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MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

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Facilitator Guide



Sector
Telecom

Sub-Sector
Passive Infrastructure

Occupation
Network (Passive) Installation

Reference ID: TEL/Q4202, Version 1.0
NSQF level 5

5G System Integrator

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Telecom Sector Skill Council of India

Estel House, 3rd Floor, Plot No:- 126, Sector 44

Gurugram, Haryana 122003

Phone: 0124-2222222

Email: tssc@tsscindia.com

Web: www.tsscindia.com

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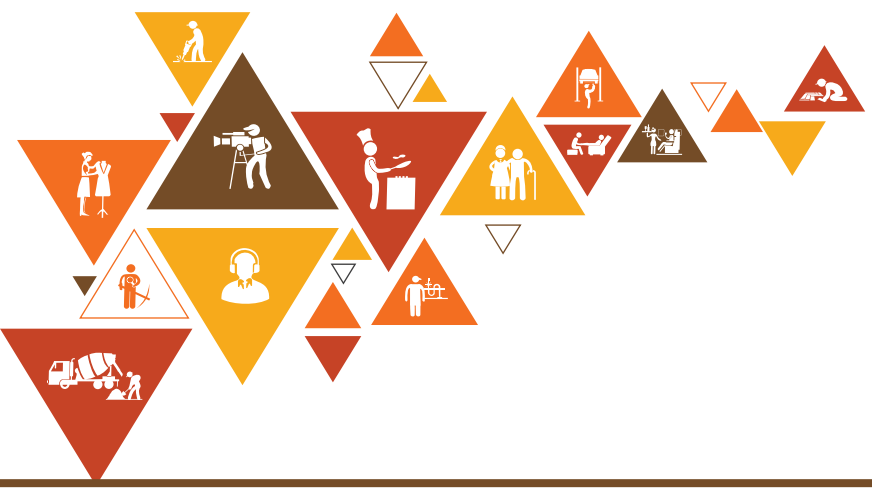

> Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission.

Shri Narendra Modi
Prime Minister of India

Acknowledgements

The Telecom Sector Skill Council (TSSC) would like to thank all the individuals and institutions who contributed in various ways towards the preparation of this facilitator guide. The guide could not have been completed without their active contribution. Special gratitude is extended to those who collaborated during the development of the different modules in the facilitator guide. Wholehearted appreciation is also extended to all who provided peer review for these modules.

The preparation of this guide would not have been possible without the telecom industry's support. Industry feedback has been extremely beneficial since inception to conclusion, and it is with the industry's guidance that we have tried to bridge the existing skill gaps in the industry. This facilitator guide is dedicated to the aspiring youth, who desire to achieve special skills that will be a lifelong asset for their future endeavours.

About this Guide

The facilitator guide (FG) for 5G System Integrator is primarily designed to facilitate skill development and training of people, who want to become professional 5G System Integrator in various stores. The facilitator guide is aligned to the Qualification Pack (QP) and the National Occupational Standards (NOS) as drafted by the Sector Skill Council (TSSC) and ratified by National Skill Development Corporation (NSDC).

It includes the following National Occupational Standards (NOSs)-

1. TEL/N4205: Set Standards for 5G Network Architecture
2. TEL/N4206: Verify and Prepare Hardware Equipment for 5G Installation
3. TEL/N4207: Design Spectrum and 5G Network Architecture
4. TEL/N4208: Implement the 5G New Radio (NR) and Radio Access
5. DGT/VSQ/N0102: Employability Skills (60 Hours)

Post this training, the participants will be able to perform tasks as professional 5G System Integrator. We hope that this Facilitator Guide provides a sound learning support to our young friends to build a lucrative career in the Telecom Skill Sector of our country.

Symbols Used

Ask


Explain


Elaborate


Notes


Objectives


Do


Demonstrate


Activity


Team Activity


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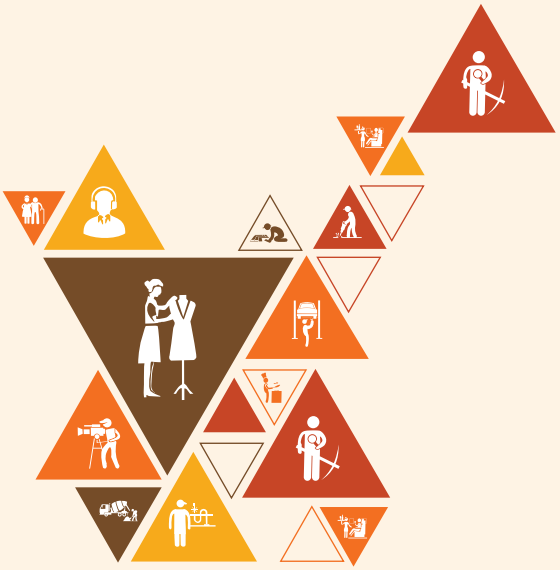
1. Introduction to the Role of 5G System Integrator

Unit 1.1 - Understanding the Telecom Industry and 5G System Integration

Unit 1.2 - Practical Application and Workflow of 5G System Integration System Integration



Bridge Module

Key Learning Outcomes 

By the end of this module, the participants will be able to:

1. Describe the size and scope of the Telecom industry and its sub-sectors.
2. Discuss the role and responsibilities of a 5G System Integrator.
3. Role play based on case studies, outlining the scope, responsibilities, and challenges of 5G System Integrator.
4. Analyse the requirements for the course and prepare for the pre- requisites of the course.

Unit 1.1: Understanding the Telecom Industry and 5G System Integration

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe the size and scope of the Telecom industry and its sub-sectors.
2. Discuss the role and responsibilities of a 5G System Integrator.
3. Identify various employment opportunities for a 5G System Integrator.
4. Discuss the organizational policies on workplace ethics, managing sites, quality standards, personnel management, and public relations (PR).

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection

Do

- Ensure the training room is set up with all necessary materials and technology.
- Begin the session by welcoming participants and outlining the agenda.
- Facilitate interactive discussions and engage participants in activities related to the learning outcomes.
- Provide real-world examples and case studies to reinforce key concepts.

Say

- Good morning/afternoon, everyone. Today, we'll be diving into the fascinating world of the Telecom industry and exploring the intricacies of 5G System Integration.
- Throughout the session, feel free to ask questions and participate actively to make the most out of our time together.
- Before starting the session, let's play an activity called the name game.

Activity

1. **Activity Name:** Name Game (Ice Breaker)
2. **Objective:** This activity is focused on breaking the ice between the participants so that they can come up confidently in putting forward their opinion
3. **Type of activity:** Group activity
4. **Resources:** Participant Handbook, Pen, Notebook, Writing Pad, etc.
5. **Duration of the activity:** 60 minutes

6. **Instructions:**
   - Arrange the class in a semi-circle/circle
   - Say your name aloud and start playing the game with your name.
   - Say, "Now, each of you shall continue with the game with your names till the last person in the circle/ semi-circle participates".
   - Listen to and watch the trainees while they play the game.
   - Ask questions and clarify if you cannot understand or hear a trainee.
   - Discourage any queries related to one's financial status, gender orientation or religious bias during the game
   - Try recognising each trainee by their name because it is not recommended for a trainer to ask the name of a trainee during every interaction
7. **Outcome:** This activity has focused on breaking the ice between the participants so that they can come up confidently, putting forward their opinion.

Ask

- Can anyone share their understanding of the Telecom industry and its importance in our daily lives?
- Have you heard about 5G technology before? If so, what do you know about it?

Elaborate

- Size and scope of the Telecom industry and its sub-sectors.
- Role and responsibilities of a 5G System Integrator.
- Various employment opportunities for a 5G System Integrator.
- Organizational policies on workplace ethics, managing sites, quality standards, personnel management, and public relations (PR).

Explain

- Workplace ethics.
- Quality standards in the Telecom industry.

Demonstrate

Demonstrate the process of site management and quality control in a hypothetical 5G deployment scenario.

Activity

1. **Activity:** Understanding 5G System Integration
2. **Objective of the activity:** To deepen participants' understanding of the role of a 5G System Integrator and the associated responsibilities.
3. **Resources:** Whiteboard, markers, presentation slides
4. **Time Duration:** 20 minutes
5. **Instructions:**
   - Divide participants into small groups.
   - Provide each group with a scenario involving a 5G deployment project.
   - Ask groups to brainstorm and outline the tasks and responsibilities of a 5G System Integrator in managing the project.
   - Groups will present their findings to the rest of the class.
   - Facilitate a discussion on the different approaches and insights shared by each group.
   - Summarize key points and clarify any misconceptions.
6. **Outcome:** Participants will gain a deeper understanding of the role and responsibilities of a 5G System Integrator through hands-on engagement with real-world scenarios.

Notes for Facilitation

- Encourage active participation and open communication among participants.
- Relate theoretical concepts to practical applications whenever possible.
- Use visual aids and real-life examples to enhance understanding.
- Foster a collaborative learning environment where participants can share their insights and experiences.
- Emphasize the importance of ethical conduct and adherence to industry standards throughout the session.

Unit 1.2: Practical Application and Workflow of 5G System Integration System Integration

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe the process workflow in the organization and the role of a 5G System Integrator.
2. List the various daily, weekly, monthly operations/activities that take place at the site under a 5G System Integrator.
3. Analyze the requirements for the course and prepare for the prerequisites of the course.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection

Do

- Set up the training environment with all necessary materials and technology.
- Facilitate interactive discussions and engage participants in activities related to the learning outcomes.
- Provide clear instructions for activities and encourage active participation.
- Offer guidance and support to ensure understanding and address any questions or concerns.

Say

- Welcome, everyone. Today, we'll be exploring the practical applications and workflow of 5G System Integration.
- Let's dive into understanding how 5G System Integrators play a crucial role in organizational workflows and daily operations.

Ask

- Can anyone share their understanding of the role of a 5G System Integrator in an organization?
- What do you think are some of the daily, weekly, and monthly activities carried out by a 5G System Integrator at a deployment site?

Elaborate

- Process workflow in the organization and the role of a 5G System Integrator.
- Daily, weekly, and monthly operations/activities at a 5G deployment site.

Explain

- Requirements for the course and preparation of prerequisites.
- Analysis of course requirements and prerequisites.

Demonstrate

Demonstrate the setup and configuration process of 5G equipment at a deployment site.

Activity

1. **Activity:** Workflow Mapping Exercise
2. **Objective of the activity:** To help participants understand the workflow of a 5G System Integrator and identify daily, weekly, and monthly operations.
3. **Resources:** Whiteboard, markers, presentation slides
4. **Time Duration:** 30 minutes
5. **Instructions:**
   - Divide participants into small groups.
   - Provide each group with a scenario involving a 5G deployment project.
   - Ask groups to map out the workflow of a 5G System Integrator, including daily, weekly, and monthly activities.
   - Groups will present their workflow maps to the rest of the class.
   - Facilitate a discussion on the similarities and differences between the presented workflows.
   - Summarize key points and highlight best practices in workflow management.
6. **Outcome:** Participants will gain a deeper understanding of the practical application and workflow of 5G System Integration through collaborative mapping exercises.

Notes for Facilitation

- Encourage active participation and collaboration among participants during group activities.
- Provide additional support to participants who may need assistance in understanding complex concepts.
- Relate theoretical knowledge to real-world scenarios to enhance relevance and applicability.
- Emphasize the importance of thorough preparation and adherence to prerequisites for successful completion of the course.
- Foster a positive learning environment where participants feel comfortable asking questions and sharing their insights.

Answers to Exercises for PHB

Multiple Choice Questions:

1. c. 10.1%
2. c. 60%
3. c. Network monitoring and troubleshooting
4. c. Network monitoring and troubleshooting
5. d. Technical reviews and audits

Descriptive Questions:

1. Refer to UNIT 1.1: Understanding the Telecom Industry and 5G System Integration
   Topic 1.1.2 Role and responsibilities of a 5G System Integrator
2. Refer to UNIT 1.2: Practical Application and Workflow of 5G System Integration System Integration
   Topic 1.2.2 Various daily, weekly, monthly operations/activities that take place at the site under a 5G System Integrator
3. Refer to UNIT 1.1: Understanding the Telecom Industry and 5G System Integration
   Topic 1.1.2 Role and responsibilities of a 5G System Integrator
4. Refer to UNIT 1.2: Practical Application and Workflow of 5G System Integration System Integration
   Topic 1.2.2 Various daily, weekly, monthly operations/activities that take place at the site under a 5G System Integrator
5. Refer to UNIT 1.1: Understanding the Telecom Industry and 5G System Integration
   Topic 1.1.3 Employment opportunities for a 5G System Integrator in India

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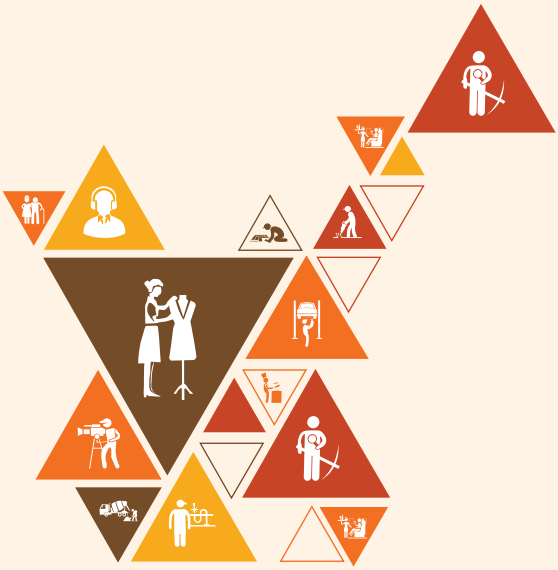
2. Set Standards for 5G Network Architecture

Unit 2.1 - 5G Technology Fundamentals and Standards System Integration

Unit 2.2 - Security and Authentication in 5G Networks

Unit 2.3 - 5G Network Planning, Deployment, and Optimization



TEL/N4205

Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Recall the technical specifications for 5G network elements, including base stations, core network components, and user equipment.
2. Explain the techniques for planning network coverage and capacity, including cell placement and interference management.
3. Discuss encryption methods, secure key exchange, and authentication protocols for network security.
4. Perform installation and configuration of base stations, RAN elements, and core network components based on network design.
5. Evaluate the current capacity of the network infrastructure and identify areas where scalability is required.
6. Analyze traffic patterns and trends to understand the growth in network demand.
7. Develop interoperability standards to ensure seamless communication between different vendors' equipment and network elements.
8. Analyze network performance metrics and make informed decisions for updates and optimizations.

