FROM SPECTRUM TO QOE

…UPWARDS INTO THE 3RD DIMENSION IN SPACE

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ROHDE&SCHWARZ
Make ideas real

From a two-man lab to a privately owned global company

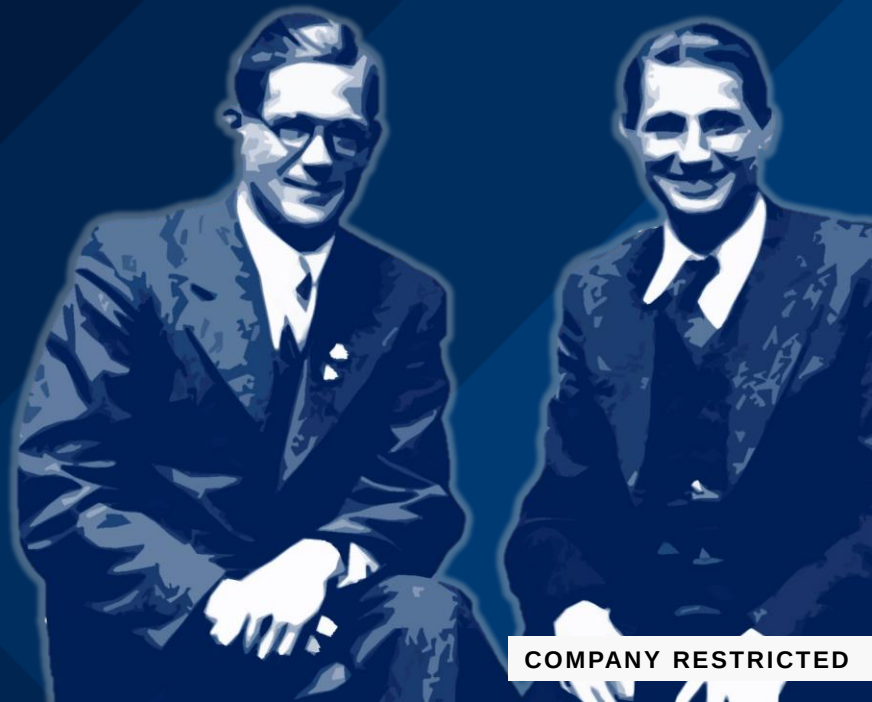
90 years
of success

€ 4.2 Bn
Net revenue BY 22/23

>14500
employees

15% of turnover
to be invested in R&D

>2 700
patents



One company - three divisions - diverse markets

We are a reliable technology partner

TEST & MEASUREMENT

Wireless I Industry, Components & Research I Aerospace & Defense Testing I Automotive

TECHNOLOGY SYSTEMS

Secure Communications I Critical Infrastructure & Networks I Government I IP Network Analytics I Broadcast, Amplifiers & Media

