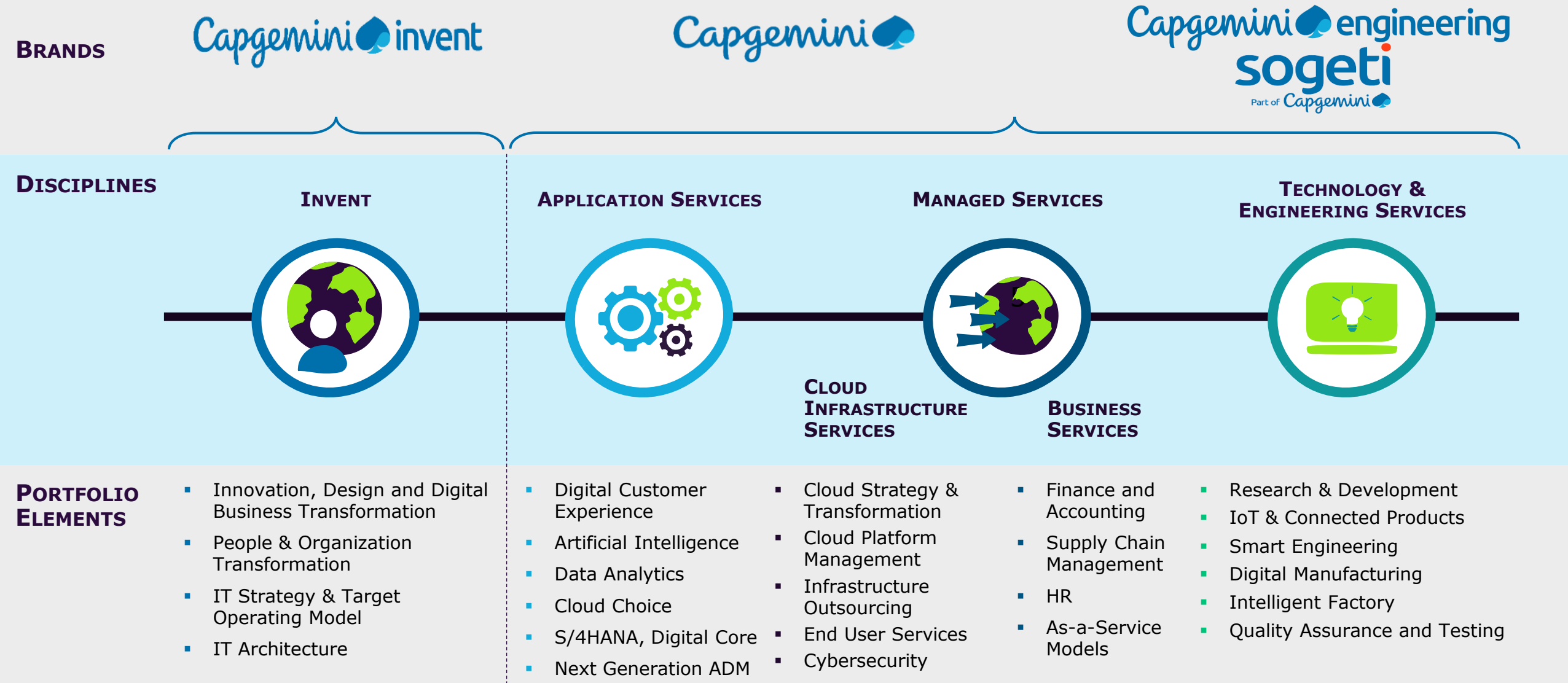
Cybersecurity

Sustainability

The Capgemini Group's portfolio delivers leading digital assets and deep end-to-end capabilities

BRANDS

Capgemini invent

Capgemini

Capgemini engineering
sogeti
Part of Capgemini

DISCIPLINES

INVENT	APPLICATION SERVICES	MANAGED SERVICES	TECHNOLOGY & ENGINEERING SERVICES

CLOUD INFRASTRUCTURE SERVICES

BUSINESS SERVICES

PORTFOLIO ELEMENTS

▪ Innovation, Design and Digital Business Transformation	▪ Digital Customer Experience	▪ Cloud Strategy & Transformation	▪ Finance and Accounting	▪ Research & Development
▪ People & Organization Transformation	▪ Artificial Intelligence	▪ Cloud Platform Management	▪ Supply Chain Management	▪ IoT & Connected Products
▪ IT Strategy & Target Operating Model	▪ Data Analytics	▪ Infrastructure Outsourcing	▪ HR	▪ Smart Engineering
▪ IT Architecture	▪ Cloud Choice	▪ End User Services	▪ As-a-Service Models	▪ Digital Manufacturing
	▪ S/4HANA, Digital Core	▪ Cybersecurity		▪ Intelligent Factory
	▪ Next Generation ADM			▪ Quality Assurance and Testing