Unit 2.1: 5G Technology Fundamentals and Standards System Integration

Unit Objectives

By the end of this unit, the participants will be able to:

1. Recall the technical specifications for 5G network elements.
2. Explain the principles of 5G technology, including beamforming, massive MIMO, and network slicing.
3. Describe the ITU's IMT-2020 framework and specific frequency bands for 5G deployment.
4. Identify the 3GPP standards defining technical specifications for 5G network elements and protocols.
5. Discuss the service-based architecture (SBA) and network function virtualization (NFV) for service delivery.
6. Discuss regulatory compliance regarding telecommunications standards and spectrum allocation policies.
7. Identify emerging networking technologies and advancements in the field of 5G.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection

Do

- Ensure all necessary materials and technology are set up before the session begins.
- Facilitate an engaging and interactive learning experience by encouraging participation and discussion.
- Provide clear explanations and examples to enhance understanding of complex technical concepts.
- Incorporate real-world case studies and practical demonstrations to illustrate key principles.

Say

- Good morning/afternoon, everyone. Today, we'll be delving into the fascinating world of 5G technology fundamentals and standards.
- Let's explore the technical specifications, principles, and standards that form the backbone of 5G networks.

Ask

- Can anyone share their understanding of the technical specifications for 5G network elements?
- What do you think are some of the emerging networking technologies in the field of 5G?

Elaborate

- Technical specifications for 5G network elements.
- Principles of 5G technology: beamforming, massive MIMO, network slicing.
- ITU's IMT-2020 framework and specific frequency bands for 5G deployment.
- 3GPP standards defining technical specifications for 5G network elements and protocols.
- Service-based architecture (SBA) and network function virtualization (NFV) for service delivery.
- Regulatory compliance regarding telecommunications standards and spectrum allocation policies.
- Emerging networking technologies and advancements in the field of 5G.

Explain

- Principles of network slicing.
- 3GPP standards for 5G.

Demonstrate

Demonstrate the process of beamforming and massive MIMO using simulation tools or practical equipment.

Activity

1. **Activity:** Standard Identification Game
2. **Objective of the activity:** To reinforce participants' understanding of 3GPP standards for 5G.
3. **Resources:** Presentation slides, whiteboard, markers
4. **Time Duration:** 20 minutes
5. **Instructions:**
    - Divide participants into teams.
    - Display a list of 3GPP standards related to 5G on the screen.
    - Each team must identify and match the correct standard with its description.
    - Teams will present their answers, and the facilitator will provide feedback and clarification.
    - The team with the most correct matches wins.
6. **Outcome:** Participants will gain a deeper understanding of 3GPP standards for 5G through interactive gameplay.

Notes for Facilitation

- Encourage active participation and collaboration among participants.
- Provide additional resources or references for further exploration of topics discussed.
- Clarify any misconceptions and address questions promptly during the session.
- Use a variety of teaching methods, including lectures, discussions, and activities, to cater to different learning styles.
- Emphasize the importance of staying updated with emerging technologies and industry standards in the fast-paced field of 5G.

Unit 2.2: Security and Authentication in 5G Networks

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe different authentication methods like SIM-based authentication, AKA, and EAP methods.
2. Discuss encryption methods, secure key exchange, and authentication protocols for network security.
3. Implement subscriber authentication and security mechanisms for secure connectivity.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection

Do

- Ensure the training environment is conducive to active learning and discussion.
- Facilitate engaging discussions and activities to reinforce key concepts.
- Provide clear instructions and guidance for hands-on activities and demonstrations.
- Encourage participants to ask questions and seek clarification throughout the session.

Say

- Welcome, everyone. Today, we'll be exploring the critical aspects of security and authentication in 5G networks.
- Let's delve into different authentication methods and encryption techniques to ensure secure connectivity in 5G.

Ask

- Can anyone name a few authentication methods used in 5G networks?
- Why is network security important in the context of 5G technology?

Elaborate

- Different authentication methods like SIM-based authentication, AKA, and EAP methods.
- Encryption methods, secure key exchange, and authentication protocols for network security.
- Subscriber authentication and security mechanisms for secure connectivity.

Explain

- Importance of secure key exchange in encryption.
- Overview of authentication protocols for network security.

Demonstrate

Demonstrate the process of subscriber authentication using SIM-based authentication and EAP methods.

Activity

1. **Activity:** Security Scenario Analysis
2. **Objective of the activity:** To apply knowledge of authentication methods and encryption techniques in real-world security scenarios.
3. **Resources:** Presentation slides, whiteboard, markers
4. **Time Duration:** 30 minutes
5. **Instructions:**
    - Present participants with a series of security scenarios involving 5G networks.
    - In small groups, participants will analyze each scenario and identify the appropriate authentication methods and encryption techniques to mitigate security risks.
    - Groups will present their findings to the rest of the class, discussing their reasoning behind each recommendation.
    - Facilitate a discussion on the effectiveness of different security measures and potential vulnerabilities in each scenario.
    - Summarize key points and emphasize the importance of implementing robust security protocols in 5G networks.
6. **Outcome:** Participants will gain practical experience in applying authentication methods and encryption techniques to enhance security in 5G networks.

Notes for Facilitation

- Foster a collaborative learning environment where participants feel comfortable sharing their ideas and insights.
- Provide additional resources or references for participants to explore further on the topic of network security.
- Encourage critical thinking and problem-solving skills during scenario analysis activities.
- Address any misconceptions or confusion regarding complex security concepts promptly.
- Emphasize the significance of staying updated with evolving security standards and best practices in the dynamic field of 5G technology.

Unit 2.3: 5G Network Planning, Deployment, and Optimization

Unit Objectives

By the end of this unit, the participants will be able to:

1. Explain techniques for planning network coverage and capacity, including cell placement and interference management.
2. Describe the implementation of voice over 5G (VoNR), IoT connectivity, and multimedia services.
3. Design a 5G network architecture to support dynamic spectrum sharing.
4. Deploy network monitoring and analytics tools to continuously monitor network performance.
5. Identify and troubleshoot network issues, such as latency, packet loss, and throughput.
6. Implement Quality of Service (QoS) mechanisms to prioritize critical services and applications.
7. Evaluate the current capacity of the network infrastructure and identify areas where scalability is required.
8. Analyze traffic patterns and trends to understand the growth in network demand.
9. Perform testing and optimization activities to verify network performance and fine-tune configuration parameters.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection

Do

- Ensure the training room is set up with all necessary materials and technology.
- Facilitate active engagement and discussion among participants throughout the session.
- Provide practical demonstrations and hands-on activities to reinforce key concepts.
- Encourage participants to ask questions and share their experiences related to network planning, deployment, and optimization.

Say

- Good morning/afternoon, everyone. Today, we'll be exploring the essential aspects of 5G network planning, deployment, and optimization.
- Let's dive into techniques for optimizing network coverage and capacity, implementing advanced services, and ensuring seamless performance.

Ask

- What are some challenges you anticipate in planning and deploying a 5G network?
- How do you think network optimization contributes to improving user experience in 5G networks?

Elaborate

- Techniques for planning network coverage and capacity, including cell placement and interference management.
- Implementation of voice over 5G (VoNR), IoT connectivity, and multimedia services.
- Designing a 5G network architecture to support dynamic spectrum sharing.
- Quality of Service (QoS) mechanisms to prioritize critical services and applications.

Explain

- Voice over 5G (VoNR) implementation.
- Quality of Service (QoS) mechanisms in 5G networks.

Demonstrate

Demonstrate the deployment of network monitoring tools and the process of analyzing network performance metrics.

Activity

1. **Activity:** Network Optimization Simulation
2. **Objective of the activity:** To simulate real-world scenarios for network planning, deployment, and optimization.
3. **Resources:** Presentation slides, whiteboard, markers
4. **Time Duration:** 45 minutes
5. **Instructions:**
   - Divide participants into small groups.
   - Provide each group with a simulated scenario involving network planning, deployment, or optimization challenges.
   - Groups will brainstorm solutions and strategies to address the given scenario.
   - Each group will present their proposed solutions to the rest of the class, explaining their rationale and approach.
   - Facilitate a discussion on the effectiveness of different solutions and lessons learned from each scenario.
   - Summarize key takeaways and best practices for network planning, deployment, and optimization.
6. **Outcome:** Participants will gain practical experience in addressing network challenges and optimizing network performance through simulation exercises.

Notes for Facilitation

- Encourage active participation and collaboration among participants during group activities.
- Provide guidance and feedback to help participants navigate complex scenarios effectively.
- Emphasize the importance of continuous monitoring and optimization to ensure the success of 5G network deployments.
- Foster a supportive learning environment where participants feel comfortable sharing their ideas and asking questions.
- Highlight the significance of staying updated with evolving technologies and industry best practices in 5G network planning, deployment, and optimization.

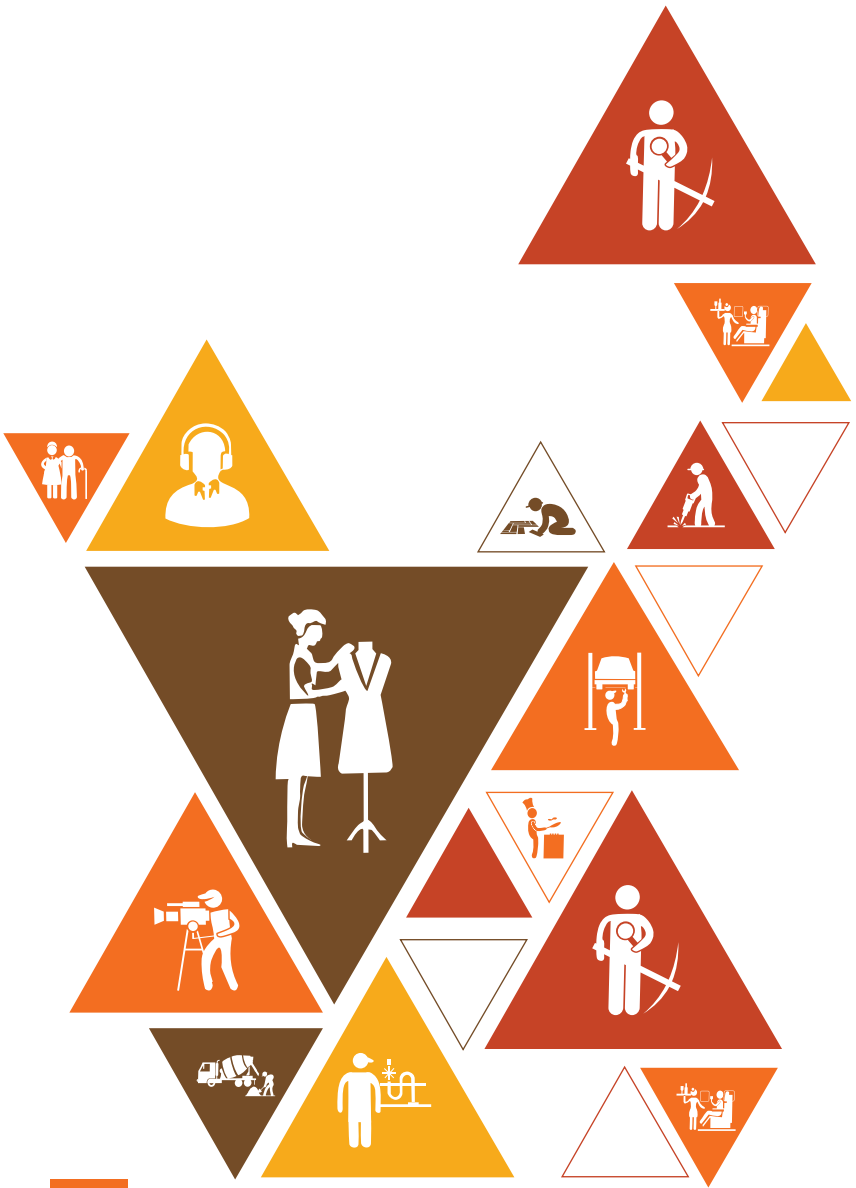
Answers to Exercises for PHB

Multiple Choice Questions:

1. c. Improving network capacity
2. b. 3GPP
3. a. Enhanced security with AKA integration
4. b. Identifying potential tower locations
5. b. Centralized Units (CUs)

Descriptive Questions:

1. Refer to UNIT 2.1: 5G Technology Fundamentals and Standards System Integration
   Topic 2.1.5 Service-based architecture (SBA) and network function virtualization (NFV)
2. Refer to Unit 2.3: 5G Network Planning, Deployment, and Optimization
   Topic 2.3.7 Network monitoring and analytics tools to continuously monitor network performance
3. Refer to Unit 2.3: 5G Network Planning, Deployment, and Optimization
   Topic 2.3.6 Network planning activities to design coverage and capacity of the 5G network
4. Refer to Unit 2.2: Security and Authentication in 5G Networks
   Topic 2.2.3 Subscriber authentication and security mechanisms for secure connectivity
5. Refer to Unit 2.1: 5G Technology Fundamentals and Standards
   Topic 2.2.3 Subscriber authentication and security mechanisms for secure connectivity



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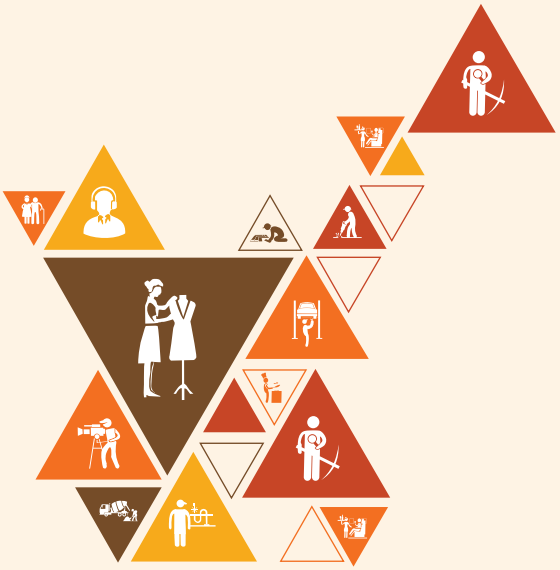
3. Verify and Prepare Hardware Equipment for 5G Installation

Unit 3.1 - Pre-Deployment Planning and Regulatory Compliance of 5G Network

Unit 3.2 - Hardware Installation and Infrastructure Setup

Unit 3.3 - Testing, Optimization, and Maintenance of 5G Networks



TEL/N4206

Key Learning Outcomes 

By the end of this module, the participants will be able to:

1. Explain the principles and concepts of Multiple Input, Multiple Output (MIMO) technology.
2. Summarize the procedures for validating and obtaining necessary licenses and permits for hardware installation.
3. Discuss health and safety regulations relevant to equipment installation and operation.
4. Describe grounding and lightning protection principles for equipment safety.
5. Summarize troubleshooting methodologies to address potential integration issues.
6. Implement proper network cable and connector configurations for seamless interconnection.
7. Verify the availability of passive and active equipment and ensure their proper installation.
8. Execute quality assurance and testing processes to verify hardware functionality and performance.