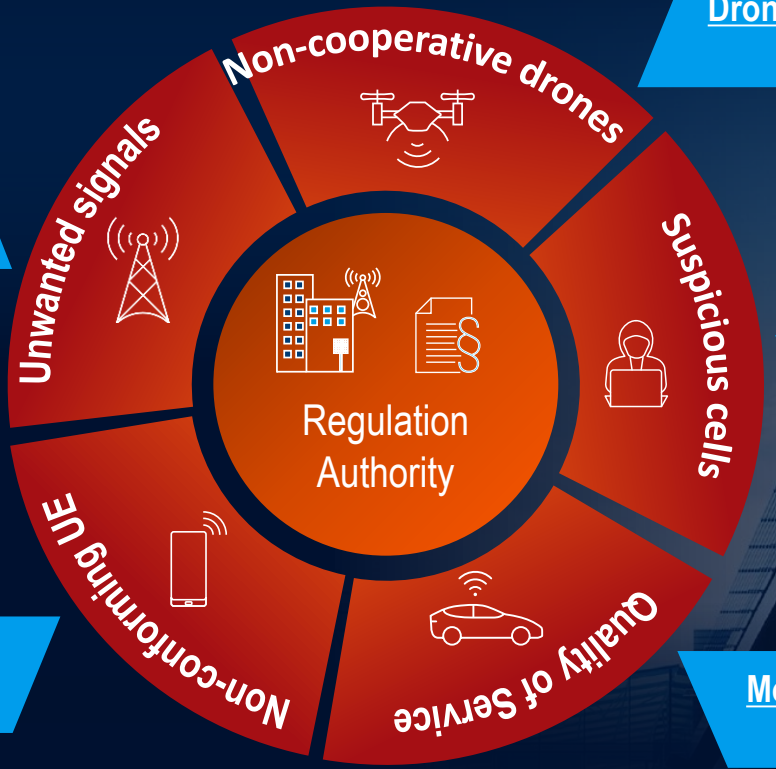
NETWORKS & CYBERSECURITY

Network & Security Solutions I Certified & High-Grade Crypto Solutions






DEDICATED SOLUTIONS TO KEEP CRITICAL INFRASTRUCTURE COMPONENTS IN SAFE OPERATION



Drone detection and countering

Spectrum Monitoring

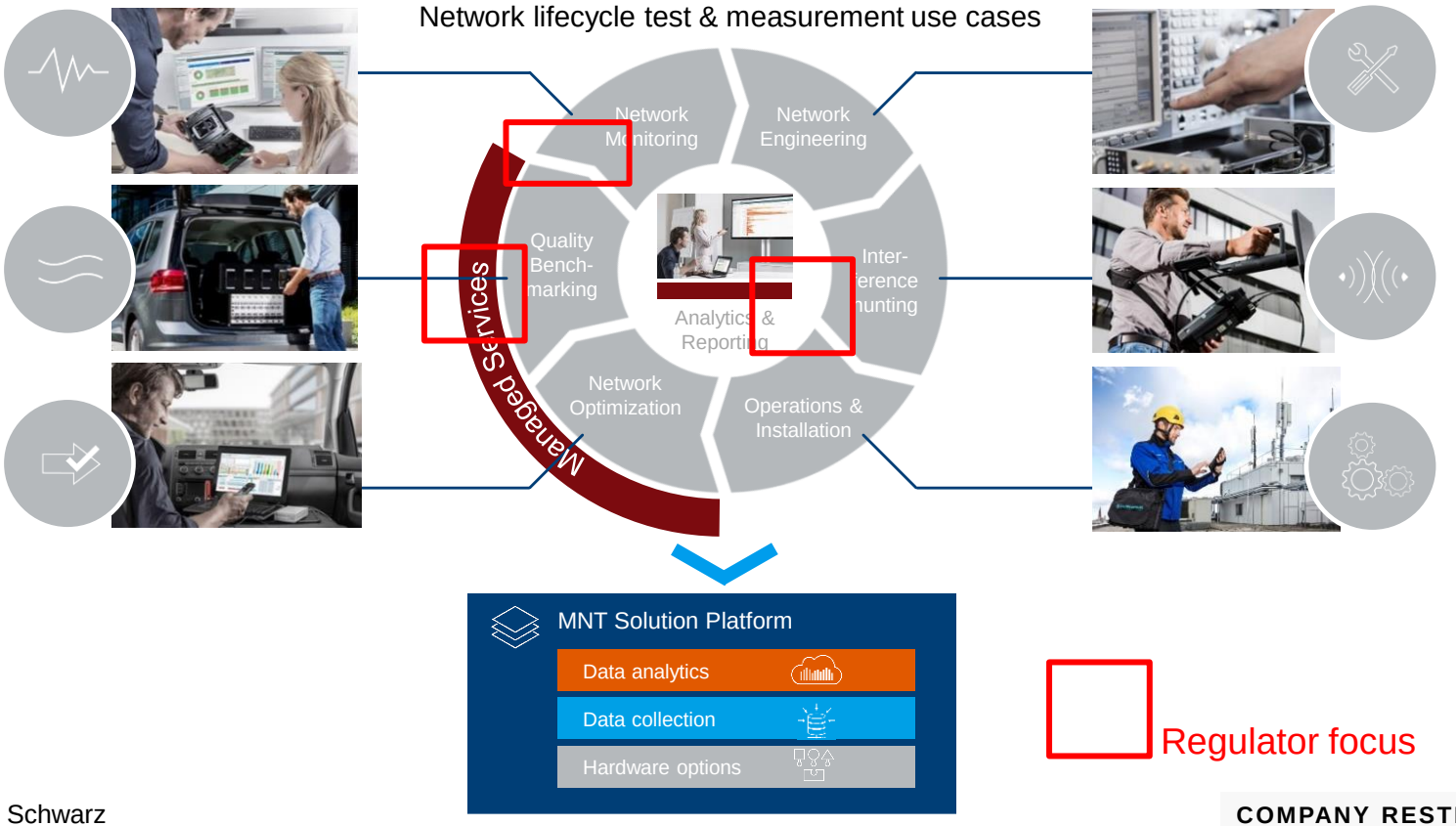
IMSI catcher detection

Device Testing

Mobile Network Testing

Solutions tailored for regulation authorities

SOLUTIONS TO IMPROVE QUALITY AND PERFORMANCE FOR ALL USE CASES IN THE NETWORK LIFECYCLE



R&S MNT TEST SOLUTION
BENEFITS – STANDARDS BASED SOLUTIONS

- Active member of standardization bodies
- Contributing and active developing algorithms (POLQA, ITU J.343.1)
- Network Performance Score (NPS)
- Interactivity Testing
- Sophisticated device integration and collection tool based on smartphones