Capgemini engineering

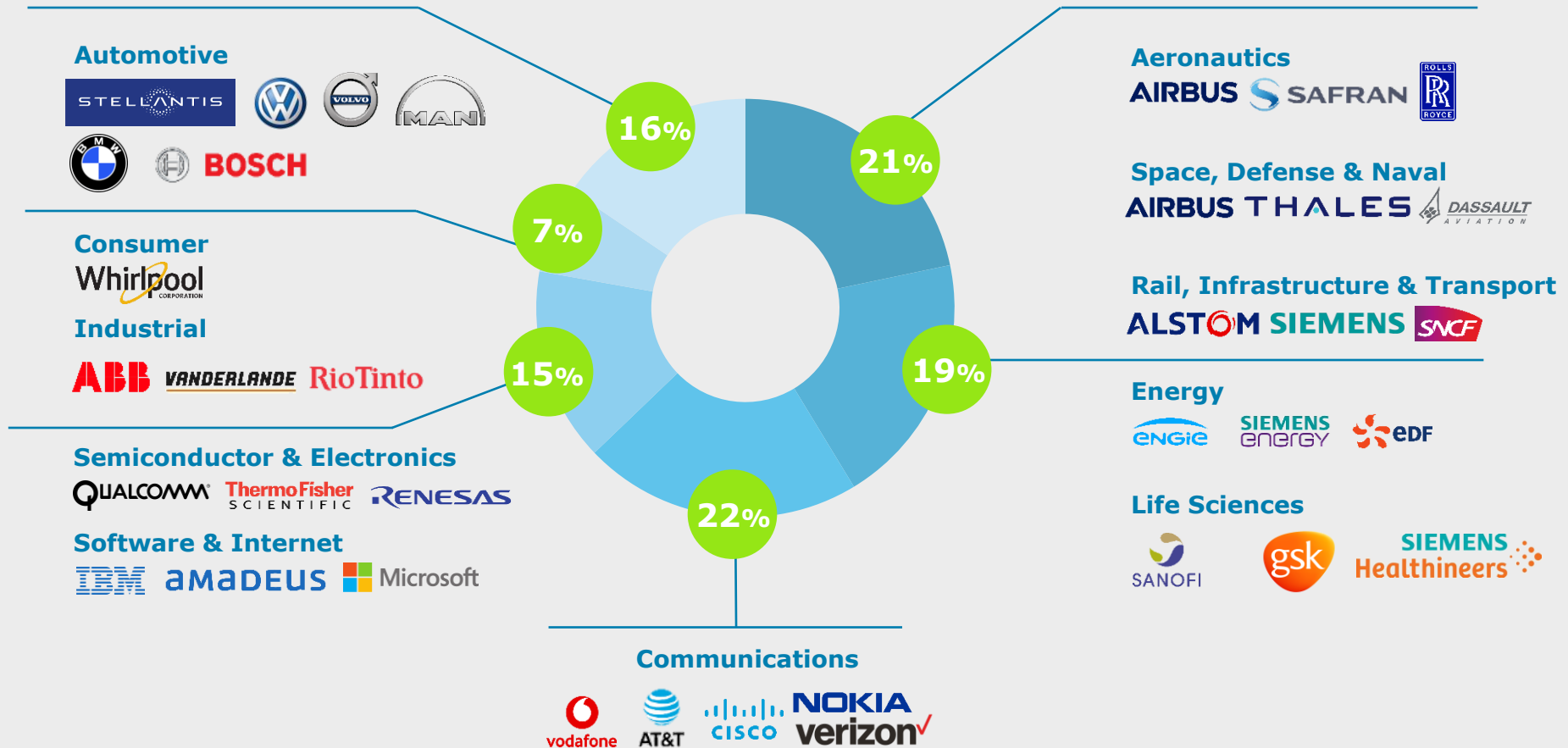## WE ARE A LONG STANDING PARTNER TO INNOVATION LEADERS **ACROSS INDUSTRIES**

30+
years expertise in product engineering

Ranked as strategic partner by

50+ clients

2/3rd
Of the top 500 global R&D spenders are clients

Automotive
STELLANTIS · VW · VOLVO · MAN · BMW · BOSCH

Consumer
Whirlpool Corporation

Industrial
ABB · VANDERLANDE · RioTinto

Semiconductor & Electronics
QUALCOMM · Thermo Fisher SCIENTIFIC · RENESAS

Software & Internet
IBM · AMADEUS · Microsoft

Communications
vodafone · AT&T · CISCO · NOKIA · verizon

Aeronautics
AIRBUS · SAFRAN · ROLLS ROYCE

Space, Defense & Naval
AIRBUS · THALES · DASSAULT AVIATION

Rail, Infrastructure & Transport
ALSTOM · SIEMENS · SNCF

Energy
ENGIE · SIEMENS energy · eDF

Life Sciences
SANOFI · gsk · SIEMENS Healthineers

Pie chart values: 16% · 21% · 7% · 19% · 15% · 22%

CAPGEMINI ENGINEERING

RAILWAY SECTOR OVERVIEW

Established presence in Railway

35+ years

Leadership in engineering and R&D services

....

5,000+

Headcount
IT & Engineering

We have strong & successful partnerships across the Railway ecosystem

Manufacturers

HITACHI Inspire the Next
ALSTOM (& BOMBARDIER)
SIEMENS
KNORR-BREMSE
BNSF RAILWAY
THALES
Talgo
CAF
Wabtec CORPORATION