Unit 3.1: Pre-Deployment Planning and Regulatory Compliance of 5G Network

Unit Objectives

By the end of this unit, the participants will be able to:

1. Recall 3GPP standards and specifications relevant to 5G network deployment.
2. Summarize the procedures for validating and obtaining necessary licenses and permits for hardware installation.
3. Define the types of network cables, connectors, and interconnection standards used in 5G networks.
4. Discuss health and safety regulations relevant to equipment installation and operation.
5. Demonstrate the ability to analyse 3GPP standards, budget, architectural, and other design documents for 5G network deployment.
6. Validate the necessary licenses and permits for hardware installation and ensure compliance.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection

Do

- Ensure the training environment is set up with all necessary materials and technology.
- Facilitate interactive discussions and activities to engage participants throughout the session.
- Provide clear instructions and guidance for reviewing standards, procedures, and documents related to 5G network deployment.
- Encourage participants to actively participate in hands-on activities and practical demonstrations.

Say

- Good morning/afternoon, everyone. Today, we'll be focusing on pre-deployment planning and regulatory compliance for 5G network deployment.
- Let's dive into the key standards, procedures, and regulations essential for successful 5G network deployment.

Ask

- Can anyone name a few 3GPP standards and specifications relevant to 5G network deployment?
- Why is it important to ensure compliance with health and safety regulations during equipment installation?

Elaborate

- 3GPP standards and specifications relevant to 5G network deployment.
- Procedures for validating and obtaining necessary licenses and permits for hardware installation.
- Types of network cables, connectors, and interconnection standards used in 5G networks.
- Health and safety regulations relevant to equipment installation and operation.
- Analysis of 3GPP standards, budget, architectural, and other design documents for 5G network deployment.
- Validation of necessary licenses and permits for hardware installation and ensuring compliance.

Explain

- Importance of health and safety regulations in equipment installation.
- Significance of complying with regulatory requirements for successful 5G network deployment.

Demonstrate

Demonstrate the process of validating licenses and permits for hardware installation.

Activity

1. **Activity:** Compliance Checklist Review
2. **Objective of the activity:** To review and analyze regulatory compliance requirements for 5G network deployment.
3. **Resources:** Presentation slides, compliance checklists
4. **Time Duration:** 30 minutes
5. **Instructions:**
   - Divide participants into small groups.
   - Provide each group with a compliance checklist containing regulatory requirements for 5G network deployment.
   - Groups will review the checklist and identify any gaps or areas that need further attention.
   - Facilitate a discussion where each group presents their findings and discusses strategies for addressing compliance requirements.
   - Encourage participants to share their insights and experiences related to regulatory compliance in network deployment.
   - Summarize key takeaways and best practices for ensuring regulatory compliance in 5G network deployment.
6. **Outcome:** Participants will gain practical experience in reviewing and analyzing regulatory compliance requirements for 5G network deployment.

Notes for Facilitation

- Encourage active participation and collaboration among participants during group activities.
- Provide guidance and support to participants as they navigate through compliance checklists.
- Emphasize the importance of thorough planning and adherence to regulatory requirements for successful 5G network deployment.
- Foster a supportive learning environment where participants feel comfortable sharing their ideas and asking questions.
- Highlight the significance of continuous monitoring and validation of licenses and permits to ensure ongoing regulatory compliance throughout the deployment process.

Unit 3.2: Hardware Installation and Infrastructure Setup

Unit Objectives

By the end of this unit, the participants will be able to:

1. Explain the principles and concepts of Multiple Input, Multiple Output (MIMO) technology.
2. Describe the functionality and technical requirements of passive equipment like antennas, feeders, and cables.
3. Discuss the functionality and technical requirements of active equipment such as gNodes and microwave link devices.
4. Explain weatherproofing and protective measures to safeguard equipment from environmental elements.
5. Identify specific tools and equipment used for installation and configuration tasks.
6. Describe grounding and lightning protection principles for equipment safety.
7. Discuss power supply and backup system requirements to support 5G hardware.
8. Explain mounting structures and hardware specifications for different installation scenarios.
9. Summarize troubleshooting methodologies to address potential integration issues.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection, Tools and equipment for hardware installation (e.g., antennas, cables, mounting structures), Safety gear (e.g., helmets, gloves), Documentation on grounding and lightning protection principles, Power supply and backup system specifications.

Do

- Ensure the training environment is set up with all necessary materials and equipment.
- Facilitate interactive discussions and practical demonstrations to engage participants throughout the session.
- Provide clear instructions and guidance for hands-on activities related to hardware installation and infrastructure setup.
- Encourage participants to actively participate in troubleshooting exercises and share their experiences.

Say

- Good morning/afternoon, everyone. Today, we'll be diving into the hardware installation and infrastructure setup for 5G networks.
- Let's explore the principles of MIMO technology and discuss the technical requirements of passive and active equipment.

Ask

- Can anyone explain the concept of Multiple Input, Multiple Output (MIMO) technology?
- What are some protective measures we can take to safeguard equipment from environmental elements?

Elaborate

- Principles and concepts of Multiple Input, Multiple Output (MIMO) technology.
- Functionality and technical requirements of passive equipment like antennas, feeders, and cables.
- Functionality and technical requirements of active equipment such as gNodes and microwave link devices.
- Weatherproofing and protective measures to safeguard equipment from environmental elements.
- Specific tools and equipment used for installation and configuration tasks.
- Grounding and lightning protection principles for equipment safety.
- Power supply and backup system requirements to support 5G hardware.

Explain

- Importance of grounding and lightning protection principles for equipment safety.
- Significance of power supply and backup system requirements for supporting 5G hardware.

Demonstrate

Demonstrate the proper installation of passive and active equipment, including grounding and lightning protection measures.

Activity

1. **Activity:** Equipment Installation Simulation
2. **Objective of the activity:** To simulate the process of installing and setting up hardware equipment for a 5G network.
3. **Resources:** Simulation kit containing mock antennas, cables, mounting structures, tools, safety gear.
4. **Time Duration:** 45 minutes
5. **Instructions:**
    - Divide participants into small groups.
    - Provide each group with a simulation kit containing mock hardware equipment and tools.
    - Assign each group a scenario related to hardware installation and infrastructure setup.
    - Groups will work together to simulate the installation process, following proper procedures and safety guidelines.

- Facilitate a debriefing session where each group shares their experiences and challenges encountered during the simulation.
- Discuss best practices and lessons learned from the activity.

6. **Outcome:** Participants will gain practical experience in simulating the installation and setup of hardware equipment for a 5G network.

Notes for Facilitation

- Emphasize the importance of following proper procedures and safety guidelines during hardware installation.
- Provide guidance and support to participants as they navigate through the simulation activity.
- Encourage collaboration and teamwork among group members to effectively complete the task.
- Foster a supportive learning environment where participants feel comfortable asking questions and seeking clarification.
- Highlight the significance of troubleshooting methodologies in identifying and resolving integration issues during hardware installation.

Unit 3.3: Testing, Optimization, and Maintenance of 5G Networks

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe the basics of network topology and architecture in 5G deployments.
2. Discuss quality assurance and testing processes for hardware functionality and performance.
3. Apply knowledge of MIMO antenna parameters to select appropriate configurations for 5G implementation.
4. Verify the availability of passive equipment and ensure its proper installation at the site.
5. Verify the availability of active equipment and ensure its proper installation at the site.
6. Design and implement grounding and lightning protection systems for equipment safety.
7. Set up and test power supply and backup systems to support 5G hardware.
8. Troubleshoot potential integration issues and resolve them effectively.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection, Testing equipment (e.g., spectrum analyzers, network analyzers), Passive and active equipment for demonstration, Safety gear (e.g., helmets, gloves).

Do

- Ensure all necessary resources and equipment are set up and ready for use.
- Facilitate interactive discussions and practical demonstrations to engage participants.
- Provide clear instructions and guidance for hands-on activities and troubleshooting exercises.
- Encourage active participation and collaboration among participants throughout the session.

Say

- Welcome, everyone. Today, we'll delve into the testing, optimization, and maintenance aspects of 5G networks.
- Let's explore the basics of network topology and architecture in 5G deployments and discuss how to ensure hardware functionality and performance.

Ask

- What are some key factors to consider when designing a grounding and lightning protection system for 5G equipment?
- Why is it important to conduct regular maintenance and testing of 5G networks?

Elaborate

- Basics of network topology and architecture in 5G deployments.
- Quality assurance and testing processes for hardware functionality and performance.
- Application of MIMO antenna parameters to select appropriate configurations for 5G implementation.
- Verification of the availability and proper installation of passive and active equipment at the site.
- Design and implementation of grounding and lightning protection systems for equipment safety.

Explain

- Importance of regular maintenance and testing for ensuring optimal performance and reliability of 5G networks.

Demonstrate

Demonstrate the setup and testing of power supply and backup systems for 5G hardware.

Activity

1. **Activity:** Maintenance and Testing Simulation
2. **Objective of the activity:** To simulate maintenance and testing procedures for 5G networks.
3. **Resources:** Simulation kit containing mock hardware equipment, testing equipment, safety gear.
4. **Time Duration:** 60 minutes
5. **Instructions:**
   - Divide participants into small groups.
   - Provide each group with a simulation kit containing mock hardware equipment and testing tools.
   - Assign each group a scenario related to maintenance or testing procedures for 5G networks.
   - Groups will work together to simulate the maintenance or testing process, following proper procedures and safety guidelines.
   - Facilitate a debriefing session where each group shares their experiences and lessons learned from the simulation.
   - Discuss best practices and key takeaways from the activity.
6. **Outcome:** Participants will gain practical experience in simulating maintenance and testing procedures for 5G networks.

Notes for Facilitation

- Ensure participants adhere to safety guidelines and protocols during hands-on activities.
- Provide assistance and guidance as needed during the simulation activity.
- Foster a collaborative learning environment where participants can share their insights and experiences.
- Encourage critical thinking and problem-solving skills during troubleshooting exercises.
- Emphasize the importance of regular maintenance and testing in ensuring the reliability and performance of 5G networks.

Answers to Exercises for PHB

Multiple Choice Questions:

1. c. Air interface for 5G
2. a. Department of Telecommunications (DoT)
3. d. Improve spectral efficiency
4. b. Ekahau Site Survey
5. c. Providing high-capacity connections to multiple devices simultaneously

Descriptive Questions:

1. Refer to Unit 3.1: Pre-Deployment Planning and Regulatory Compliance of 5G Network
   Topic 3.1.1 Standards and Regulations Framework
2. Refer to Unit 3.1: Pre-Deployment Planning and Regulatory Compliance of 5G Network
   Topic 3.1.2 Safety and Compliance Management
3. Refer to Unit 3.2: Hardware Installation and Infrastructure Setup
   Topic 3.2.3 Functionality and technical requirements of active equipment such as gNodes and microwave link devices
4. Refer to Unit 3.2: Hardware Installation and Infrastructure Setup
   Topic 3.2.4 Weatherproofing and protective measures to safeguard equipment from environmental elements
5. Refer to Unit 3.3: Testing, Optimization, and Maintenance of 5G Networks
   Topic 3.3.1 Infrastructure Foundations in 5G Deployments

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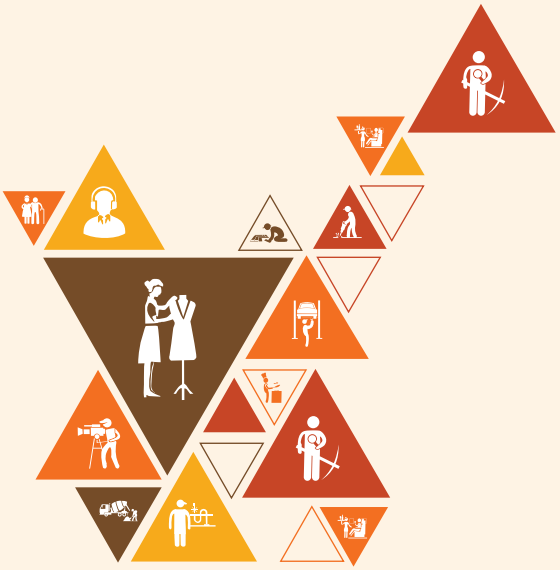
4. Design Spectrum and 5G Network Architecture

Unit 4.1 - Fundamentals of 5G Technology and Spectrum Management

Unit 4.2 - Network Design and Management for 5G Integration



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Key Learning Outcomes

By the end of this module, the participants will be able to:

1. Define the principles of wireless communication, including RF propagation, modulation techniques, and spectral efficiency.
2. Explain 3GPP standards and specifications for 5G networks, focusing on frequency bands and channel access methods.
3. Analyze radio wave propagation principles and their impact on coverage, interference, and capacity planning in wireless networks.
4. Apply spectrum analysis and measurement techniques to assess spectrum availability and interference levels.
5. Utilize frequency planning and resource allocation methods to meet diverse requirements of 5G services and applications.
6. Evaluate network architecture and design principles for dynamic spectrum sharing and efficient coexistence of different operators and technologies.
7. Explain advanced spectrum management techniques like cognitive radio, spectrum sensing, and dynamic spectrum access.
8. Interpret spectrum licensing and frequency coordination processes to comply with regulatory requirements and avoid interference.
9. Discuss network integration principles, including handover mechanisms, seamless mobility management, QoS mechanisms, and security considerations in heterogeneous network environments.

Unit 4.1: Fundamentals of 5G Technology and Spectrum Management

Unit Objectives

By the end of this unit, the participants will be able to:

1. Define the principles of wireless communication, including radio frequency (RF) propagation, modulation techniques, and spectral efficiency.
2. Explain the 3GPP standards and specifications for 5G networks, including frequency bands and channel access methods.
3. Analyze the principles of radio wave propagation and its impact on coverage, interference, and capacity planning in wireless networks.
4. Describe the regulatory guidelines and spectrum allocation policies governing the use of wireless frequency bands for telecommunications.
5. Apply techniques for spectrum analysis and measurement to assess spectrum availability and interference levels.
6. Utilize methods for frequency planning and resource allocation to meet the diverse requirements of 5G services and applications.
7. Interpret spectrum licensing and frequency coordination processes to comply with regulatory requirements and avoid interference.
8. Explain advanced spectrum management techniques, such as cognitive radio, spectrum sensing, and dynamic spectrum access.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection, Spectrum analyzer, Frequency spectrum charts, Regulatory guidelines and documents.

Do

- Ensure all necessary resources and equipment are set up and ready for use.
- Encourage active participation and engagement throughout the session.
- Facilitate discussions and activities that promote understanding and application of key concepts.
- Provide clear explanations and examples to enhance comprehension.