- Own scanner products means complete ownership

Tasks of ITU Regulators

- Spectrum management
  - Allocate and license interference-free (!) spectrum
  - Identify Technology trends, e.g. 5G SA, private networks & NTN
- QoS/QoE
  - Foster competition among operators to the benefit of end-users
  - Improve the Quality continuously
  - Use Standards based Test Tools & Methodologies (Network Performance Scoring & Interactivity Testing).
  - …

TRENDS IN NETWORK USAGE AND APPLICATIONS

- **2G/3G (GSM/UMTS)** era → *Test calls, FTP/HTTP up-/download, SMS, Ping*
  - Rather constant network setups after optimization
  - Except cell load: rather constant behavior in performance, congestion in telephony

- **4G (LTE**
  - Inter-T
  - Still tir

- **5G / 6G**
  - Highly
    (e.g. p
  - Achiev

- UDP packet switched communication will become dominant
  - Real-time applications (from video chat to virtual reality / Metaverse)
  - Web-content delivery using QUIC by HPPTP/3

- IMS/SIP based signaling for many services
  - VoLTE / VoNR
  - E-Call in cars
  - Mission critical communication (MCX) by IMS/3GPP
  - FRMCS* for railways / public transport communication

* Future Railway Mobile Communication System

REGULATORY ASPECTS IN MOBILE COMMUNICATION

Spectrum	*Coverage Radio Technology*	*QoS / QoE Network Performance*
▶ License conditions	▶ Radio coverage	▶ Data speed
▶ Spectrum clearance	▶ Technology usage	▶ Service KPIs
▶ Borders, Spill-over	▶ Geographical resolution	▶ QoE performance
		▶ Network performance score
Applies to		
▶ Public networks	▶ Public networks	▶ Public networks
▶ Mission critical private networks	▶ Mission critical private networks	▶ Mission critical private networks
▶ Business critical private networks		

REGULATORY ASPECTS IN MOBILE COMMUNICATION
WHAT'S COMING NEXT?

- Performance evaluation according to network category
  - Performance for a human user is defined differently than in machine type communication
  - New KPIs, different importance, adjusted test and measurement procedures
- Communication over non-terrestrial networks (NTN) aka 'Starlink'
- 5G broadcasting (formal: 'LTE based 5G terrestrial broadcast')
- Mission critical communication (MCX, 3GPP defined, IMS/SIP based, broadband communication)
  - Starting a private slices in public networks, later dedicated frequencies / networks
- Measuring 3rd dimension in space (approximating indoor coverage, evaluation of air corridors)
  …see next

DRONES – A BOOMING MARKET
DRONES AND MOBILE NETWORK TESTING: TWO KEY AREAS

- Testing aerial networks for aerial services
- Drones to perform network testing tasks

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DRONES AND MOBILE NETWORK TESTING: TWO KEY AREAS

- Testing aerial networks for aerial services
  - The capability of aerial networks to guarantee safe and secure drone flights (also in ‘beyond visual line of sight’: BVLOS)
  - Air corridor evaluating and securing
  - Passive testing for spectrum, coverage, interference
  - Active resting by emulating traffic patterns commercial UAV* (*Example: Traffic pattern ‘drone control’ in ITU-T G.1051*)

- Drones to perform network testing tasks
  - Drones can be effective to substitute time-consuming and hard-to-perform (access rights) indoor tests even for upper floor levels.
  - Monitoring and analysis of the transmission of microwave links (at antenna height), including interference hunting
  - Passive testing for spectrum, coverage, interference
  - Active resting of data and telephony services

* UAV: Unmanned Aerial Vehicle

DRONES – A BOOMING MARKET
DRONES AND MOBILE NETWORK TESTING: TWO KEY AREAS

- Ready for passive measurements (spectrum, scanner, coverage, interference)
- Ready for active measurements (data services, remote communication testing)

Mobile Network Testing

THANK YOU