Infrastructure Providers & Operators

RATP
SNCF
västtrafik
NetworkRail
TMB Transports Metropolitans de Barcelona
UNDERGROUND
renfe
NSW Transport RailCorp
ProRail
NATS
TRAFIKVERKET
DB
COMBOIOS DE PORTUGAL
adif
SBB CFF FFS
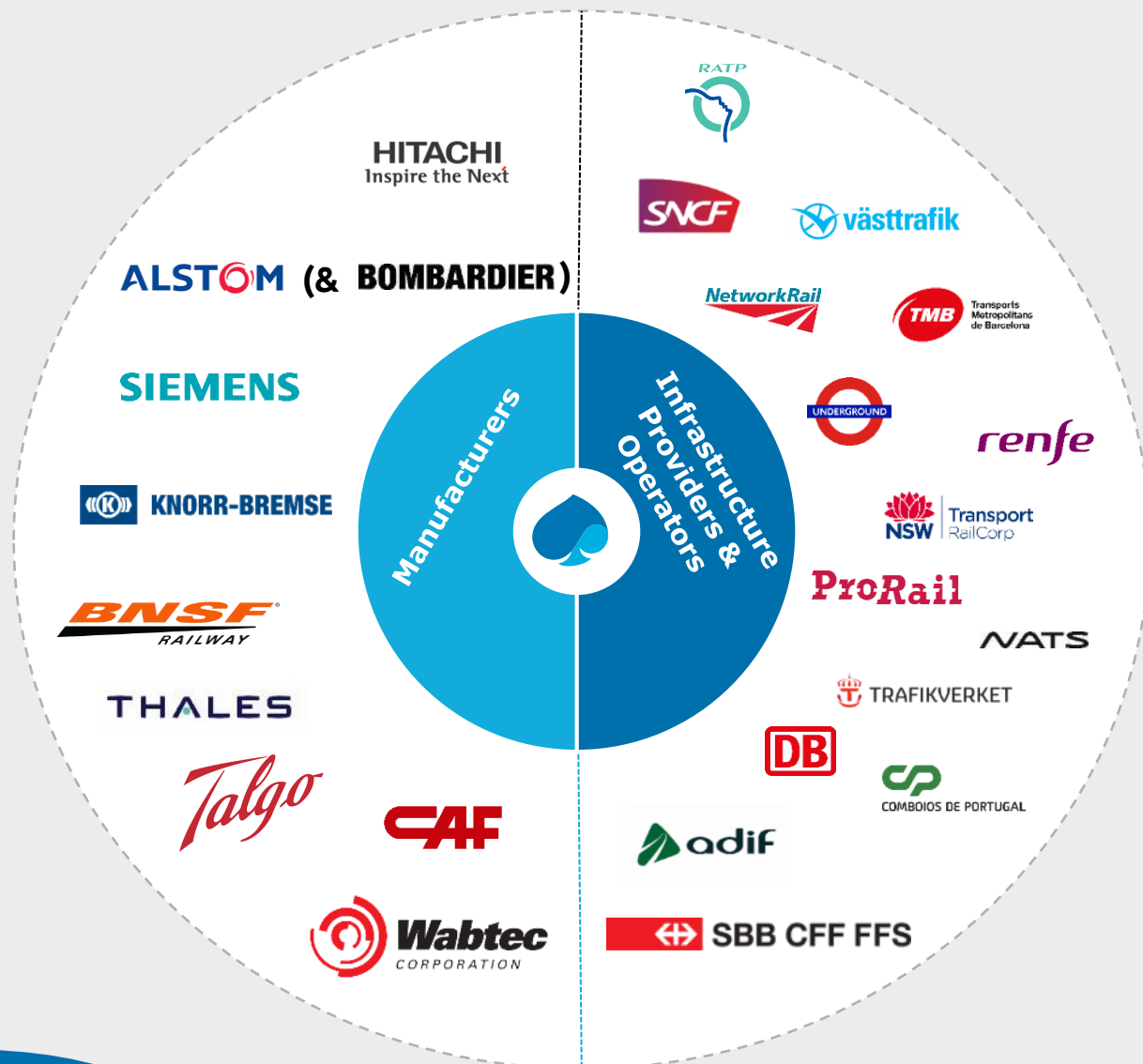
THE RAILWAY offering portfolio
For Manufacturers, Infrastructure Providers & Operators

PRODUCT		OPERATIONS & SERVICES		
01	**02**	**03**	**04**	**05**
Optimized Engineering for Rolling Stock	**Control Command & Signalling Systems**	**Next-Gen Infrastructure & Traffic Management**	**Intelligent Manufacturing & Supply Chain**	**Intelligent Support & Services**
Embracing Rolling Stock full lifecycle, from Design and Verification & Validation up to Test & Commissioning	**Development and integration of critical, autonomous control & command systems**	**Advanced systems, tools and process to monitor the infrastructures & traffic**	**Advanced tools and processes to embrace the Industry 4.0 revolution**	**Services for better long-term efficiency**
▪ Design-To-X ▪ Managed Test Services (V&V- T&C) ▪ Decarbonization (H2 – battery)	▪ End-to-End Critical Software Engineering ▪ Autonomous Train	▪ Supervision & Monitoring systems ▪ Operation Control Center (OCC)	▪ Smart Factory for Rolling Stock ▪ Intelligent Supply Chain	▪ Digital Technical publications ▪ Signalling Software maintenance ▪ Railway Academy

TECHNOLOGIES

06

Digital Enablers for Railway - Next generation digital solutions to address railway challenges at scale

- Digital Continuity (Digital Twin / Product Lifecycle Management)
- Transition to 5G for Rail (Future Railway Mobile Communication System)
- Advanced Analytics & Artificial Intelligence for predictive maintenance solutions

DIGITALISATION & OPERATIONS

RENATO RODRIGUES
CAPGEMINI ENGINEERING

1. **EVOLUTION OF SIGNALLERS' ROLE**

2. **DISPATCHERS AND MITIGATION OF CASCADING DELAYS**

3. **TRAIN DRIVERS**

4. **FUTURE FOR OPERATIONAL STAFF**

5. **INCREASING COMPLEXITY IN THE SYSTEM?**

6. **OPERATIONAL RULES & HARMONISATION**

„ORKAN"
STORY

EVOLUTION OF SIGNALLERS' ROLE (FAHRDIENSTLEITER)

