German Academy of Digital Education

5G TECHNOLOGY

COURSE OVERVIEW

CREATING CHANCES

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WELCOME TO DADB
German Academy of Digital Education

Telecommunication is not only one of the fundamental enabling technologies for many applications, devices, and business models, but it is also the subject of rapid advances. Digital wireless communication systems are consistently expected to respond to people's increasingly complex needs, with an increasing number of devices to be connected, higher data rates and more reliable connectivity.

The industrial sector is also undergoing a massive transformation with the digitalization of assets as part of Industry 4.0. To meet industrial demand for skilled 5G engineers, we have worked with German academic and industrial experts to develop the DADB 5G course.

I encourage you to explore the course, and to work with us to boost the careers of young professionals in India and abroad.

Torsten Herfert
Managing Director
DADB German Academy of Digital Education GmbH

» By using **modern digital media techniques**, we can help students get to grips with the complexity of lectures given by professors in German universities, using our **„Made in Germany"** higher education format. Our mission is to create a **unique educational experience** that is unrivaled in the international education marketplace. «

ABOUT DADB

As a global player in the digital education market, DADB offers industry-relevant online courses in the sustainable technologies sector, bringing German engineering know-how to the world.
Our vision is to become India's leading provider of high-quality German Engineering and Industrial Education, by making international standards of learning accessible to Indian students through innovative, hands-on, and affordable online learning experiences.

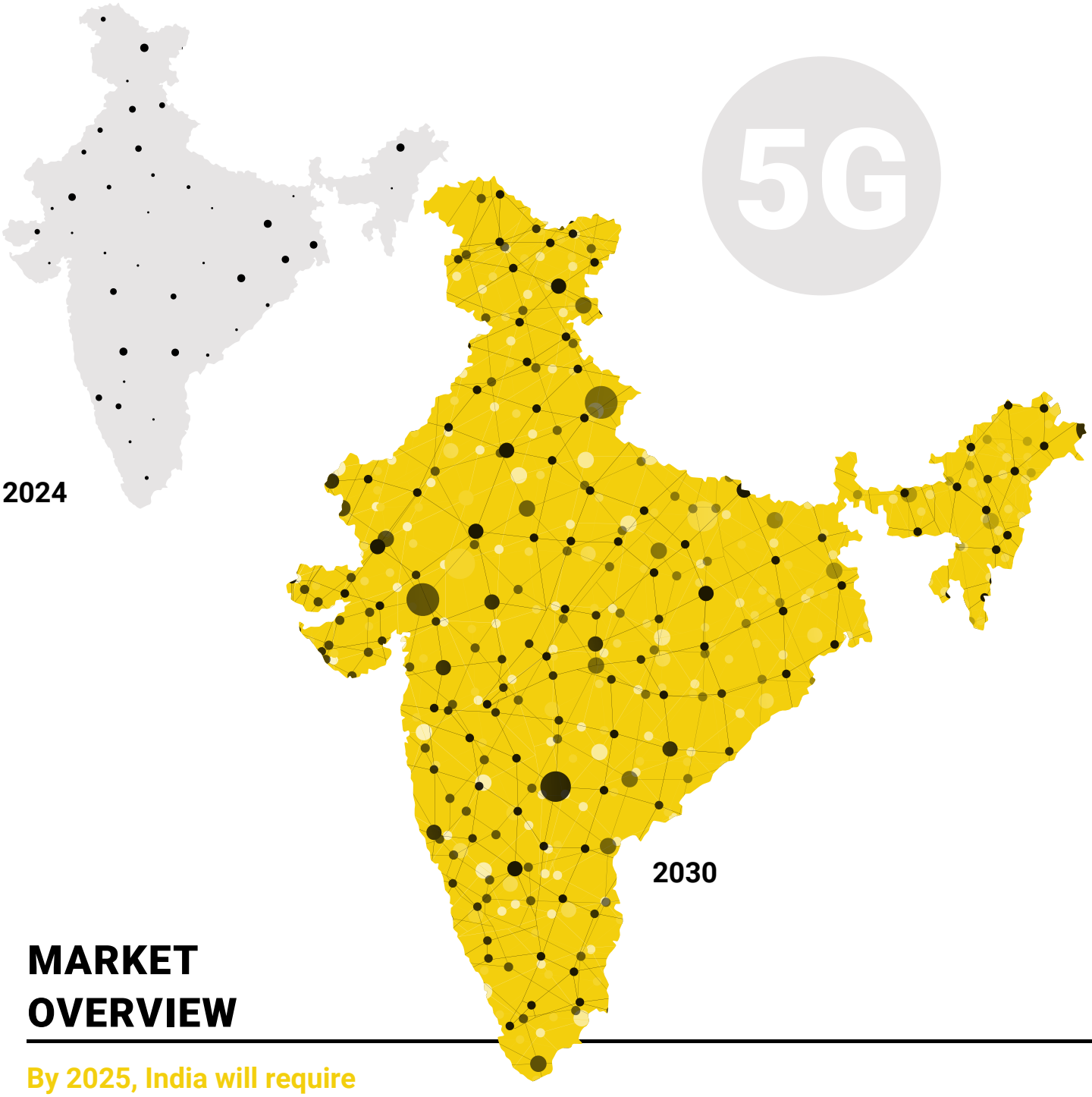
The idea emerged out of a lecture tour in India, when our Managing Director Dr.-Ing. Carsten Schröder was asked "Can we bring German professors to India and share German engineering know-how with students here?"