Say

- Welcome, everyone. Today, we'll explore the fundamentals of 5G technology and spectrum management.
- Let's begin by understanding the principles of wireless communication and how they relate to 5G networks.

Ask

- What are some examples of modulation techniques used in wireless communication?
- How do regulatory guidelines impact spectrum allocation for telecommunications?

Elaborate

- Principles of wireless communication, including RF propagation, modulation techniques, and spectral efficiency.
- 3GPP standards and specifications for 5G networks, including frequency bands and channel access methods.
- Principles of radio wave propagation and its impact on coverage, interference, and capacity planning in wireless networks.
- Regulatory guidelines and spectrum allocation policies governing the use of wireless frequency bands for telecommunications.
- Techniques for spectrum analysis and measurement to assess spectrum availability and interference levels.
- Methods for frequency planning and resource allocation to meet the diverse requirements of 5G services and applications.

Explain

- Spectrum management techniques, such as cognitive radio, spectrum sensing, and dynamic spectrum access.

Demonstrate

Practical demonstration of spectrum analysis using a spectrum analyzer.

Activity

1. **Activity:** Spectrum Analysis and Planning
2. **Objective of the activity:** To analyze spectrum availability and plan frequency resources for 5G networks.
3. **Resources:** Spectrum analyzer, Frequency spectrum charts, Whiteboard, Markers.
4. **Time Duration:** 45 minutes
5. **Instructions:**
   - Divide participants into small groups.
   - Provide each group with a spectrum analyzer and frequency spectrum charts.
   - Assign each group a scenario related to spectrum analysis and planning for a 5G deployment.
   - Groups will use the spectrum analyzer to analyze available frequencies and plan resource allocation based on the given scenario.

- Each group will present their findings and proposed frequency allocation on the whiteboard.
- Facilitate a discussion on the challenges and considerations involved in spectrum management for 5G networks.

6. **Outcome:** Participants will gain hands-on experience in spectrum analysis and planning for 5G deployments.

Notes for Facilitation

- Encourage collaboration and problem-solving among participants during the activity.
- Provide guidance and support as needed during spectrum analysis and planning exercises.
- Emphasize the importance of spectrum management in optimizing 5G network performance and capacity.
- Highlight real-world examples and case studies to illustrate concepts and principles.
- Foster a supportive learning environment where participants feel comfortable asking questions and sharing insights.

Unit 4.2: Network Design and Management for 5G Integration

Unit Objectives

By the end of this unit, the participants will be able to:

1. Describe network slicing concepts and how to tailor virtual network instances for different services and user groups.
2. Understand the principles of network integration and interworking between different types of networks, including cellular, Wi-Fi, and satellite.
3. Discuss handover mechanisms and seamless mobility management across heterogeneous network environments.
4. Analyze quality of service (QoS) mechanisms and traffic engineering techniques for efficient resource allocation and prioritization.
5. Examine the role of Fully Qualified Domain Name (FQDN) in the 5G core network for efficient communication between network functions and services.
6. Explore security considerations and authentication mechanisms for seamless connectivity and roaming between integrated networks.
7. Understand evolving trends and developments in wireless communication technologies and spectrum management practices.
8. Evaluate network architecture and design principles for dynamic spectrum sharing and efficient coexistence of different operators and technologies.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection.

Do

- Ensure all necessary resources and equipment are set up and ready for use.
- Foster an interactive and collaborative learning environment throughout the session.
- Encourage participants to ask questions and engage in discussions related to the learning outcomes.
- Facilitate hands-on activities and demonstrations to reinforce key concepts.

Say

- Welcome, everyone. Today, we'll delve into the intricacies of network design and management for seamless 5G integration.
- Let's begin by exploring the fundamental concepts of network slicing and its significance in tailoring virtual network instances for diverse services.

Ask

- What are some examples of services that could benefit from network slicing in a 5G environment?
- How do handover mechanisms contribute to seamless mobility management across heterogeneous network environments?

Elaborate

- Network slicing concepts and their application in tailoring virtual network instances for different services and user groups.
- Principles of network integration and interworking between cellular, Wi-Fi, and satellite networks.
- Handover mechanisms and seamless mobility management across heterogeneous network environments.
- Quality of Service (QoS) mechanisms and traffic engineering techniques for efficient resource allocation and prioritization.
- The role of Fully Qualified Domain Name (FQDN) in the 5G core network for efficient communication between network functions and services.
- Security considerations and authentication mechanisms for seamless connectivity and roaming between integrated networks.
- Evolving trends and developments in wireless communication technologies and spectrum management practices.

Explain

- The significance of dynamic spectrum sharing and efficient coexistence of different operators and technologies.

Demonstrate

Practical demonstration of network slicing implementation using virtualization software.

Activity

1. **Activity:** Network Design Simulation
2. **Objective of the activity:** To simulate the design and integration of a 5G network architecture.
3. **Resources:** Whiteboard, Markers, Presentation slides.
4. **Time Duration:** 60 minutes
5. **Instructions:**
   - Divide participants into small groups.
   - Assign each group a scenario related to designing and integrating a 5G network architecture.
   - Provide participants with access to presentation slides containing relevant network design principles and considerations.

- Each group will design and present their proposed 5G network architecture on the whiteboard, highlighting key components and integration strategies.
- Facilitate a discussion on the strengths and weaknesses of each proposed architecture, emphasizing best practices and optimization techniques.

6. **Outcome:** Participants will gain practical experience in designing and integrating 5G network architectures, applying key principles and considerations discussed during the session.

Notes for Facilitation

- Encourage active participation and collaboration among group members during the activity.
- Provide guidance and feedback on proposed network architectures to enhance understanding and learning outcomes.
- Emphasize the importance of considering diverse services and user groups when designing network slices.
- Highlight real-world examples and case studies to illustrate network integration and management concepts.
- Foster a supportive learning environment where participants feel empowered to explore and experiment with network design principles and techniques.

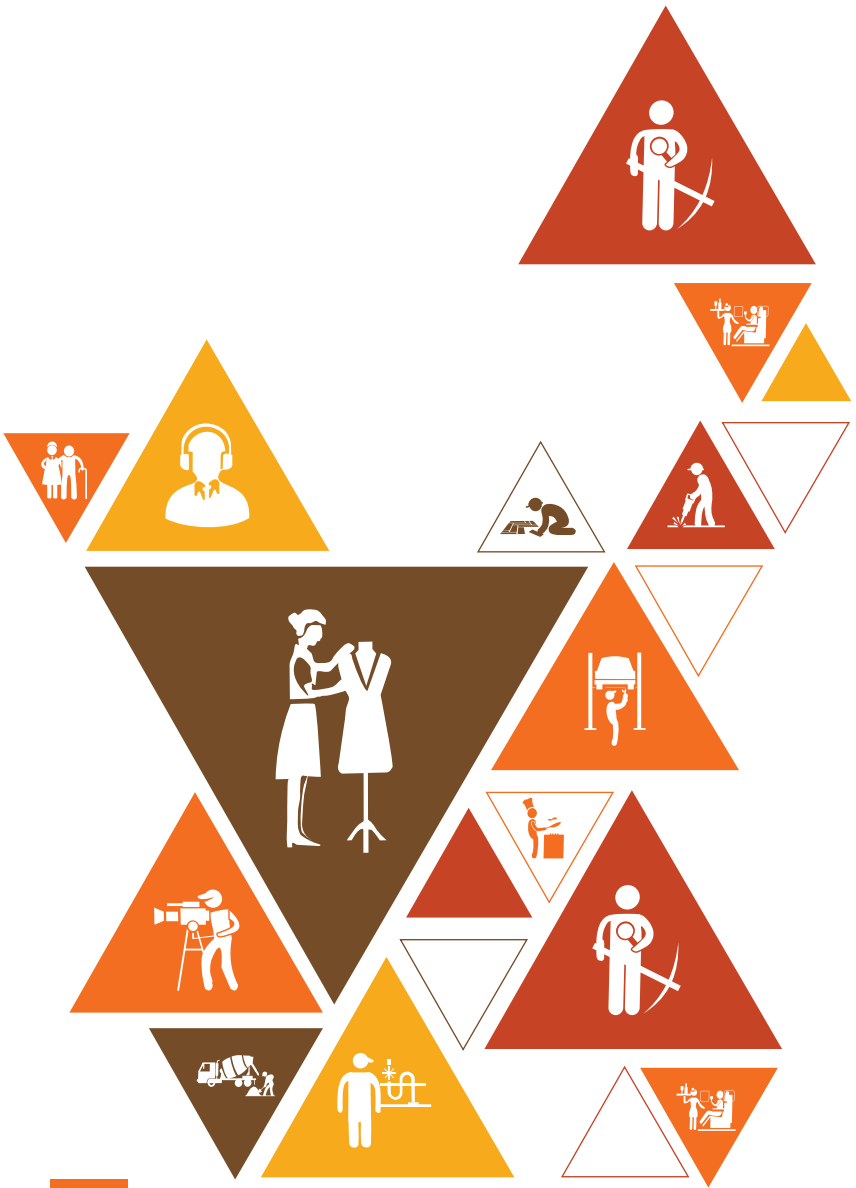
Answers to Exercises for PHB

Multiple Choice Question

1. c. Attenuation of RF signals as they travel through space
2. b. Quadrature Amplitude Modulation (QAM)
3. b. Efficient use of available spectrum
4. d. Enhanced system capacity
5. c. Interoperability issues

Descriptive Questions:

1. Refer to Unit 4.1: Fundamentals of 5G Technology and Spectrum Management
   Topic Line-of-Sight (LOS) and Non-Line-of-Sight (NLOS) Propagation
2. Refer to Unit 4.2: Network Design and Management for 5G Integration
   Topic 4.2.5 Fully Qualified Domain Name (FQDN) in the 5G core network
3. Refer to Unit 4.2: Network Design and Management for 5G Integration
   Topic 4.2.6 Security Considerations and Authentication Mechanisms
4. Refer to Unit 4.2: Network Design and Management for 5G Integration
   Topic 4.2.7 Evolving Trends and Developments in Wireless Communication
5. Refer to Unit 4.2: Network Design and Management for 5G Integration
   Topic 4.2.8 Network Architecture and Design Principles for Dynamic Spectrum Sharing



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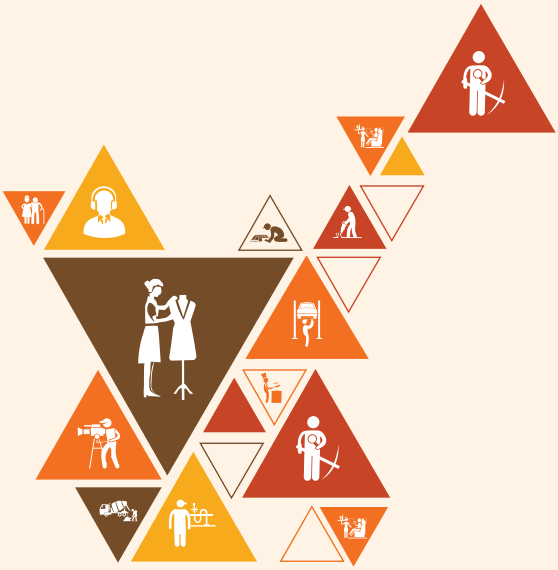
5. Implement the 5G New Radio (NR) and Radio Access

Unit 5.1 - Securing the 5G Network Edge

Unit 5.2 - 5G Network Monitoring and Analysis

Unit 5.3 - 5G Applications and Implementation



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Key Learning Outcomes

By the end of this module, the trainees will be able to:

1. Describe the technical specifications and best practices for implementing robust network access control mechanisms in 5G networks to prevent unauthorized access and irregular data resources.
2. Explain the purpose and functions of firewalls and intrusion detection/prevention systems (IDS/ IPS) in monitoring and filtering incoming and outgoing traffic in 5G networks.
3. Discuss the principles and benefits of content filtering mechanisms in blocking access to specific websites, domains, or IP addresses associated with foreign or irregular data resources.
4. Summarize the concepts and capabilities of traffic analysis tools and anomaly detection systems for monitoring network traffic patterns and identifying irregular or suspicious behaviour in 5G networks.
5. Compare and contrast the utilization of deep packet inspection (DPI) techniques to analyze packet contents and identify foreign or irregular data resources based on specific protocols, signatures, or patterns in 5G networks.
6. Explain the importance of regular updates and patches for all network components, including routers, switches, firewalls, and security systems, to ensure the latest security measures are in place in 5G networks.
7. Describe the continuous monitoring and analysis of network traffic, security logs, and system events to detect and respond to any attempts to access or distribute foreign or irregular data resources in 5G networks.
8. Discuss the principles and concepts of 5G NR Physical Channels and Signals and their significance in 5G network monitoring.
9. Explain the acquisition and utilization of specialized monitoring equipment capable of analysing 5G NR physical channels and signals for real-time monitoring and analysis.
10. Summarize the steps involved in monitoring different 5G NR physical channels, such as the downlink and uplink channels, control channels, synchronization channels, and reference signals, to ensure proper functioning and performance.
11. Describe the process of conducting real-time monitoring of the 5G NR physical channels and signals to capture dynamic changes and fluctuations in the network.
12. Explain the methods for analysing resource allocation and scheduling mechanisms used for downlink transmission in 5G networks.
13. Discuss the identification and configuration of BWP Configuration in 5G networking for efficient resource utilization and management.
14. Explain the role of Physical Layer Procedures in 5G networks and their impact on network performance and efficiency.
15. Describe the procedures for Initial Access and Cell Search in 5G networks and their significance in maintaining network connectivity and coverage.
16. Discuss the operations and procedures involved in PSS and SSS Detection in 5G networks for cell identification and synchronization.
17. Explain the process of capturing received signals and performing frequency analysis to identify the frequency range where the PSS and SSS signals are expected to be present in 5G networks.
18. Describe the implementation of error handling mechanisms to account for cases where the PSS or SSS signals are weak, corrupted, or not detected correctly in 5G networks.