1 TECHNICAL EVOLUTION OF INTERLOCKINGS
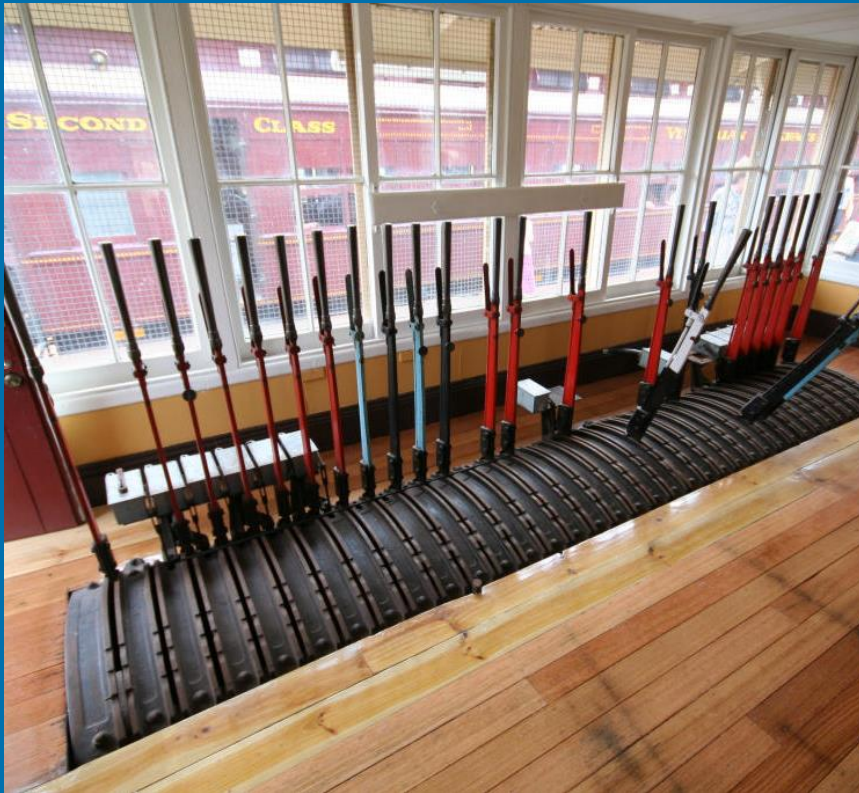
1 Technical evolution of interlockings

Credit: Signalhead
Source: Wikipedia

Credit: Plutowiki
Source: Wikipedia

1. Harmonisation of HMI

1. THREE MAIN PILLARS OF CHANGE FOR SIGNALLERS

levers & wire -> copper wire -> fiber optics

Larger control areas: < 100m   < 10 km   unlimited

Fully manual -> intervention in delays and degraded operation

Harmonisation –> One harmonised HMI nationwide

1. Signaller automation