Back in Berlin, the idea was conceived to make professors' lectures available online rather than via their own classrooms. Immediately, it became apparent that online learning had very special requirements. A new learning format has been developed to integrate students interactively into the lectures and provide insight into practice from industry experts.

We are convinced that social responsibility does not exclude economic efficiency. Over the years, we have nurtured successful partnerships with industry, universities, colleges, and skills councils, aiming at one goal – making **Made in Germany** technical education accessible for the world's younger generations. This is why our claim – **Creating Chances** – strongly represents our belief that education is essential.

DADB courses are created in close cooperation with university professors and industry experts in Germany. The digital materials are geared towards the needs of teachers and students, with clear learning objectives and innovative course content that are responsive to industry requirements and the demand for well-educated talent.

CONNECTING. COLLABORATING. COOPERATING.



MARKET OVERVIEW

By 2025, India will require
22 MILLION skilled workers in 5G-focused industries.

The telecom sector alone is projected to employ **OVER 6 MILLION WORKERS** in 2025, with a **29.5 % GROWTH RATE** focused on 5G roles.

Projected Revenue in the telecom sector by 2030 **USD 61.2 BILLION**

THIS REMARKABLE GROWTH HIGHLIGHTS THE INCREASING ADOPTION OF 5G TECHNOLOGIES ACROSS VARIOUS SECTORS.

JOB PERSPECTIVES

Key skills needed are technical knowledge of devices, open-source architecture, IoT, and 5G infrastructure.

5G NETWORK ENGINEER

The job of a 5G engineer includes designing, installing, and managing telecom devices and services, such as copper wire telephone cabling, fiber optic cabling, and other internet protocol data systems.

5G SYSTEM ARCHITECT

A system architect is responsible for implementing and overseeing network security measures to protect data and network integrity. Furthermore, the architect will ensure network performance, reliability, and security.

5G SECURITY SPECIALIST

Security specialists implement cybersecurity measures that protect an organizations' computer networks and systems. Security specialists also secure data networks, intercept security breaches, and make changes to improve security.

5G SOFTWARE DEVELOPER

This role requires to be familiar with all phases of embedded software development. The job involves developing, debugging, and testing 5G rApps (remote applications) developed to be running on top of 5G services.