19. Discuss the continuous validation and verification of the accuracy and reliability of the PSS and SSS detection process in 5G networks.
20. Illuminate on the implementation of 5G in an industrial 4.0 setting, such as manufacturing, production, transportation, and warehousing, and assess its impact on operations and efficiency.
21. Elaborate how to implement 5G in various sectors, such as agriculture, entertainment, smart education, and public safety, and evaluate its suitability for different applications and services.
22. Show how to implement network access control mechanisms using suitable tools and equipment to secure the 5G system from unauthorized access and irregular data resources.
23. Deploy firewalls and intrusion detection/prevention systems (IDS/IPS) to monitor and filter network traffic and assess their effectiveness in mitigating threats in 5G networks.
24. Utilize content filtering mechanisms to block access to specific websites, domains, or IP addresses associated with foreign or irregular data resources in a practical network environment.
25. Employ traffic analysis tools and anomaly detection systems to monitor and analyse network traffic patterns for irregular or suspicious behaviour in a simulated 5G network scenario.
26. Configure and operate specialized monitoring equipment to capture and analyse 5G NR physical channels and signals in a laboratory setting.
27. Conduct real-time monitoring of 5G NR physical channels and signals using monitoring equipment to capture dynamic changes and fluctuations in network performance.
28. Analyse resource allocation and scheduling mechanisms for downlink transmission in a practical 5G network setup.
29. Perform frequency analysis on captured signals to identify the frequency range of PSS and SSS signals in a simulated 5G network.
30. Demonstrate the process of synchronizing received signals with the expected timing and frame structure of the 5G system using monitoring equipment in a laboratory environment.
31. Apply suitable ways to implement error handling mechanisms to address weak, corrupted, or undetected PSS or SSS signals in a simulated 5G network.
32. Use appropriate techniques to install and rectify analog and digital beamforming in a practical 5G network configuration.
33. Inspect and configure beamforming settings to optimize beamforming performance in 5G networks.

Unit 5.1: Securing the 5G Network Edge

Unit Objectives

By the end of this unit, the trainees will be able to:

1. Describe technical specifications and best practices for robust network access control mechanisms in 5G networks, focusing on preventing unauthorized access and irregular data resource activities.
2. Explain the purpose and functions of firewalls and intrusion detection/prevention systems (IDS/ IPS) in monitoring and filtering incoming and outgoing traffic in 5G networks to enhance security.
3. Discuss the principles and benefits of content filtering mechanisms for blocking access to specific websites, domains, or IP addresses associated with foreign or irregular data resources in 5G networks.
4. Summarize the concepts and capabilities of traffic analysis tools and anomaly detection systems in 5G networks, emphasizing their role in monitoring traffic patterns and identifying irregular or suspicious behaviour.
5. Compare and contrast the utilization of deep packet inspection (DPI) techniques to analyse packet contents and identify foreign or irregular data resources based on specific protocols, signatures, or patterns in 5G networks.
6. Explain the importance of regular updates and patches for all network components in 5G networks, including routers, switches, firewalls, and security systems, to ensure the latest security measures are in place.
7. Describe the principles and concepts of continuous monitoring and analysis of network traffic, security logs, and system events to detect and respond to any attempts to access or distribute foreign or irregular data resources in 5G networks.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection.

Do

- Create a supportive and interactive learning environment where participants feel comfortable asking questions and sharing insights.
- Use real-world examples and case studies to illustrate key concepts and enhance understanding.
- Encourage group discussions and collaborative problem-solving activities to reinforce learning.
- Provide practical demonstrations or simulations to showcase the implementation of security measures in 5G networks.

Say

- Welcome, everyone. Today, we'll explore the essential strategies and techniques for securing the 5G network edge to safeguard against unauthorized access and irregular data resource activities.
- Let's begin by understanding the importance of robust network access control mechanisms in 5G networks and how they contribute to overall security.

Ask

- What are some potential risks associated with unauthorized access to 5G networks?
- How do intrusion detection/prevention systems enhance the security of 5G networks?

Elaborate

- Technical specifications and best practices for robust network access control mechanisms in 5G networks.
- Purpose and functions of firewalls and intrusion detection/prevention systems (IDS/IPS) in monitoring and filtering incoming and outgoing traffic.
- Principles and benefits of content filtering mechanisms for blocking access to specific websites, domains, or IP addresses associated with irregular data resources.
- Concepts and capabilities of traffic analysis tools and anomaly detection systems in monitoring traffic patterns and identifying suspicious behavior.
- Utilization of deep packet inspection (DPI) techniques to analyze packet contents and identify irregular data resources.
- Importance of regular updates and patches for all network components to ensure the latest security measures are in place.
- Principles and concepts of continuous monitoring and analysis of network traffic, security logs, and system events to detect and respond to security threats.

Explain

- The role of deep packet inspection (DPI) techniques in analyzing packet contents for security purposes.

Demonstrate

Practical demonstration of setting up and configuring a firewall and intrusion detection/prevention system in a simulated 5G network environment.

Activity

1. **Activity:** Security Policy Development
2. **Objective of the activity:** To develop a security policy framework for securing the 5G network edge.
3. **Resources:** Whiteboard, Markers, Presentation slides.
4. **Time Duration:** 60 minutes
5. **Instructions:**
    - Divide participants into small groups.
    - Provide each group with a scenario related to securing the 5G network edge.
    - Using the whiteboard or presentation slides, guide participants through the process of developing a comprehensive security policy framework tailored to their assigned scenario.

- Encourage participants to consider various security measures, such as network access control, firewall configurations, content filtering, and anomaly detection.
- Each group will present their developed security policy framework, explaining the rationale behind their choices and how they address potential security threats.

6. **Outcome:** Participants will gain practical experience in developing a security policy framework for securing the 5G network edge, incorporating key concepts and techniques discussed during the session.

Notes for Facilitation

- Emphasize the importance of staying updated on emerging security threats and implementing proactive security measures.
- Encourage participants to actively engage in group discussions and share their insights and experiences related to network security.
- Provide guidance and feedback to ensure that participants understand the relevance and applicability of security measures in 5G networks.
- Reinforce the importance of regular training and awareness programs to educate network personnel on security best practices.
- Foster a collaborative learning environment where participants feel empowered to contribute to discussions and problem-solving activities related to network security.

Unit 5.2: 5G Network Monitoring and Analysis

Unit Objectives

By the end of this unit, the trainees will be able to:

1. Explain the process of obtaining and utilizing monitoring equipment capable of analyzing 5G NR physical channels and signals for real-time monitoring and analysis.
2. Summarize the steps involved in monitoring various 5G NR physical channels, including downlink and uplink channels, control channels, synchronization channels, and reference signals, ensuring proper functioning and performance.
3. Describe the process of conducting real-time monitoring of 5G NR physical channels and signals to capture dynamic changes and fluctuations in the network.
4. Explain the methods for analyzing resource allocation and scheduling mechanisms used for downlink transmission in 5G networks.
5. Discuss the identification and configuration of BWP (Bandwidth Part) Configuration in 5G networking for efficient resource utilization and management.
6. Explain the role of Physical Layer Procedures in 5G networks and their impact on network performance and efficiency.
7. Discuss the operations and procedures involved in PSS (Primary Synchronization Signal) and SSS (Secondary Synchronization Signal) Detection in 5G networks for cell identification and synchronization.

Resources to be Used

Participant handbook, Notepad, Pen, Whiteboard, Markers, Presentation slides, Overhead projector or large screen, Computer/laptop with internet connection.

Do

- Foster an interactive learning environment by encouraging questions and discussions throughout the session.
- Use case studies and practical examples to illustrate concepts and enhance understanding.
- Incorporate hands-on activities or demonstrations to reinforce key learning points.
- Provide opportunities for participants to apply the knowledge gained through group exercises or simulations.

Say

- Welcome, everyone. Today, we'll dive into the intricacies of 5G network monitoring and analysis to ensure optimal network performance and efficiency.
- Let's explore the tools and techniques for real-time monitoring and analysis of 5G NR physical channels and signals.

Ask

- Why is real-time monitoring and analysis essential for maintaining the performance of a 5G network?
- What are some challenges associated with monitoring and analyzing 5G NR physical channels and signals?

Elaborate

- Obtaining and utilizing monitoring equipment capable of analyzing 5G NR physical channels and signals for real-time monitoring and analysis.
- Steps involved in monitoring various 5G NR physical channels, including downlink and uplink channels, control channels, synchronization channels, and reference signals.
- Process of conducting real-time monitoring of 5G NR physical channels and signals to capture dynamic changes and fluctuations in the network.
- Methods for analyzing resource allocation and scheduling mechanisms used for downlink transmission in 5G networks.
- Identification and configuration of Bandwidth Part (BWP) Configuration in 5G networking for efficient resource utilization and management.
- Role of Physical Layer Procedures in 5G networks and their impact on network performance and efficiency.
- Operations and procedures involved in Primary Synchronization Signal (PSS) and Secondary Synchronization Signal (SSS) Detection in 5G networks for cell identification and synchronization.

Explain

- Importance of real-time monitoring and analysis in maintaining the performance and efficiency of 5G networks.

Activity

1. **Activity:** Network Monitoring Simulation
2. **Objective of the activity:** To simulate the process of real-time monitoring and analysis of 5G NR physical channels and signals.
3. **Resources:** Whiteboard, Markers, Presentation slides, Computer/laptop with internet connection.
4. **Time Duration:** 60 minutes
5. **Instructions:**
   - Divide participants into small groups.
   - Provide each group with a simulated scenario involving monitoring and analysis of 5G NR physical channels and signals.
   - Using the whiteboard or presentation slides, guide participants through the steps of conducting real-time monitoring and analysis based on their assigned scenario.
   - Encourage participants to discuss their findings and observations, as well as any challenges encountered during the simulation.

- Facilitate a group discussion to debrief the simulation and highlight key takeaways and best practices for effective network monitoring and analysis.

6. **Outcome:** Participants will gain practical experience in conducting real-time monitoring and analysis of 5G NR physical channels and signals, enhancing their understanding of network monitoring techniques.

Notes for Facilitation

- Encourage active participation and collaboration among participants during group activities and discussions.
- Provide guidance and clarification as needed to ensure that participants grasp the concepts and techniques discussed.
- Emphasize the importance of continuous learning and staying updated on advancements in 5G network monitoring and analysis.
- Foster a supportive learning environment where participants feel comfortable sharing their insights and experiences.
- Reinforce the relevance of network monitoring and analysis in optimizing 5G network performance and ensuring a seamless user experience.

Unit 5.3: 5G Applications and Implementation

Unit Objectives

By the end of this unit, the trainees will be able to:

1. Illuminate on the implementation of 5G in an industrial 4.0 setting, such as manufacturing, production, transportation, and warehousing, and assess its impact on operations and efficiency.
2. Elaborate how to implement 5G in various sectors, such as agriculture, entertainment, smart education, and public safety, and evaluate its suitability for different applications and services.
3. Use appropriate techniques to install and rectify analogy and digital beamforming in a practical 5G network configuration.
4. Inspect and configure beamforming settings to optimize beamforming performance in 5G networks.

Resources to be Used

Participant handbook, notepad, pen, whiteboard, markers, presentation slides, overhead projector or large screen, computer/laptop with internet connection.

Do

- Begin the session by welcoming participants and providing a brief overview of the agenda.
- Ensure that all necessary resources for the session are set up and functioning properly.
- Engage participants in discussions and practical exercises related to 5G implementation and applications.
- Demonstrate beamforming techniques using appropriate tools and equipment.

Say

- Welcome, everyone, to today's session on 5G Applications and Implementation. We'll be exploring the various sectors where 5G can be implemented and its impact on operations and efficiency.
- Throughout the session, feel free to ask questions and participate actively in discussions. Your engagement will enrich our learning experience.

Ask

- How familiar are you with the concept of 5G and its potential applications in different industries?
- Can you think of any specific examples where implementing 5G could significantly improve efficiency or service delivery?

Elaborate

- Implementation of 5G in industrial 4.0 settings
- 5G applications in agriculture, entertainment, smart education, and public safety
- Analog and digital beamforming techniques
- Optimizing beamforming performance in 5G networks

Explain

Analog and digital beamforming

Demonstrate

Practical demonstration of beamforming techniques using simulation software or hardware tools.

Activity

1. **Activity:** Beamforming Optimization Exercise
2. **Objective of the activity:** To understand how to configure and optimize beamforming performance in a 5G network.
3. **Resources:** Whiteboard, markers, presentation slides.
4. **Time Duration:** 20 minutes
5. **Instructions:**
    - Divide participants into small groups.
    - Provide each group with a hypothetical scenario where beamforming needs to be optimized.
    - Ask groups to brainstorm and sketch out potential beamforming configurations on the whiteboard.
    - Facilitate a discussion on each group's approach and provide feedback on optimization strategies.
6. **Outcome:** Participants will gain practical insights into optimizing beamforming performance in real-world scenarios.

Notes for Facilitation

- Encourage active participation and collaboration among participants throughout the session.
- Provide real-world examples and case studies to illustrate the concepts discussed.
- Be prepared to address technical questions and provide additional resources for further learning.
- Break down complex concepts into digestible chunks to ensure understanding.
- Allocate sufficient time for hands-on activities and practical demonstrations to reinforce learning.

Answers to Exercises for PHB

Multiple Choice Questions

1. c. Controlling incoming and outgoing traffic
2. d. Plixer
3. b. Maximizing spectral efficiency
4. c. To adapt to dynamic network changes
5. c. Dynamic and customizable beams

Answer the following:

1. Refer to Unit 5.3: 5G Applications and Implementation
   Topic 5.3.3 Inspection and Configuration of Beamforming Settings in 5G Networks
2. Refer to Unit 5.1 Securing the 5G Network Edge
   Topic 5.1.2 Purpose and Functions of Firewalls and Intrusion Detection/Prevention Systems (IDS/IPS) in 5G Network Traffic Monitoring
3. Refer to Unit 5.1 Securing the 5G Network Edge
   Topic 5.1.9 Employment of Traffic Analysis Tools and Anomaly Detection Systems in Simulated 5G Network Scenarios
4. Refer to Unit 5.2: 5G Network Monitoring and Analysis
   Topic 5.2.3 5G Network Procedures and Operations
5. Refer to Unit 5.2: 5G Network Monitoring and Analysis
   Topic 5.2.4 Signal Capture and Analysis in 5G Networks

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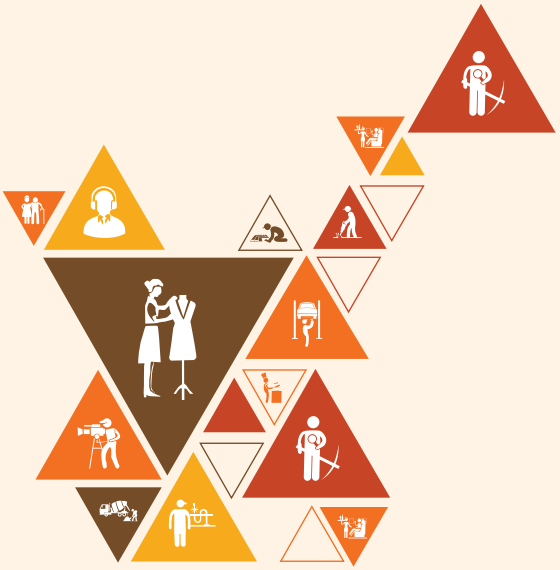
6. Employability Skills



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Scan the QR codes or click on the link for the e-books

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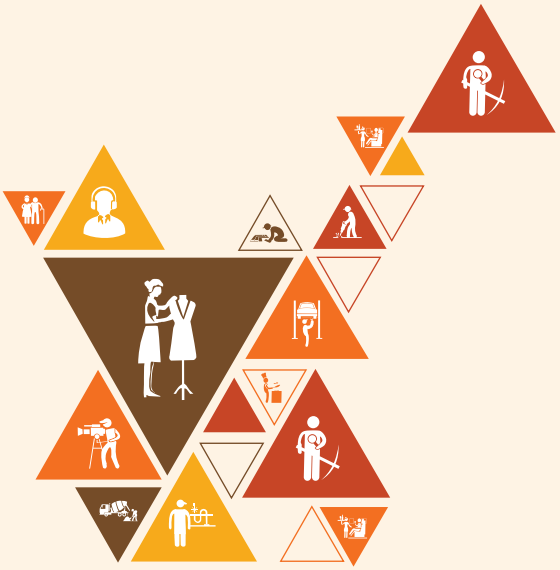
7. Annexures

Annexure I: Training Delivery Plan

Annexure II: Assessment Criteria

Annexure III: List of QR Codes Used in PHB



Annexure I

Training Delivery Plan

Training Delivery Plan			
Program Name:	5G System Integrator		
Qualification Pack Name & Ref. ID	5G System Integrator, TEL/Q4202, V2.0		
Version No.	2.0	**Version Update Date**	31/08/2021
Pre-requisites to Training (if any)	Not Applicable		
Training Outcomes	**By the end of this program, the participants will be able to:** 1. Evaluate the availability of hardware equipment at a specified site location. 2. Establish standards for designing a 5G network architecture. 3. Create a comprehensive design for spectrum allocation and 5G network architecture. 4. Implement 5G New Radio (NR) and Radio Access technologies 5. Explain the importance of organising work and resources as per health and Safety standards.		

