Review Questions:

5G network slicing: applications and benefits within industry:

1. *Give two main functions/requirements of a virtual network in 5G network slicing*

• Ensure that every network slice is isolated from others. • Dynamically assign and manage network slices.
• Keep service security.
• Ensure network slicing is transparent to customers.

• Support the end-to-end resource management.

2. *Explain in your own words what a network slice is*.

A slice is a part of a network which is created by dividing a physical network infrastructure into multiple network parts. They should all be isolated from each other logically even though they share the same re- sources.

3. What are the main benefits of network slicing and why?

Flexibility and multi-tenancy, i.e. making it possible to serve many users simultaneously and reconfigure the slices dynamically based on consumers' needs. The communication systems can also become much more energy and resource efficient which is more sustainable in both an ecological and economical perspective.

4. Within the automotive sector many areas benefit from network slicing. Give some examples and explain why.

Traffic safety need low latency, autonomous driving depend on coverage and reliablity, and infotainment mainly on data rates. These all need to function in a crowded environment (mainly urban) and therefore network slicing can be used to optimize all of these services simultaneously and allocate resources between them.

5. AR/VR requests high capacity network to fulfill high density computing. Which are the main technologies to realize this feature? Please motivate your answer.

To fulfill this feature, the network should be divided along spatial dimen- sion, which is called spatial division multiplexing (SDM). Different space represents different service. Resources will be distributed to different ser- vice according to the space. In the meanwhile, slice isolation should be guaranteed. Isolation is used to prevent deleting the slice resources and ensure the security of each *slice*.

5G New Radio: Next Generation Radio Access Network:

6. Re-farming of 4G LTE bands, in order to improve the coverage of 5G NR is not considered as a good solution. Please briefly explain why.

Re-farming low band carriers from 4G without a corresponding increase in 5G devices penetration might lead to congestion of the remaining 4G LTE carriers, degrading indoor coverage for LTE users who still represent the majority of the subscriber base. This co-existence between 5G and 4G LTE can thus be considered as a flexible re-farming solution.

7. Give two key categories of services that 5G NR supports and briefly explain them.

• eMBB/xMBB is for high data rate services. This means there is a need for high bandwidth and high modulation orders

- mMTC is for the interconnection of high volume of IoT devices.
- URLLC focuses on latency-sensitive and highly reliable services.

Energy efficiency and sustainability solutions for mobile networks:

8. Give two technical solutions and explain in your own words why they make mobile net- works more energy efficient or energy sustainable.

Localisation strategies in ultra-dense networks:

9. Briefly describe one location information which could be used for improving the perfor- mance of a communication system.

Location of Users: A possible way to improve wireless communication is to utilize the locations of the users, in order to get an better estimation of the channel. By using the package with the location information to estimate the channel the process time is greatly reduced. This is a time saving method that minimizes the number of transmissions while still getting an accurate estimation. Since wireless communication is greatly affected by the environment it is vital to get an accurate estimation of the channel properties in order to guarantee a reliable communication. Static environment: By building a channel database with information about static environment, such as buildings in urban environment, the prediction will be more accurate since the major statistical properties are mapped. This database could help predict for instance the expected shadowing when a user is moving in a urban environment in a more accurate way then with less prior knowledge of the channel.

Energy efficiency challenges in home capillary M2M networks:

10. Name two approaches and briefly describe how they can improve the energy efficiency of a M2M network mentioned in the report "Energy efficiency challenges in home capillary M2M networks".

Acceptable answers (Two are needed): 1) "The ADAPT algorithm, which uses tuning of backoff parameters in CSMA/CA to maintain reliability while conserving power." NOTE: backoff parameters to conserve power is needed as answer.
2) "Hybrid CSMA/CA, which utilize subgroups and TDMA time slots for these subgroups to reduce overall collisions to save energy from retransmissions." NOTE: subgroups with TDMA to reduce collision/retransmissions is needed as answer.
3) "EBI-CSMA/CA or EP-CSMA/CA, where the former utilize backoff intervals to perform energy transfer and the latter utilize dedicated energy packets." NOTE: if the two methods are missmatched it would be an incorrect answer.
4) "Energy harvesting of motion artefacts, where harvesters can utilize the vibration/ movement of the environment and convert it to electric energy via materials such as piezoelectric/magnetostrictive materials" NOTE: mentioning of vibrations or movements in order to convert it to electric energy is enough.
5) "Energy harvesting of RF energy, where ambient RF signals sent out from other devices using e.g WiFi (routers, mobile phones, computers) are converted to DC via rectifying circuits." NOTE: mentioning graphene rectennas without mentioning that they might not provide enough energy is incorrect.

Future challenges with Massive MIMO, Reconfigurable Intelligent Surfaces and Teraherz Communication:

11. What is a key implementation challenge with reconfigurable intelligent surfaces (RIS)?

Performing channel estimations, to optimize the SNR in the different propagation environments. Having a dynamic changing environment makes this a challenge. Estimating the channel is considered to be necessary to optimize the phase-shifts caused by the surface. It is mentioned that this can be done by implementing some sort of feedback solution with sensors integrated in the surface.

High Altitude Platform Concepts andImplementations:

12. Mention at least one advantage and one disadvantage of High Altitude Platforms (HAPs) in comparison with terrestrial systems, and briefly explain them.

13. Explain the advantages and disadvantages of High Altitude Platforms (HAPs) in com- parison with the satellite system.

C-V2X Assisted Automated Driving:

14. How is an individual user equipment (UE) able to know that resources are occupied or available in PC5?

Checking sci messages containing information about resource reservations

15. In regard to what aspect is PC5 better than DSRC?

PC5 can increase rate of successful warning message delivery