5G NETWORK PLANNER

A 5G Planner designs and optimizes the radio access network of a 5G cellular network. This includes determining the optimal placement of base stations, configuring antenna systems, and managing radio frequency interference to ensure reliable and efficient communication for end-users.

5G TECHNOLOGY COURSE

MERGING ACADEMIA AND INDUSTRY

This course explores the rapidly changing digital world, opening paths to a variety of jobs and preparing you for a connected future. Students learn how 5G enables technologies, architectures, and network planning and how campus 5G networks are designed and tested.

LEARNING OBJECTIVES

- **Gain insight into the advanced 5G communication networks.**
- **Familiarize yourself with the 5G network architecture and new 5G technologies.**
- **Analyze the various network types, planning processes, and deployment options via industrial examples.**
- **Explore various 5G use cases and understand the setup of 5G Campus Networks.**
- **Analyze hardware elements and implementation aspects of 5G networks.**
- **Get insights into 5G system testing and testbeds.**

LEARNING OUTCOME

Upon completion of this course, the students will be able to

1. **Interpret the various advanced communication networks and 5G cellular networks.**
2. **Explain the 5G network architecture and enabling 5G technologies.**
3. **Illustrate the various network types, process in planning and deployment option of 5G networks.**
4. **Appraise the 5G use cases and Campus networks.**
5. **Differentiate various 5G hardware and able to integrate the system implementation aspects.**
6. **Analyze 5G system testing and define elements of 5G testbeds.**

LEARNING EXPERIENCE

A SERIES OF LECTURES BY GERMAN PROFESSORS

Using online technology, we create lectures by renowned German professors.

INTERACTIVE EXCERSICES AND APPLICATIONS

A variety of interactive applications are included in our courses. By practicing and applying their skills in a controlled digital environment, students gain hands-on experience.

INDUSTRY EXPERTS

We connect theory and practice with the expertise of German and international industry experts. As a result, theoretical knowledge is tested on practical showcases.

A LEARNING CONTROL

Students can monitor their progress on an ongoing basis with our self-assessment tools.

ASSESSMENTS

During this course, students take up to two intermediate exams and a final exam created in collaboration with the German professor and monitored using proctoring tools. Upon passing the exam, students receive a blockchain-verified certificate of completion.

INNOVATIVE LEARNING PLATFORM

Our fast and interactive learning platform enables students to learn anytime and anywhere.


5G TESTING REQUIREMENTS
5G BASE STATIONS (gNodeB/gNB)

Professor Dr. Axel Sikora, DADB Summer University 2024 in partnership with Offenburg University of Applied Sciences

COURSE INSTRUCTOR

Prof. Dr.-Ing. Axel Sikora is a leading academic at Offenburg University of Applied Sciences, heading the Institute of Reliable Embedded Systems and Communication Electronics (ivESK). He is also involved in the Hahn-Schickard Institute of Applied Research, leading two engineering divisions. As of 2019, he has been affiliated with the University of Freiburg's engineering faculty.

- Founder and head of the Steinbeis Transfer Center Embedded Design and Networking and shareholder of STACKFORCE GmbH, an independent and successful spin-off engineering company around IoT connectivity solutions.
- Author and editor of several textbooks, and of more than 200 peer-reviewed papers in the field of embedded design and wireless & wired networking.
- Chairman of the annual embedded world conference (Nuremberg) – the world's largest event on the topic.
- Scientific Advisor to both the annual Wireless Congress (Munich) and the annual IoT Conference (Stuttgart).