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
1	**Introduction to the role of 5G System Integrator**	**Navigating the Telecom Landscape: 5G Integration and Industry Overview**	• Describe the size and scope of the Telecom industry and its sub-sectors. • Discuss the role and responsibilities of a 5G System Integrator.	Bridge Module	Classroom lecture/ PowerPoint Presentation/ Question & Answer and Group Discussion	Training Kit - Trainer Guide, Presentations, White-board, Marker, Projector, Laptop, Video Films	8 Theory (03:00) Practical (05:00)
		Exploring Career Paths for 5G System Integrators and Organizational Best Practices	• Identify various employment opportunities for a 5G System Integrator. • Discuss the organisational policies on workplace ethics, managing sites, quality standards, personnel management and public relations (PR).	Bridge Module			8 Theory (03:00) Practical (05:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Enhancing Efficiency: The Role and Operations of 5G System Integrators	• Describe the process workflow in the organization and the role of 5G System Integrator. • List the various daily, weekly, monthly operations/activities that take place at the site under 5G System Integrator.	Bridge Module			7 Theory (02:00) Practical (05:00)
		Exploring the Role of a 5G System Integrator: Scope, Responsibilities, and Challenges, Alongside Pre-Requisites Analysis	• Role play based on case studies, outlining the scope, responsibilities, and challenges of 5G System Integrator. • Analyse the requirements for the course and prepare for the pre- requisites of the course.	Bridge Module			7 Theory (02:00) Practical (05:00)
2	**Set Standards for 5G Network Architecture**	**5G Technology Fundamentals**	• Explain the principles and fundamentals of 5G technology, such as beamforming, massive MIMO, and network slicing. • Describe different authentication methods like SIM-based authentication, AKA, and EAP methods for securing subscribers. • Discuss encryption methods, secure key exchange, and authentication protocols for network security.	TEL/N4205 PC1, PC8, KU1, KU5, KU8, KU18	Classroom lecture/ PowerPoint Presentation/ Question & Answer and Group Discussion	Training Kit (Trainer Guide, Presentations), Whiteboard, Marker, Projector, Laptop, Projector, Whiteboard, Marker, Laptop, 5G Network Equipment, Spectrum Analyzer, Network Monitoring Tools, Handheld Devices, Simulation Software, Traffic Generators,	7 Theory (04:00) Practical (03:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		IMT-2020 Frame-work	• Describe the ITU's IMT-2020 framework and the specific frequency bands designated for 5G deployment. • Discuss regulatory compliance regarding telecommunications standards and spectrum allocation policies. • Identify emerging networking technologies and advancements in the field of 5G.	TEL/N4205 PC2, PC18, KU2, KU17, KU18		QoS Testing Tools, Drive Testing Equipment, Network Planning Software, Authen-tication Protocols, Network Security Tools, Net-work Per-formance Testing Tools	7 Theory (04:00) Practical (03:00)
		3GPP Stan-dards	• Identify the 3GPP standards that define the technical specifications for 5G network elements and protocols. • Discuss the service-based architecture (SBA) and network function virtualization (NFV) for service delivery in 5G networks. • Explain QoS mechanisms like bearer control, flow control, and resource reservation in 5G.	TEL/N4205 PC1, PC6, PC10, KU3, KU6, KU11			7 Theory (04:00) Practical (03:00)
		Network Planning	• Conduct network planning activities to design the coverage and capacity of the 5G network. • Analyze traffic patterns and trends to understand the growth in network demand. • Evaluate the current capacity of the network infrastructure and identify areas where scalability is required.	TEL/N4205 PC6, PC11, PC18, KU7, KU12, KU14			7 Theory (04:00) Practical (03:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Installation & Deployment	• Design a 5G network architecture to support dynamic spectrum sharing between different operators and technologies. • Perform installation and configuration of base stations, RAN elements, and core network components based on network design. • Verify if the existing hardware and equipment can support the increased traffic.	TEL/N4205 PC4, PC9, PC14, KU15, KU18			7 Theory (04:00) Practical (03:00)
		Security Implementation	• Implement subscriber authentication and security mechanisms to ensure secure connectivity. • Develop interoperability standards to ensure seamless communication between different vendors' equipment and network elements. • Implement Quality of Service (QoS) mechanisms to prioritize critical services and applications	TEL/N4205 PC7, PC13, PC17, KU5, KU8, KU11			8 Theory (04:00) Practical (04:00)
		Network Monitoring	• Deploy network monitoring and analytics tools to continuously monitor network performance. • Utilize monitoring tools like SNMP, NetFlow, and Deep Packet Inspection (DPI) to assess network performance.	TEL/N4205 PC15, PC16, KU10, KU13, KU14, KU20			8 Theory (04:00) Practical (04:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Analyze network performance metrics and make informed decisions for updates and optimizations.				
		Trouble-shoot-ing	• Identify and troubleshoot network issues, such as latency, packet loss, and throughput.	TEL/N4205 PC16			8 Theory (04:00) Practical (04:00)
		Testing & Optimiza-tion	• Perform testing and optimization activities to verify the network's performance and fine-tune configuration parameters.	TEL/N4205 PC9			8 Theory (04:00) Practical (04:00)
		Integra-tion of Network Types	• Integrate network types for seamless connectivity, including cellular, Wi-Fi, and satellite networks.	TEL/N4205 PC5			8 Theory (04:00) Practical (04:00)
		Scalability Assess-ment	• Evaluate the current capacity of the network infrastructure and identify areas where scalability is required.	TEL/N4205 PC11			8 Theory (04:00) Practical (04:00)
		Traffic Analysis	• Analyze traffic patterns and trends to understand the growth in network demand.	TEL/N4205 PC12			8 Theory (06:00) Practical (02:00)
3	**Equipment steriliza-tion and validation**	**Steriliza-tion and decontam-ination quality**	• Recall 3GPP standards and specifications relevant to 5G network deployment. • Explain the principles and concepts of Multiple Input, Multiple Output (MIMO) technology.	TEL/N4206 PC1, KU16	Classroom lecture/ PowerPoint Presentation/ Question & Answer and Group Discussion	Training Kit (Trainer Guide, Pre-sentations), White-board, Marker, Projector, Laptop, Projector, Screen, White-board, Markers, Laptops, Training Materials, Handouts,	8 Theory (04:00) Practical (04:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Describe the functionality and technical requirements of passive equipment like antennas, feeders, and cables. • Discuss the functionality and technical requirements of active equipment such as gNodes and microwave link devices.			5G Network Equipment (gNB, antennas, cables, etc.), Tools (e.g., screwdrivers, wrenches), Simulation Software, Spectrum Analyzer, Network Monitoring Tools, Safety Equipment (e.g., gloves, safety goggles), Power Supply/Battery Backup, Inventory Management System, Testing Equipment, Interconnection Components (network cables, connectors), Weatherproofing Materials, Lightning Protection Systems, Mounting Structures (towers, poles),	
		Methodology for area inspection	• Summarize the procedures for validating and obtaining necessary licenses and permits for hardware installation. • Explain weatherproofing and protective measures to safeguard equipment from environmental elements. • Identify specific tools and equipment used for installation and configuration tasks. • Define the types of network cables, connectors, and interconnection standards used in 5G networks. • Describe grounding and lightning protection principles for equipment safety.	TEL/N4206 PC2,P-C3,KU2,KU3			8 Theory (04:00) Practical (04:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Types of decontamination	• Discuss power supply and backup system requirements to support 5G hardware. • Explain mounting structures and hardware specifications for different installation scenarios. • Describe inventory management practices and techniques for equipment tracking. • Explain inspection techniques to identify damages or defects in hardware equipment. • Discuss health and safety regulations relevant to equipment installation and operation.	TEL/N4206 PC4,P-C5,KU3,KU5		Health and Safety Guidelines, Trouble-shooting Guides.	8 Theory (04:00) Practical (04:00)
		Compliance requirements for sterilization operations	• Summarize troubleshooting methodologies to address potential integration issues. • Describe the basics of network topology and architecture in 5G deployments. • Explain quality assurance and testing processes for hardware functionality and performance. • Demonstrate the ability to analyze 3GPP standards, budget, architectural, and other design documents for 5G network deployment. • Apply knowledge of MIMO antenna parameters to select appropriate configurations for 5G implementation	TEL/N4206 PC6, PC7, PC8, KU6, KU7 , KU8			8 Theory (04:00) Practical (04:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Importance of quality checks	• Verify the availability of passive equipment and ensure its proper installation at the site. • Verify the availability of active equipment and ensure its proper installation at the site. • Validate the necessary licenses and permits for hardware installation and ensure compliance. • Inspect hardware equipment for weatherproofing and protective enclosures to meet environmental requirements. • Demonstrate the use of specialized equipment and tools for installation and configuration tasks. • Implement proper network cable and connector configurations for seamless interconnection.	TEL/N4206 PC9, PC10, PC11, KU9, KU10, KU11			8 Theory (02:00) Practical (06:00)
		Types of PPE	• Design and implement grounding and lightning protection systems for equipment safety. • Set up and test power supply and backup systems to support 5G hardware. • Demonstrate the installation of mounting structures and hardware for secure antenna placement. • Conduct a thorough inventory check and track hardware items as per the deployment plan.	TEL/N4206 PC12,PC13, KU12,KU13			8 Theory (04:00) Practical (04:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Decontamination, inspection, cleaning and sterilization	• Perform equipment inspection to identify any damages or defects before installation. • Follow health and safety regulations during equipment installation and operation. • Troubleshoot potential integration issues and resolve them effectively.	TEL/N4206 PC14, PC15, KU14, KU15			8 Theory (04:00) Practical (04:00)
		Identify operational issues	• Design and plan network topology and architecture for efficient 5G deployment. • Execute quality assurance and testing processes to verify hardware functionality and performance	TEL/N4206 PC16, KU16,KU17			4 Theory (02:00) Practical (02:00)
4	**Design Spectrum and 5G Network Architecture**	**Wireless Communication Principles, 5G Standards, and Spectrum Regulations**	• Define the principles of wireless communication, including radio frequency (RF) propagation, modulation techniques, and spectral efficiency. • Explain the 3GPP standards and specifications for 5G networks, including frequency bands and channel access methods. • Describe the regulatory guidelines and spectrum allocation policies governing the use of wireless frequency bands for telecommunications	TEL/N4207 PC1, PC2, KU1,KU2	Classroom lecture/ PowerPoint Presentation/ Question & Answer and Group Discussion	Training Kit (Trainer Guide, Presentations), Whiteboard, Marker, Projector, Laptop, Projector, Screen, Whiteboard, Markers, Laptops, Training Materials, Handouts, 5G Network Equipment (gNB, antennas, cables, etc.), Tools (e.g., screwdrivers,	7 Theory (04:00) Practical (03:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Optimizing Wireless Networks	• Analyze the principles of radio wave propagation and its impact on coverage, interference, and capacity planning in wireless networks. • Apply techniques for spectrum analysis and measurement to assess spectrum availability and interference levels. • Utilize methods for frequency planning and resource allocation to meet the diverse requirements of 5G services and applications.	TEL/N4207 PC3, PC4, KU3, KU4		wrenches), Simulation Software, Spectrum Analyzer, Network Monitoring Tools, Safety Equipment (e.g., gloves, safety goggles), Power Supply/Battery Backup, Inventory Management System, Testing Equipment, Interconnection Components (network cables, connectors), Weatherproofing Materials, Lightning Protection Systems, Mounting Structures (towers, poles), Health and Safety Guidelines, Troubleshooting Guides.	7 Theory (04:00) Practical (03:00)
		Advanced Spectrum Management and Network Slicing	• Evaluate network architecture and design principles for dynamic spectrum sharing and efficient coexistence of different operators and technologies. • Explain advanced spectrum management techniques, such as cognitive radio, spectrum sensing, and dynamic spectrum access. (KU8) • Interpret spectrum licensing and frequency coordination processes to comply with regulatory requireements and avoid interference. • Describe network slicing concepts and how to tailor virtual network instances for different services and user groups.	TEL/N4207 PC5,P-C6,KU5,KU6			7 Theory (04:00) Practical (03:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Integrated Network Interwork-ing	• Understand the principles of network integration and interworking between different types of networks, including cellular, Wi-Fi, and satellite. • Discuss handover mechanisms and seamless mobility management across heterogeneous network environments. • Analyze quality of service (QoS) mechanisms and traffic engineering techniques for efficient resource allocation and prioritization. • Examine the role of Fully Qualified Domain Name (FQDN) in the 5G core network for efficient communication between network functions and services. • Explore security considerations and authentication mechanisms for seamless connectivity and roaming between integrated networks.	TEL/N4207 PC7,P-C8,KU7,KU8			7 Theory (04:00) Practical (03:00)
		Wireless Communi-cation	• Understand evolving trends and developments in wireless communication technologies and spectrum management practices.	TEL/N4207 PC9, PC10, KU9, KU10			7 Theory (04:00) Practical (03:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Define the principles of wireless communication, including radio frequency (RF) propagation, modulation techniques, and spectral efficiency. • Explain the 3GPP standards and specifications for 5G networks, including frequency bands and channel access methods. • Describe the regulatory guidelines and spectrum allocation policies governing the use of wireless frequency bands for telecommunications.				
		Radio Wave Propagation Analysis & Spectrum Measurement for Wireless Networks	• Analyze the principles of radio wave propagation and its impact on coverage, interference, and capacity planning in wireless networks. • Apply techniques for spectrum analysis and measurement to assess spectrum availability and interference levels.	TEL/N4207 PC11, PC12, KU11, KU12			8 Theory (04:00) Practical (04:00)
		Advanced Techniques for 5G Spectrum Management	• Utilize methods for frequency planning and resource allocation to meet the diverse requirements of 5G services and applications. • Evaluate network architecture and design principles for dynamic spectrum sharing and efficient coexistence of different operators and technologies.	TEL/N4207 PC13, PC14, KU13, KU14			8 Theory (04:00) Practical (04:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Explain advanced spectrum management techniques, such as cognitive radio, spectrum sensing, and dynamic spectrum access.				
		Managing Spectrum Licensing, Frequency Coordination, and Network Slicing for Regulatory Compliance and Service Customization	• Interpret spectrum licensing and frequency coordination processes to comply with regulatory requirements and avoid interference. • Describe network slicing concepts and how to tailor virtual network instances for different services and user groups.	TEL/N4207 PC15, PC16, KU15, KU16			8 Theory (04:00) Practical (04:00)
		Network Integration: Seamless Mobility Across Cellular, Wi-Fi, and Satellite Networks	• Understand the principles of network integration and interworking between different types of networks, including cellular, Wi-Fi, and satellite. • Discuss handover mechanisms and seamless mobility management across heterogeneous network environments.	TEL/N4207 PC17, PC18, KU17, KU18			8 Theory (04:00) Practical (04:00)
		Enhancing 5G Efficiency	• Analyze quality of service (QoS) mechanisms and traffic engineering techniques for efficient resource allocation and prioritization. • Examine the role of Fully Qualified Domain Name (FQDN) in the 5G core network for efficient communication between network functions and services.	TEL/N4207 PC18, KU19			8 Theory (04:00) Practical (04:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Security and Authentication in Seamless Network Roaming	• Explore security considerations and authentication mechanisms for seamless connectivity and roaming between integrated networks.	TEL/N4207 PC19, KU19			8 Theory (04:00) Practical (04:00)
		Wireless Communication Technology and Spectrum Management Trends	• Understand evolving trends and developments in wireless communication technologies and spectrum management practices.	TEL/N4207 PC19, KU19, KU20			8 Theory (02:00) Practical (06:00)
5	**Implement the 5G New Radio (NR) and Radio Access**	**Securing 5G Networks**	• Describe the technical specifications and best practices for implementing robust network access control mechanisms in 5G networks to prevent unauthorized access and irregular data resources. • Explain the purpose and functions of firewalls and intrusion detection/prevention systems (IDS/IPS) in monitoring and filtering incoming and outgoing traffic in 5G networks. • Discuss the principles and benefits of content filtering mechanisms in blocking access to specific websites, domains, or IP addresses associated with foreign or irregular data resources.	TEL/N4208 PC1, PC2, PC3, PC4, KU1, KU2	Classroom lecture/ PowerPoint Presentation/ Question & Answer and Group Discussion	Training Kit (Trainer Guide, Presentations), Whiteboard, Marker, Projector, Laptop, Projector, Screen, Whiteboard, Markers, Laptops, Training Materials, Handouts, 5G Network Equipment (gNB, antennas, cables, etc.), Tools (e.g., screwdrivers, wrenches), Simulation Software, Spectrum Analyzer, Network Monitoring Tools,	7 Theory (04:00) Practical (03:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Summarize the concepts and capabilities of traffic analysis tools and anomaly detection systems for monitoring network traffic patterns and identifying irregular or suspicious behavior in 5G networks			Safety Equipment (e.g., gloves, safety goggles), Power Supply/Battery Backup, Inventory Management System, Testing Equipment, Interconnection Components (network cables, connectors), Weatherproofing Materials, Lightning Protection Systems, Mounting Structures (towers, poles), Health and Safety Guidelines, Troubleshooting Guides.	
		Securing 5G Networks: DPI Techniques, Patch Management, and Continuous Monitoring	• Compare and contrast the utilization of deep packet inspection (DPI) techniques to analyze packet contents and identify foreign or irregular data resources based on specific protocols, signatures, or patterns in 5G networks. • Explain the importance of regular updates and patches for all network components, including routers, switches, firewalls, and security systems, to ensure the latest security measures are in place in 5G networks. • Describe the continuous monitoring and analysis of network traffic, security logs, and system events to detect and respond to any attempts to access or distribute foreign or irregular data resources in 5G networks.	TEL/N4208 PC5, PC6, PC7, KUU4, KU5, KU6			7 Theory (04:00) Practical (03:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Real-Time Monitoring of 5G NR Physical Channels and Signals: Principles, Equipment, and Procedures	• Discuss the principles and concepts of 5G NR Physical Channels and Signals and their significance in 5G network monitoring. • Explain the acquisition and utilization of specialized monitoring equipment capable of analyzing 5G NR physical channels and signals for real-time monitoring and analysis. • Summarize the steps involved in monitoring different 5G NR physical channels, such as the downlink and uplink channels, control channels, synchronization channels, and reference signals, to ensure proper functioning and performance. • Describe the process of conducting real-time monitoring of the 5G NR physical channels and signals to capture dynamic changes and fluctuations in the network	TEL/N4208 PC9, PC10, PC11, PC12, KU7, KU8, KU9			7 Theory (04:00) Practical (03:00)
		Resource Management and Optimization in 5G Networks	• Explain the methods for analyzing resource allocation and scheduling mechanisms used for downlink transmission in 5G networks. • Discuss the identification and configuration of BWP Configuration in 5G networking for efficient resource utilization and management.	TEL/N4208 PC13, PC14, PC15, PC16, KU10, KU11			7 Theory (04:00) Practical (03:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Explain the role of Physical Layer Procedures in 5G networks and their impact on network performance and efficiency. • Describe the procedures for Initial Access and Cell Search in 5G networks and their significance in maintaining network connectivity and coverage. • Discuss the operations and procedures involved in PSS and SSS Detection in 5G networks for cell identification and synchronization.				
		Integration of 5G Signal Detection and Error Handling in Industrial 4.0 Environments	• Explain the process of capturing received signals and performing frequency analysis to identify the frequency range where the PSS and SSS signals are expected to be present in 5G networks. • Describe the implementation of error handling mechanisms to account for cases where the PSS or SSS signals are weak, corrupted, or not detected correctly in 5G networks. • Discuss the continuous validation and verification of the accuracy and reliability of the PSS and SSS detection process in 5G networks.	TEL/N4208 PC17, PC18, PC19, PC20, KU12, KU13, KU14			7 Theory (04:00) Practical (03:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Illuminate on the implementation of 5G in an industrial 4.0 setting, such as manufacturing, production, transportation, and warehousing, and assess its impact on operations and efficiency.				
		Imple-menting 5G	• Elaborate how to implement 5G in various sectors, such as agriculture, entertainment, smart education, and public safety, and evaluate its suitability for different applications and services. • Show how to implement network access control mechanisms using suitable tools and equipment to secure the 5G system from unauthorized access and irregular data resources.	TEL/N4208 PC21, PC22, PC23, KU15, KU16			7 Theory (04:00) Practical (03:00)
		Enhancing Security Measures in 5G Net-works	• Deploy firewalls and intrusion detection/ prevention systems (IDS/IPS) to monitor and filter network traffic and assess their effectiveness in mitigating threats in 5G networks. • Utilize content filtering mechanisms to block access to specific websites, domains, or IP addresses associated with foreign or irregular data resources in a practical network environment.	TEL/N4208 PC24, PC25, KU 17, KU18			8 Theory (04:00) Practical (04:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
			• Employ traffic analysis tools and anomaly detection systems to monitor and analyze network traffic patterns for irregular or suspicious behavior in a simulated 5G network scenario				
		5G NR Monitoring, Analysis, and Resource Allocation	• Configure and operate specialized monitoring equipment to capture and analyze 5G NR physical channels and signals in a laboratory setting. • Conduct real-time monitoring of 5G NR physical channels and signals using monitoring equipment to capture dynamic changes and fluctuations in network performance. • Analyze resource allocation and scheduling mechanisms for downlink transmission in a practical 5G network setup	TEL/N4208 PC26, PC27, KU19, KU20			8 Theory (04:00) Practical (04:00)
		Analyzing PSS and SSS Frequency Ranges in Simulated 5G Networks	• Perform frequency analysis on captured signals to identify the frequency range of PSS and SSS signals in a simulated 5G network.	TEL/N4208 PC28, KU 21			8 Theory (04:00) Practical (04:00)
		Synchronizing Signals in 5G Lab Environment	• Demonstrate the process of synchronizing received signals with the expected timing and frame structure of the 5G system using monitoring equipment in a laboratory environment	TEL/N4208 PC29, KU22			8 Theory (04:00) Practical (04:00)