- No known project for complete signaller automation

- Potential for automating some voice communication

Agenda

2

DISPATCHERS AND CASCADING DELAYS (DISPONENTEN)

Epilogue of „Orkan" story

2.1 Cascading delays - Dispatcher's role

02:48 - An incident near Cheltenham closes the line

Source: Network Rail
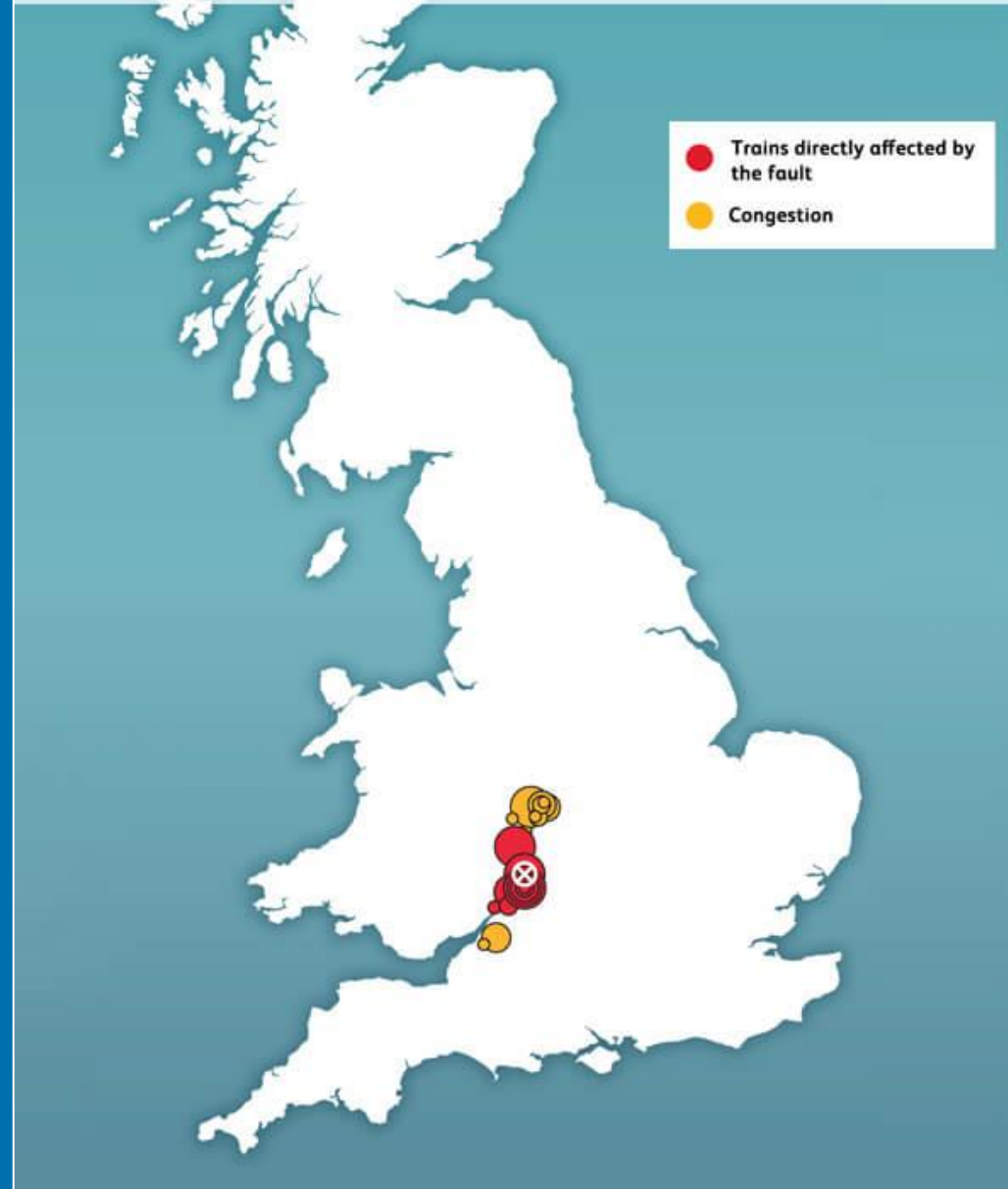
15:18 - 12 hours after the incident, much of the network is affected
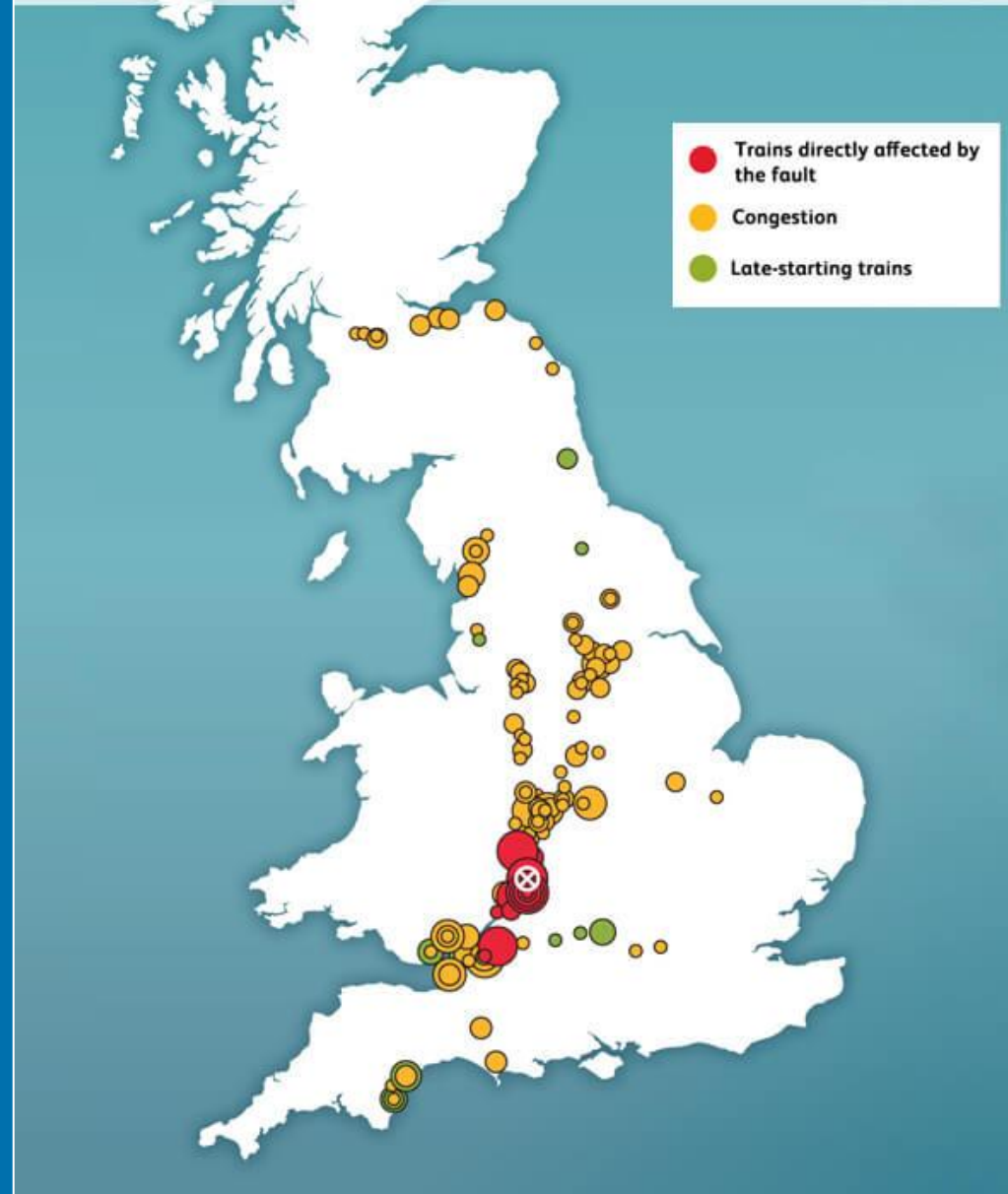
Trains directly affected by the fault