INDUSTRY EXPERTS AND SHOWCASES

ENTERPRISES	Rhode & Schwarz, LS Telcom AG, Techcom Consulting, Wirepas, CampusGenius
TELECOM INDUSTRY PLAYERS	MECA Software, Qualcomm, Nokia Siemens, Intel
RESEARCH & SCIENCE LABS	Frauenhofer Insitute for Telecommunications, Hahn-Schickard Institute of Applied Research, Offenburg University of Applied Sciences, TU Dresden

MODULES OVERVIEW

MODULE 1
Introduction to Advanced Communication Networks and 5G Cellular Networks

MODULE 2
5G Network Architecture and Key 5G New Radio Technologies

MODULE 3
5G Networks – Types, Planning and Deployment options

MODULE 4
5G Use cases and Campus Networks

MODULE 5
5G Hardware and Implementation Aspects

MODULE 6
5G – System testing, Testbeds, and Industrial showcases

MODULE 1

Introduction to Advanced Communication Networks and 5G Cellular Networks

01 Course Introduction
- Prof. Dr-Ing. Axel Sikora and industry partners introduction
- Outline of the course contents

02 Introduction to Advanced Communication Networks
- Explanation of wireless communication importance
- Deep diving into fast-growing network technologies
- Key ideas and architectures

03 ISO-OSI Reference Models
- The need for the model
- Description of layer functionalities
- Hierarchical communication

04 Protocols, Standards and Service Models
- The role of protocols in networks
- Standardization of communication
- Suitable service models

05 Mobile Communication and 5G
- Cellular network evolution
- Fundamentals of mobile communication
- 4G and 5G technologies

06 5G – Requirements, Services and Standardization
- Details of ITU-R requirements for 5G
- Linking requirements to service development
- Standardization activities

MODULE 2

5G Network Architecture and Key 5G New Radio Technologies

07 5G Use Cases, Technical Ingredients and Market Overview
- Three main 5G use cases
- Technical ingredients for 5G
- A market segment overview

08 Expert Interviews and Use Cases
- Interviews with experts from Qualcomm and Nokia
- Demonstrations from TU Dresden
- Insights into 5G evolution and projects

09 Architecture of 5G Cellular Communication Networks
- Mobile network architecture design
- Network components and interactions
- Architecture across generations

10 5G Base Station, Access, and Core Network Architecture
- Dynamic and scalable 5G framework
- Radio Access Networks (RANs) in focus
- Advanced 5G architecture, explained

11 5G New Radio (NR)
- The 5G New Radio interface introduction
- The spectrum used for 5G NR
- Significance of 5G NR in communication

12 4G LTE, 5G NR Fixed Frame Structure and Numerology
- Introduction to the 5G NR frame structure
- Fixed frame structure in 4G LTE
- The flexible numerology in 5G NR

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5G Networks – Types, Planning and Deployment options

13 Wireless Propagation Aspects
- Wireless propagation mechanisms
- Theoretical and practical aspects
- Factors affecting wireless channels

14 5G NR Enabling Technologies
- RF-modulation and digital signal processing
- New innovations in the physical layer
- Technologies moving closer to physical limits

15 5G Radio Access Networks (RAN)
- Key elements of 5G RAN
- RAN architectures comparison across generations
- 5G RAN architecture in detail

16 Multiple Inputs Multiple Output (MIMO) and Expert Presentation
- The fundamentals of MIMO technology
- Massive MIMO implementations
- A demonstration of 5G mmWaves & MIMO using FPGAs

17 O-RAN, C-RAN, Expert Interview and Presentations
- O-RAN and C-RAN architectures
- Benefits and potential challenges
- An expert presentation on O-RAN's role in 5G

18 Expert Interviews on „Localization"
- 5G NR's importance for localization
- Expert insights from Fraunhofer IIS
- 5G testbed for Industry 4.0

19 5G Radio Network Planning and Optimization
- RF planning fundamentals
- Cost-effective transceiver setup
- The processes and requirements for planning

20 Smart Spectrum Solutions
- The importance of spectrum efficiency
- Cost-efficient spectrum management
- A presentation on Smart Spectrum Solutions from LS Telcom

21 Demonstration of an RF Planning Tool
- CHIRplus_TC - a Radio Network Planning Tool by LS Telcom
- High-performance network design
- Planning high-quality networks

22 5G Core and Transport Network
- Key technologies in the core network
- Major elements and functionalities
- The transport network's components