SL	Module Name	Session name	Session Objectives	NOS	Methodology	Training Tools/Aids	Duration (hours)
		Implementing Error Handling for Weak PSS/SSS Signals in Simulated 5G Network	• Apply suitable ways to implement error handling mechanisms to address weak, corrupted, or undetected PSS or SSS signals in a simulated 5G network.	TEL/N4208 PC26, PC29, KU20, KU22			8 Theory (04:00) Practical (04:00)
		Optimizing Beamforming Performance in Practical 5G Networks	• Use appropriate techniques to install and rectify analog and digital beamforming in a practical 5G network configuration. • Inspect and configure beamforming settings to optimize beamforming performance in 5G networks	TEL/N4208 PC29, PC30, KU 22, KU23			8 Theory (06:00) Practical (02:00)
Total Duration							**Theory: 180:00** **Practical: 180:00**
Employability Skills (DGT/VSQ/N0101) **(https://www.skillindiadigital.gov.in/content/list)**							**60:00**
OJT							**00:00**
Apprenticeship Training (AT)							**00:00**
Total Duration							**PR + TH + OJT + ES= 420 : 00**

Annexure II

Assessment Criteria

CRITERIA FOR ASSESSMENT OF TRAINEES

Assessment Criteria for 5G System Integrator	
Job Role	**5G System Integrator**
Qualification Pack	**TEL/Q4202, V2.0**
Sector Skill Council	**Telecom Sector Skill Council**

S. No.	Guidelines for Assessment
1	The assessment for the theory part will be based on knowledge bank of questions approved by the SSC.
2	Assessment will be conducted for all compulsory NOS, and where applicable, on the selected elective/ option NOS/ Set of NOS.
3	Individual assessment agencies will create unique question papers for theory part for each candidate at each examination/training centre (as per assessment criteria below).
4	Individual assessment agencies will create unique evaluations for skill practical for every student at each examination/training centre based on this criterion.
5	To pass the Qualifications File, every trainee should score a minimum of 50% of aggregate marks.
6	In case of unsuccessful completion, the trainee may seek reassessment on the Qualification File.

Assessment Outcomes	Assessment Criteria for Outcomes	Marks Allocation		
		Theory	Practical	Viva
TEL/N4205: Set Standards for 5G Network Architecture	PC1. define the technical specifications for 5G network elements, including base stations (gNB), core network components, and user equipment	-	-	2
	PC2. determine the frequency bands to be used for the IMT-2020 deployment.	3	4	-
	PC3. allocate and specify the frequency bands to be used for 5G deployment, considering spectrum availability and compatibility	2	-	2
	PC4. install the necessary infrastructure equipment, including base stations, Radio Access Network (RAN), and core network elements such as the serving and gateway	3	3	1
	PC5. configure the RAN elements, including the base stations, eNodeB-EPC (Evolve Packet Core) and RNCs (Radio Network Controllers) or gNodeB.	3	4	-
	PC6. perform network planning activities to design the coverage and capacity of the network	2	3	-
	PC7. implement subscriber authentication and security mechanisms.	3	-	1
	PC8. enable specific services and features, such as voice calls, data services, messaging, and multimedia services	5	1	-

	PC9. perform testing and optimization activities to verify the network's performance and fine-tune the configuration parameters	5	2	-
	PC10. analyse performance requirements for 5G networks, such as data rates, latency, and reliability, to ensure high-quality service delivery	2	4	-
	PC11. evaluate the current capacity of your network infrastructure and identify the areas where scalability is required	3	2	-
	PC12. analyze the traffic patterns and trends to understand the growth in network demand	6	2	-
	PC13. develop interoperability standards to ensure seamless communication between different vendors' equipment and network elements	3	4	1
	PC14. determine if the existing hardware and equipment can support the increased traffic demands	3	-	-
	PC15. implement network monitoring and analytics tools to continuously monitor network performance	1	3	1
	PC16. identify and troubleshoot network issues, such as latency, packet loss, and throughput	3	3	-
	PC17. implement Quality of Service (QoS) mechanisms to prioritize critical services and applications, ensuring a consistent and reliable user experience	3	3	1
	PC18. address regulatory aspects, including compliance with local and international telecommunications regulations and spectrum allocation policies	-	2	1
	NOS Total	**50**	**40**	**10**
TEL/N4206: Verify and Prepare Hardware Equipment for 5G Installation	PC1. analyse 3GPP standards, budget, architectural, and other design documents as per client specifications	-	4	1
	PC2. identify the basic parameters of Multiple Input, Multiple Output (MIMO) antenna (diversity gain, MIMO capacity, etc.) for implementation of 5G antenna	5	4	1
	PC3. ensure that all passive equipment such as antenna (single, dual, triple band, MIMO), feeder, and jumper cable, and all the other necessary equipment are available at the site	1	4	-
	PC4. ensure that all active equipment such as gNB, microwave link devices, etc. are available at the site	1	2	1
	PC5. analyse solution life cycle management activities for successful deployment, such as evaluation and impact assessment of the solution and its components, and/or revisions if required	4	3	2
	PC6. validate that the necessary licenses and permits for installing and operating the hardware equipment at the site have been obtained and are up-to-date	4	4	-
	PC7. check the availability of weatherproofing and protective enclosures to safeguard the hardware equipment from environmental factors like rain, dust, and extreme temperatures	2	2	1
	PC8. verify the compatibility and interoperability of the hardware equipment from different vendors to avoid potential integration issues during installation	3	2	-
	PC9. ensure that any specialized equipment, tools, and accessories required for installation and configuration are available and ready for use	2	3	-
	PC10. check the availability of required network cables, connectors, and other interconnection components to establish connectivity between different equipment units	4	2	1