Congestion

Late-starting trains

22:48 - 20 hours on and the effects are being felt across the country

Trains directly affected by the fault
Congestion
Late-starting trains

22:48 - 20 hours on and the effects are being felt across the country

Legend:
- Trains directly affected by the fault (red)
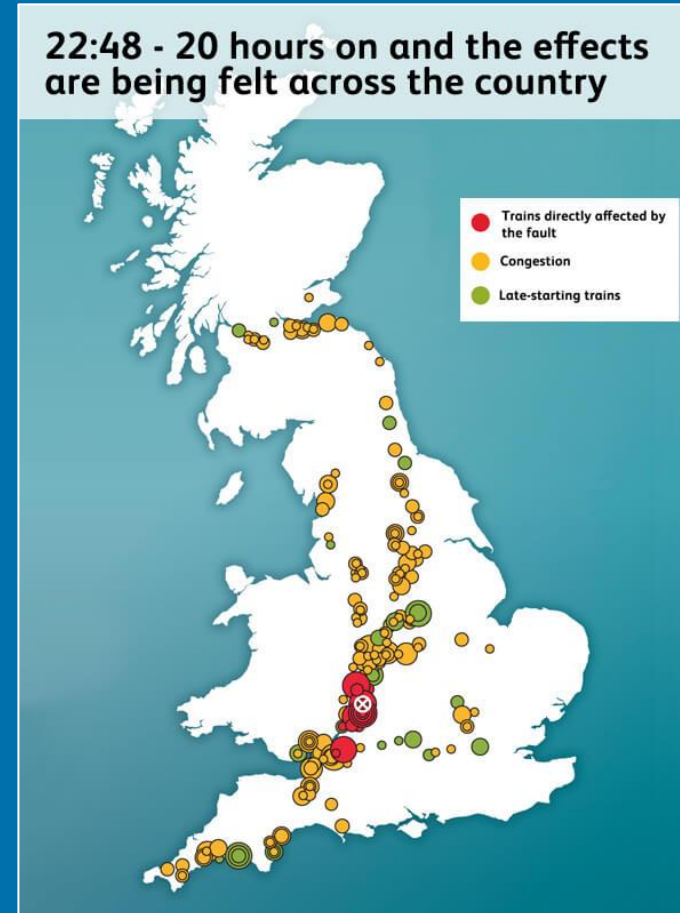- Congestion (yellow)
- Late-starting trains (green)
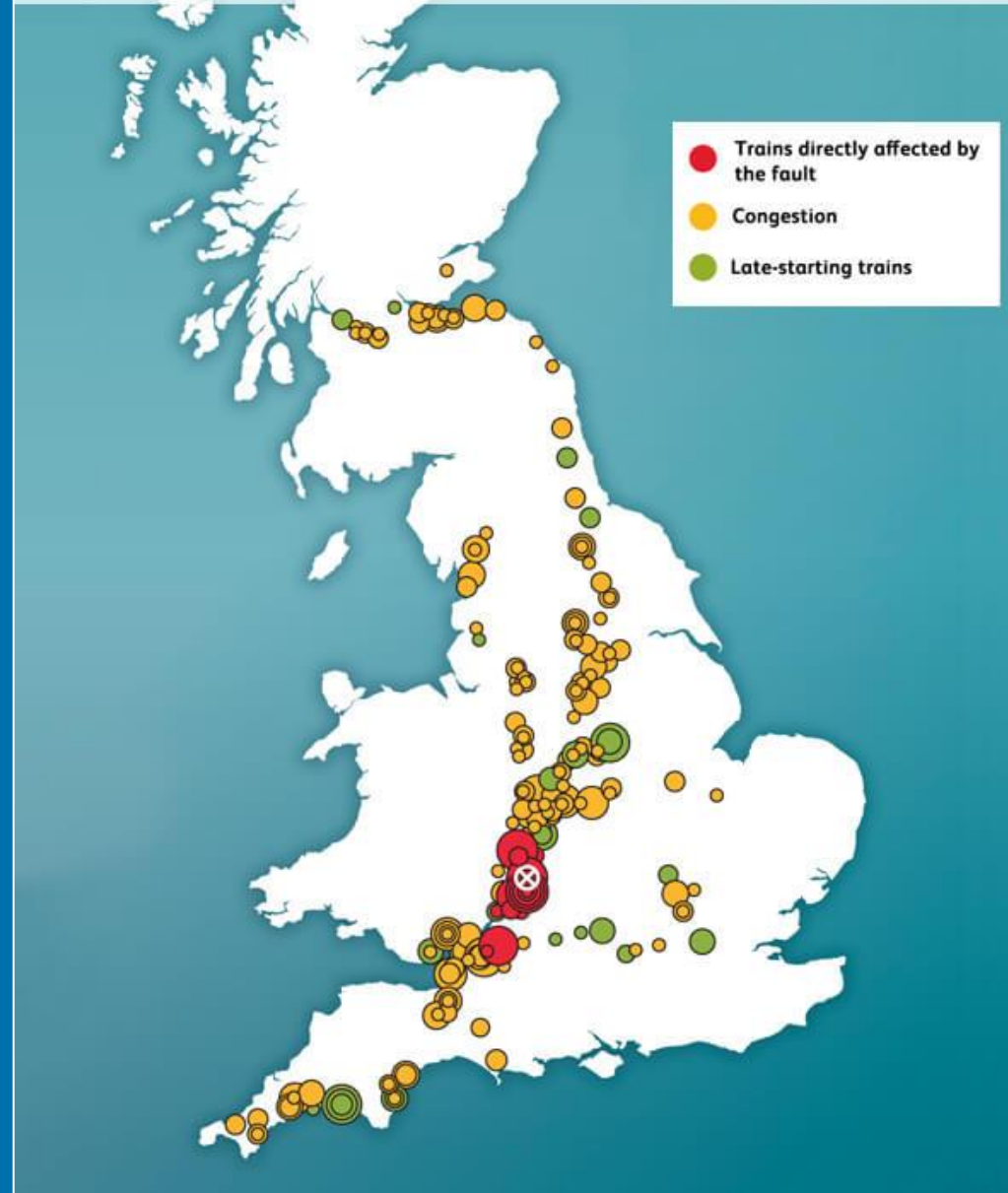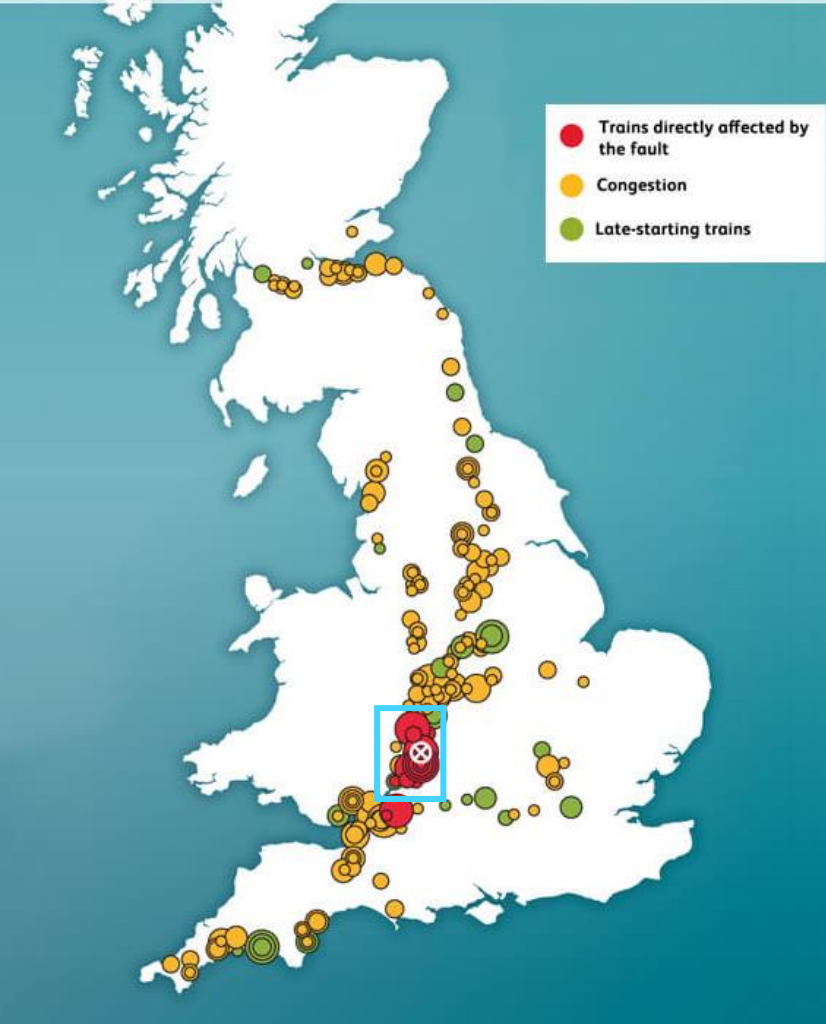
2 CASCADING DELAYS – HUMAN DISPATCHERS