23 5G Deployments
- Different 5G deployment methods
- Outline of the deployment process steps
- Ongoing global 5G deployments

MODULE 4

5G Use cases and Campus Networks

24 5G Use Cases
- eMBB, uRLLC, and mMTC services
- The flexibility of 5G networks
- Examples of different 5G use cases

25 eMBB, URLLC and mMTC Use Cases
- The eMBB use case for enhanced broadband
- uRLLC for ultra-reliable low-latency communications
- mMTC for massive machine-type communication

26 5G Campus Networks
- How campus networks differ from standard networks
- How they are set up and operated
- Key features of campus networks

27 Expert Interviews Campus Network
- Key features of 5G campus networks
- Showcase of innovative campus network solutions
- Demonstrations of industry innovations

28 Expert Interviews Industrial 5G
- Factory and process automation
- Siemens Digital Industries – experts' insights
- The role of 5G in driving industrial automation

29 Narrowband Wireless Wide Area Networks
- Narrowband IoT and LTE-M technologies
- Meeting technical requirements
- Use cases for narrowband wireless networks

30 Low Power Wide Area Networks (LPWAN)
- Popular LPWAN technologies: an explanation
- Applications in wireless communication
- A presentation on LPWAN and Cellular IoT from Hahn Schickard Association

31 Expert Interviews, Cellular IoT
- Machine-to-machine communication
- Challenges and advantages of cellular IoT
- Insights into the future of cellular IoT

MODULE 5

5G Hardware and Implementation Aspects

32 5G Hardware and Implementation Aspects

- Historical hardware developments
- Antenna systems for base stations
- Hardware implementations in cellular infrastructure

33 Expert Interviews 5G Hardware

- Key 5G hardware features
- Antenna measurement setups
- Innovations in 5G hardware systems

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5G – System testing, Testbeds, and Industrial showcases

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- Testing fundamentals
- Challenges and requirements in 5G testing
- Testing lifecycle for 5G products

35 Test Environment, 5G Physical Layer and System Testing Overview
- Simulations, testbeds, and field tests
- 5G testing environments – demo
- The importance of 5G system testing

36 Expert Presentations – 5G Field Test and Measurements
- A presentation by Rohde & Schwarz
- 5G test and measurement solutions
- Testing needs across 5G stages

37 Demonstrations of 5G Campus Europe Testbeds, Part 1
- 5G-SMART project testbeds – introduction
- Adaptive machining using sensor platforms
- Production process monitoring

38 Demonstrations of 5G Campus Europe Testbeds, Part 2
- Testbed features in detail
- Additional project demonstrations
- Adaptive technology demonstrations, continued

39 Expert Presentation – Systematic Functional Testing of NB-IoT
- Functional testing concepts
- A demonstration from Fraunhofer ISS and Hahn Schickard
- Testing procedures for NB-IoT

40 Interviews – Towards 6G
- Key technologies proposed for 6G
- Interview with Ulrich Dropmann from Nokia Bell Labs
- Insights from 5G expert Prof. Dr. Frank Fitzek from TU Dresden

WE HAVE MORE

Step into the world of boundless knowledge with our comprehensive range of courses. At DADB, we believe in offering a diverse array of educational opportunities that cater to various interests and career aspirations.
From courses in renewable energies to the latest 5G technology, our offerings are thoughtfully designed to empower you on your learning journey. We invite you to explore the next page to discover the rich tapestry of possibilities that await, providing you with the tools and insights needed to excel in today's dynamic digital landscape.

DADB COURSES

INTERNET OF THINGS (IoT)
Prof. Dr.-Ing. Norbert Gronau
University of Potsdam

SOLAR ELECTRIC ENERGY SYSTEMS
Prof. Dr.-Ing. habil. Stefan Krauter
University of Paderborn

HYDROGEN TECHNOLOGY
Prof. Dr.-Ing. Thomas Schmidt
University of Applied Sciences Münster

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ACCESS THE FUTURE

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