	PC11. confirm the availability of necessary grounding and lightning protection systems to protect the equipment from electrical surges and ensure safety	2	1	-
	PC12. verify that the power supply and backup power systems (e.g., batteries, generators) are available and sufficient to support the 5G hardware equipment at the site	5	2	-
	PC13. ensure that the required mounting structures and hardware, such as towers, poles, or rooftop installations, are in place to securely and appropriately mount the antennas and other equipment	4	2	1
	PC14. conduct a thorough inventory check to confirm that all the hardware equipment items mentioned in the deployment plan are present and accounted for at the site	4	3	1
	PC15. coordinate with logistics and procurement teams to ensure timely delivery of any missing or additional hardware equipment needed for the installation	5	-	1
	PC16. inspect the condition and quality of the hardware equipment to ensure it is free from damage or defects before installation	4	2	-
	NOS Total	**50**	**40**	**10**
TEL/N4207: Design Spectrum and 5G Network Architecture	PC1. analyze spectrum availability and regulations to determine suitable frequency bands for 5g deployment	2	2	-
	PC2. plan and allocate frequency resources to different services and applications based on their requirements and priority	4	-	2
	PC3. design 5G network architecture to support dynamic spectrum sharing between different operators and technologies	-	4	1
	PC4. optimize radio access network (RAN) design to ensure efficient utilization of available spectrum resources	3	2	-
	PC5. evaluate the impact of interference and propagation characteristics on spectrum allocation and network coverage	5	-	-
	PC6. implement advanced spectrum management techniques, such as cognitive radio, to enhance spectrum efficiency	2	2	-
	PC7. insert frequency bands for 5G	-	2	-
	PC8. deploy the rectified traffic for 5G network	-	2	1
	PC9. identify suitable sites for installing 5G network equipment, such as base stations or small cells	3	-	1
	PC10. Install and configure the necessary network equipment, including base stations, antennas, and routers, based on the network design and specifications	2	4	-
	PC11. perform extensive testing of the network to ensure proper functionality, coverage, and capacity	2	3	-
	PC12. familiarize with the capabilities, limitations, and integration requirements of each network type	4	-	-
	PC13. identify the different network types that need to be integrated and combined, such as cellular, Wi-Fi, satellite, or other specialized networks	2	2	1
	PC14. evaluate the interoperability of the network types and their compatibility with each other	4	3	-
	PC15. utilize integration techniques to ensure interoperability and smooth handover between Wi- Fi, and 4G/5G networks	3	3	1
	PC16. design and optimize network architectures that efficiently combine and utilize different network types to provide seamless connectivity and coverage	3	4	1

	PC17. implement traffic management techniques, such as Quality of Service (QoS) mechanisms, traffic shaping, and load balancing, to prioritize and allocate resources efficiently based on traffic requirements	5	4	1
	PC18. address challenges related to network handoff, authentication, and roaming across diverse network architectures	3	2	-
	PC19. use FQDN in the 5G core network to enable efficient and scalable communication between network functions, 5G numbering, addressing services, and devices	3	1	1
	NOS Total	**50**	**40**	**10**
TEL/N4208: Implement the 5G New Radio (NR) and Radio Access	PC1. implement robust network access control mechanisms to prevent unauthorized or irregular data resources from accessing the 5G system	1	2	-
	PC2. deploy firewalls and intrusion detection/prevention systems (IDS/IPS) to monitor and filter incoming and outgoing traffic	2	3	1
	PC3. utilize content filtering mechanisms to block access to specific websites, domains, or IP addresses associated with foreign or irregular data resources	1	3	1
	PC4. employ traffic analysis tools and anomaly detection systems to monitor network traffic patterns and identify irregular or suspicious behavior	2	2	-
	PC5. implement deep packet inspection (DPI) techniques to analyze packet contents and identify foreign or irregular data resources based on specific protocols, signatures, or patterns	1	2	-
	PC6. ensure that all network components, including routers, switches, firewalls, and security systems, are regularly updated with the latest security patches and firmware updates	1	-	1
	PC7. continuously monitor network traffic, security logs, and system events to detect and respond to any attempts to access or distribute foreign or irregular data resources	1	1	-
	PC8. monitor 5G NR Physical Channels and Signals	2	1	-
	PC9. acquire specialized monitoring equipment capable of analyzing 5G NR physical channels and signals	2	1	-
	PC10. use the monitoring equipment to capture the 5G NR physical channels and signals	-	3	-
	PC11. monitor the different 5G NR physical channels, such as the downlink and uplink channels, control channels, synchronization channels, and reference signals	1	1	-
	PC12. conduct real-time monitoring of the 5G NR physical channels and signals to capture dynamic changes and fluctuations	2	2	-
	PC13. analyze the resource allocation and scheduling mechanisms used for downlink transmission	1	2	-
	PC14. identify and configure BWP Configuration of 5G networking	-	1	-
	PC15. work with Physical Layer Procedures of 5G networks	1	-	1
	PC16. layer the data signals to Initial Access and Cell Search	1	1	-
	PC17. operate the PSS and SSS Detection	2	2	-
	PC18. capture the received signals using a suitable receiver or monitoring equipment capable of capturing the 5G signals	1	3	1
	PC19. perform a frequency analysis on the captured signals to identify the frequency range where the PSS and SSS signals are expected to be present	1	3	-

	PC20. synchronize the received signals with the expected timing and frame structure of the 5G system	2	2	1
	PC21. implement error handling mechanisms to account for cases where the PSS or SSS signals are weak, corrupted, or not detected correctly	2	2	-
	PC22. continuously validate the accuracy and reliability of the PSS and SSS detection process by monitoring the detected signals and verifying the correctness of the cell identification	2	2	1
	PC23. channel Estimation and Equalization with nodes for 5G connectivity	1	1	1
	PC24. demodulate and Decode the backend coding of 5G networks	1	2	-
	PC25. install and rectify Analog Beamforming	1	2	-
	PC26. station and reconstruct Digital Beamforming	-	2	-
	PC27. inspect the Hybrid Beamforming	1	2	-
	PC28. fix beamforming configuration	1	2	-
	PC29. implement 5G in industrial 4.0 such as manufacturing, production, transportation and warehousing	3	-	1
	PC30. implement 5G in various sectors such as agriculture, entertainment, smart education and public safety	3	-	1
	NOS Total	**40**	**50**	**10**
DGT/VSQ/N0102: Employability Skills (60 Hours)	Introduction to Employability Skills	1	1	-
	PC1. identify employability skills required for jobs in various industries	-	-	-
	PC2. identify and explore learning and employability portals	-	-	-
	Constitutional values – Citizenship	1	1	-
	PC3. recognize the significance of constitutional values, including civic rights and duties, citizenship, responsibility towards society etc. and personal values and ethics such as honesty, integrity, caring and respecting others, etc.	-	-	-
	PC4. follow environmentally sustainable practices	-	-	-
	Becoming a Professional in the 21st Century	2	4	-
	PC5. recognize the significance of 21st Century Skills for employment	-	-	-
	PC6. practice the 21st Century Skills such as Self- Awareness, Behaviour Skills, time management, critical and adaptive thinking, problem-solving, creative thinking, social and cultural awareness, emotional awareness, learning to learn for continuous learning etc. in personal and professional life	-	-	-
	Basic English Skills	2	3	-
	PC7. use basic English for everyday conversation in different contexts, in person and over the telephone	-	-	-
	PC8. read and understand routine information, notes, instructions, mails, letters etc. written in English	-	-	-
	PC9. write short messages, notes, letters, e-mails etc. in English	-	-	-
	Career Development & Goal Setting	1	2	-
	PC10. understand the difference between job and career	-	-	-
	PC11. prepare a career development plan with short- and long-term goals, based on aptitude	-	-	-
	Communication Skills	2	2	-
	PC12. follow verbal and non-verbal communication etiquette and active listening techniques in various settings	-	-	-

	PC13. work collaboratively with others in a team	-	-	-
	Diversity & Inclusion	1	2	-
	PC14. communicate and behave appropriately with all genders and PwD	-	-	-
	PC15. escalate any issues related to sexual harassment at workplace according to POSH Act	-	-	-
	Financial and Legal Literacy	2	3	-
	PC16. select financial institutions, products and services as per requirement	-	-	-
	PC17. carry out offline and online financial transactions, safely and securely	-	-	-
	PC18. identify common components of salary and compute income, expenses, taxes, investments etc	-	-	-
	PC19. identify relevant rights and laws and use legal aids to fight against legal exploitation	-	-	-
	Essential Digital Skills	3	4	-
	PC20. operate digital devices and carry out basic internet operations securely and safely	-	-	-
	PC21. use e- mail and social media platforms and virtual collaboration tools to work effectively	-	-	-
	PC22. use basic features of word processor, spreadsheets, and presentations	-	-	-
	Entrepreneurship	2	3	-
	PC23. identify different types of Entrepreneurship and Enterprises and assess opportunities for potential business through research	-	-	-
	PC24. develop a business plan and a work model, considering the 4Ps of Marketing Product, Price, Place and Promotion	-	-	-
	PC25. identify sources of funding, anticipate, and mitigate any financial/ legal hurdles for the potential business opportunity	-	-	-
	Customer Service	1	2	-
	PC26. identify different types of customers	-	-	-
	PC27. identify and respond to customer requests and needs in a professional manner.	-	-	-
	PC28. follow appropriate hygiene and grooming standards	-	-	-
	Getting ready for apprenticeship & Jobs	2	3	-
	PC29. create a professional Curriculum vitae (Résumé)	-	-	-
	PC30. search for suitable jobs using reliable offline and online sources such as Employment exchange, recruitment agencies, newspapers etc. and job portals, respectively	-	-	-
	PC31. apply to identified job openings using offline/online methods as per requirement	-	-	-
	PC32. answer questions politely, with clarity and confidence, during recruitment and selection	-	-	-
	PC33. identify apprenticeship opportunities and register for it as per guidelines and requirements	-	-	-
	NOS Total	**20**	**30**	**-**

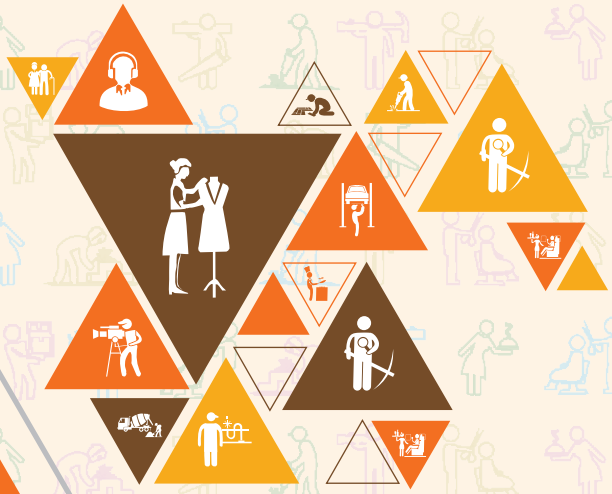
Annexure III

List of QR Codes Used in PHB

Module No.	Unit No.	Topic Name	Page No. in PHB	Link for QR Code (s)	QR code (s)
Module 1: Introduction to the role of 5G System Integrator (Bridge Module)	Unit 1.1: Understanding the Telecom Industry and 5G System Integration	1.1.1 Size and scope of the Telecom industry in India	18	https://www.youtube.com/watch?v=QpP2Wgg0bdQ	Jobs and Career in Telecom
		1.1.2 Role and responsibilities of a 5G System Integrator	18	https://www.youtube.com/watch?v=mo1lNRKnayA	5G: The Next-Gen Network
	Unit 1.2: Practical Application and Workflow of 5G System Integration	1.2.1 Workflow in the organization and the role of a 5G System Integrator	18	https://www.youtube.com/watch?v=pqufACBXeP8	What it takes to start a System Integrator
Module 2: Set Standards for 5G Network Architecture	Unit 2.1: 5G Technology Fundamentals and Standards	2.1.1 Technical specifications for 5G network elements	67	https://www.youtube.com/watch?v=Q6YxHz_07zk	5G Network Architecture
	Unit 2.2: Security and Authentication in 5G Networks	2.2.1 Different authentication methods like SIM-based authentication, AKA, and EAP methods	67	https://www.youtube.com/watch?v=UYPOmNA3WNg	EAP and EAP TLS

Module No.	Unit No.	Topic Name	Page No. in PHB	Link for QR Code (s)	QR code (s)
	Unit 2.3: 5G Network Planning, Deployment, and Optimization	What is interference management?	67	https://www.youtube.com/watch?v=zbIMcLVYa_0	Technology - HetNet (Small Cells)
Module 3: Verify and Prepare Hardware Equipment for 5G Installation	Unit 3.1: Pre-Deployment Planning and Regulatory Compliance of 5G Network	3.1.1 Standards and Regulations Framework	112	https://www.youtube.com/watch?v=z3vqIZn1slU	5G Standard & Specification – ITU & 3GPP
	Unit 3.2: Hardware Installation and Infrastructure Setup	3.2.1 Principles and concepts of Multiple Input, Multiple Output (MIMO) technology	112	https://www.youtube.com/watch?v=saY__kumXLg	What is MIMO - Multiple Input Multiple Output
Module 4: Design Spectrum and 5G Network Architecture	Unit 4.1: Fundamentals of 5G Technology and Spectrum Management	4.1.1 Principles of Wireless Communication	140	https://www.youtube.com/watch?v=fPTrifr-wLw	Principles of Modern CDMA/ MIMO/OFDM Wireless
	Unit 4.2: Network Design and Management for 5G Integration	4.2.1 Network Slicing	140	https://www.youtube.com/watch?v=kqpo9LCspiI	What is network slicing?

Module No.	Unit No.	Topic Name	Page No. in PHB	Link for QR Code (s)	QR code (s)
Module 5: Implement the 5G New Radio (NR) and Radio Access	Unit 5.1 Securing the 5G Network Edge	5.1.1 Technical Specifications and Best Practices for Robust Network Access Control in 5G Networks	172	https://www.youtube.com/watch?v=i-OYNqJqatI	What is network access control (NAC) ?
	Unit 5.2: 5G Network Monitoring and Analysis	5.2.1 5G NR Physical Channel Monitoring	172	https://www.youtube.com/watch?v=nyzHkIpWFjE	Learn to Navigate the 5G Frame and Channels
	Unit 5.2: 5G Network Monitoring and Analysis	5.2.1 5G NR Physical Channel Monitoring	172	https://www.youtube.com/watch?v=vhB4yV9nVEI	5G NR Physical layer explained with demo
Employability Skills				https://www.skillindiadigital.gov.in/content/list	



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Address: **Telecom Sector Skill Council of India**
Estel House, 3rd Floor, Plot No:- 126, Sector 44
Gurugram, Haryana 122003
Email: tssc@tsscindia.com
Web: www.tsscindia.com
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