- "Small" area of responsibility - < 100 km of tracks
- Experience - Consider only relevant options:
  - Usual platforms
  - Usual routes
  - Feedback from the past
- Apply rules of priority by train type: intercity, urban, freight, …

2 Cascading delays – automation

- There has been research of this problem in operations research for many years with limited success:
  - Larger areas of calculation lead to NP-hard problems
  - Use of heuristics and other methods to reduce computing time
  - Decisions need to be quick – in minutes or < 1m
  - Decision to be trusted by dispatchers (Disponenten)

- Only a few traffic management systems employ automated conflict detection & advisory systems for conflict solution, e.g. RCS by SBB

- Use of Artificial Intelligence is being tested but considered immature
  - Using deep learning or reinforcement learning – same technology as used by Google for the boardgame Go
  - BUT Some optimism at DSD@DB for using AI in production in the next decade

22:48 - 20 hours on and the effects are being felt across the country

- Trains directly affected by the fault
- Congestion
- Late-starting trains

2. Two main pillars of change for dispatchers

Partial automation -> conflict detection & passenger information

Harmonisation –> One modern harmonised HMI nationwide

2. AI & role of dispatchers

- If the purpose of using algorithms is making more complex decisions

- If humans are still involved in the decisions (very likely)

- Need to re-design how information is presented

2. NOWADAYS – TRAIN DIAGRAM

Zeitachse

Agenda

3

TRAIN DRIVERS

3. Train driver's role

3. ETCS ROLL-OUT

3. ATO GoA2

Agenda

1. **Evolution of signallers' role**

2. **Dispatchers and mitigation of cascading delays**

3. **Train drivers**

4. **Increasing complexity in the system?**

5. **Operational rules & harmonisation**

6. **Future for operational staff**
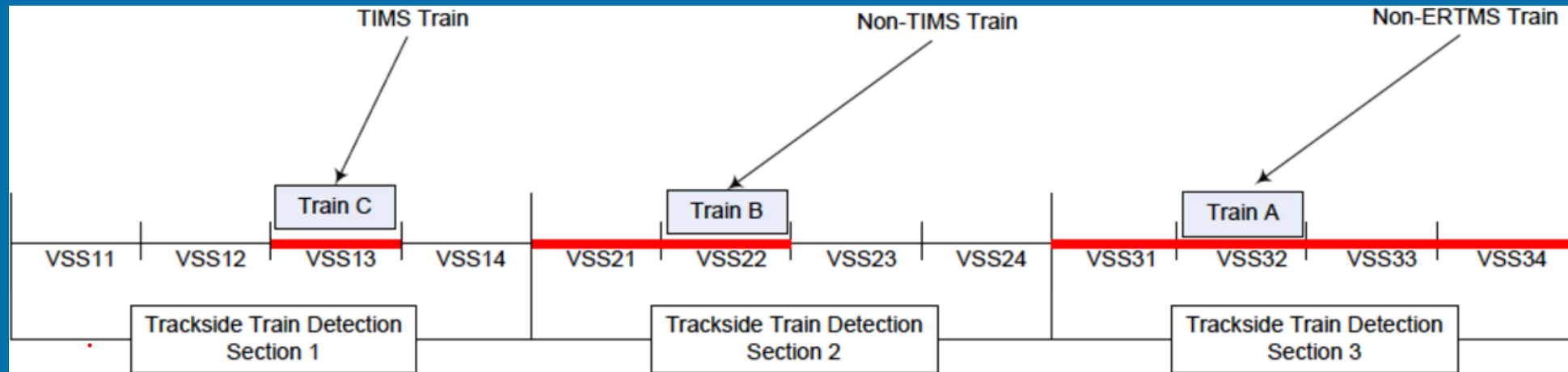
4

INCREASING COMPLEXITY IN THE SYSTEM?

4. FEATURE MIX

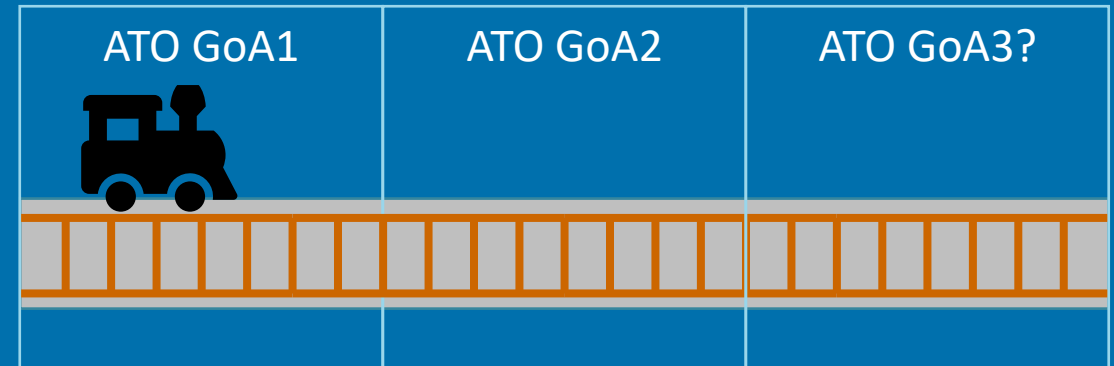| Features	Mandatory?
ETCS radio-based (no light signals)	Yes
Driver advisory	Optional
ATO GoA 2 / GoA 3 / GoA 4	Optional
Trackside train detection (Achszähler)	Optional
Automated coupling	Optional
Onboard train integrity	Optional
Onboard positioning	Optional

4. Mix of trains with/out TIMS (onboard integrity)

4. ROUTES WITH DIFFERENT ATO LEVELS

ATO GoA1	ATO GoA2	ATO GoA3?

4. FEATURE MIX

Features	Mandatory?
ETCS radio-based (no light signals)	Yes
Driver advisory	Optional
ATO GoA 2 / GoA 3 / GoA 4	Optional
Trackside train detection (Achszähler)	Optional
Automated coupling	Optional
Onboard train integrity	Optional
Onboard positioning	Optional

4. View of Toshiba PC desktop

4. VIEW OF DELL PC DESKTOP

4. View of Lenovo PC desktop

4.
TECHNICAL DIVERSITY AND PROBLEMS FOR OPERATIONAL STAFF

No standard interfaces - migration from GSM-R to modern communications (FRMCS) – mostly not an operational issue

…

Different HMI

Different procedures

Different training

4. ETCS Driver HMI – Moving Block

4. ETCS Driver HMI – Fixed Block

Agenda

5

OPERATIONAL RULES & HARMONISATION

5. Jungle of ETCS implementations

Ambiguous TSI – defective level crossing

Fully manual

France: ETCS FS mode + HMI icon + Slow down

Italy: ETCS On Sight mode (Fahren auf Sicht) + Slow down

Czechia: GoA2 + TSR (speed restriction)

5. IDEAS FOR THE FUTURE

Operational Needs:
Look for obstacles at
the level crossing

Fully
manual

Harmonised
Implementation A
Human lok driver

5. IDEAS FOR THE FUTURE

Operational Needs:
Look for obstacles at
the level crossing

Harmonised
Implementation A
Human lok driver

Harmonised
Implementation B
Partial automation

Harmonised
Implementation C
Fully automated

Country
x

Country
y

Country
z

Country
w

5. Barriers for interoperability

- Insufficient rollout of ETCS (weak business case)

- Non-harmonised operations for ETCS L2
  - E.g. Defective level crossing
  - Frequent use of voice communication & No use of English
    - need to learn national language to B1 level - Even for reaching the next station across the border, e.g PT <-> ES

Agenda

1. EVOLUTION OF SIGNALLERS' ROLE

2. DISPATCHERS AND MITIGATION OF CASCADING DELAYS

3. TRAIN DRIVERS

4. INCREASING COMPLEXITY IN THE SYSTEM?

5. OPERATIONAL RULES & HARMONISATION

6. FUTURE FOR OPERATIONAL STAFF

6

FUTURE FOR
OPERATIONAL STAFF

6. Advantages of automation

- Mitigates demographic problem

- Increased flexibility
    - Control from anywhere
    - Standardised HMIs & training
    - Less need for driver route knowledge

- Higher productivity and lower OpEx (operational costs)
    - Reduced number of locations (1500 -> 100)
    - Each operational staff oversees larger areas

6. FUTURE OF WORK FOR OPERATIONAL STAFF

Role	Coming changes	How certain?
Signallers / Fahrdienstleiter	• Standard HMI -> can control any area • DSTW/ESTW increases productivity	DSD deployment of DSTW + ETCS L2oS
Dispatchers / Disponenten	• Standard HMI -> can oversee any area • Some decision support	PRISMA introduction in Sep 2024
Train drivers	• Simplification of rule book • Partial job harmonisation EU-wide	Ril 400 Roll-out of ETCS L2oS

6. Future of work for operational staff

Role	More distant future - speculative
Signallers	• Reduction of voice communication - automation • Work also in English • IT support for less common procedures and situations
Dispatchers	• AI/Reinforcement learning -> larger supervision areas • Increased automation
Train drivers	• Reduction of voice communication - automation • Work also in English • IT support for less common procedures and situations • Widespread ATO GoA2?

6. Reasons to continue automating

- Demographics
    - Problem to recruit operational staff -> requires higher productivity
    - Europe-wide harmonisation -> single market for operational staff

- Increase competitiveness
    - Railway competitiveness has stagnated
    - ticket prices are not competitive
    - Strong competition from other sectors

- Partial automation:
    - Swings between reduced workload in normal situations and extreme workload in degraded situations
        - Can Lead to distractions
    - Loss of skills, examples from other sectors, e.g. Air France 447 Rio - Paris

Capgemini engineering

Renato Rodrigues
Capgemini Engineering

Mobile: +49 (0)173 1714087
Linkedin: www.linkedin.com/in/renato-rodrigues-343223b/

About Capgemini Engineering

Capgemini Engineering combines, under one brand, a unique set of strengths from across the Capgemini Group: the world leading engineering and R&D services of Altran – acquired by Capgemini in 2020 - and Capgemini's digital manufacturing expertise. With broad industry knowledge and cutting-edge technologies in digital and software, Capgemini Engineering supports the convergence of the physical and digital worlds. It helps its clients unleash the potential of R&D, a key component of accelerating their journey towards Intelligent Industry. Capgemini Engineering has more than 52,000 engineer and scientist team members in over 30 countries across sectors including aeronautics, space and defense, automotive, railway, communications, energy, life sciences, semiconductors, software & internet and consumer products.

Learn more at

www.capgemini-engineering.com