EC6014-COGNITIVE RADIO QUESTION BANK

UNIT I - INTRODUCTION TO SOFTWARE DEFINED RADIO

PART A

1.What is Software - Defined Radio?

"Software Defined Radio is a radio that is flexible (programmable)to accommodate various physical layer formats and protocols" – joe Mitola (MITRE) coined this working definition in 1991 – implied from the definition, SDR is a multiband multimode radio which dynamic capability defined through software covering all layers of the OSI protocols stack

2.Define the basic concept of SDR?

The basic concept of the SDR software is that the radio can be totally configured or defined by the software so that a common platform can be used across a number of areas and the software used to change the configuration of the radio for the function required at a given time .There is also the possibility that it can then be re-configured as upgrades to standards arrive, or if it is required to meet another role, or if the scope of its operation is changed

3.What is the need of SDR?

The need for software defined radios is underlined and the most important notions used for such reconfigurable transceivers are thoroughly define.The role of standards in radio development is emphasized and the usage of transmission mode parameter in the construction of software-define radios is described .The software communications architecture is introduced as an example for framework that allow an object-oriented devlopment of software – define radios

4.What are the potential benefits of SDR?

- Accomadate multipke air-interface standards.
- Facilitate transition by bridging legacy and future technologies.
- Allow multiple services and incentives for equipage.
- Implement "future-proof" concept and capable for insertions of future technolgies and allow easy upgrades

5.What is Cognitive Radio?

Cogintive Radio(CR) is an adaptive, intelligent radio and network technology that can automatically detect available channels in a wireless spectrum and change teransmission parameters enabling more communications to run concurrently and also improve radio operating behavior

6.What are the new application enabled by CR?

- Dynamic spectrum access
- Self-organizing networks
- Cellular data boost
- Machine to machine communication
- Cognitive jamming system
- Real-time spectrum markets
- Cognitive gateways\bridges
- Synthetic (cooperative)MIMO
- Coginitive spectrum management
- Coginitive routing

7.What are the performance metric improved by CR?

- Improving spectrum utilization & efficiency
- Improving interoperability between legacy and emerging systems
- Improving link reliability
- Less expensive radios
- Enhancing SDR techniques
- Extended battery life
- Extended coverage

8.What are the tradeoffs required in SDR?

- Antenna tradeoffs
- RF and IF processing tradeoffs
- Interference suppression
- RF MEMS
- Digital architecture

9.What is meant by spectrum pooling?

The unused spectrum of primary user can be used by secondary users for high – speed wireless communications whie simultaneously ensuring that the primary user's rights are not violated This idea of using multiple noncontiguous portions of spectrum is referred to as spectrum pooling

10.What is a spectrum hole?

Spectrum hole is a band of frequencies assigned to a primary user, but at a particular time and specific geographic locations, the band is not being utilized by the user

11.What is an agile radio?

The important feature that differentiates cognitive radios from normal radios is their agility; it is also known as agile radios

12.What is spectrum agility?

It refers to the discovery strategies for available spectrum as well as opportunistic transmission in the identified spectrum. It also refers to advanced sensing capabilities

13.Define the term data explosion?

Data explosion is the phenomenon that occurs in communicatiom systems where the number of user exceeds the predicted levels

14.What is the role of spectrum policy?

Role of spectrum policy is to alleviate artificial spectrum scarcity ,promote efficiency and also encourage innovations. And the proposal for spectrum policy fall into two categories

- Spectrum property Rights
- Spectrum commons

15.Mention the type of antenna's used in CR?

Wideband antennas ,frequency,pattern and polarization reconfigurable antennas,etc.,

PART B

1) Think of any other term related to CR. Does the CR community need more terms to describe its work or is the descriptive process complete? Provide justification for your statements.
2) Discuss the future of CR as a technology for the development of new applications.

3) Define *spectrum efficiency* under CR. How is spectrum efficiency dependent on the various aspects of CR?
4) Describe the challenges and opportunities of cognitive radio.
5) Explain the architecture of SDR with neat diagrams and its implications.
6) Is spectrum scarce or plentiful? Explain your answer.
7) Briefly discuss the antenna design in cognitive radio.
8) Discuss in detail about the potential benefits and technology tradeoffs in SDR.
9) Explain the network & hardware design considerations in SDR.
10) Discuss about standardization activity in cognitive radio.

UNIT II SDR ARCHITECTURE

PART A

1. What is parameter controlled (PaC) SDR.?

SDR transceiver that differs from a conventional transceiver only by the fact that it can be reconfigured via a control bus supplying the processing units with the parameters which describes the desired standard.

2. What are the architecture implications of the SDR?

Architecture implications has been done using architecture principles
Architecture principle#1: Bounded modules
Architecture principle#2: Explicit Extensible Interface topology
Architecture principle#3: Distributed Layered Virtual Machine Reference model.

3. What are the limitations of SDR?

- There are technology limits on achievable RF performances.
- The choice of architecture depends on the available technology e.g ADC performance , semiconductor technology.
- Software reliability may define overall radio reliability, rather than hardware limitations.

4. What is the software design tradeoffs?

Software design tradeoffs occurs between

- Communications services.
- Radio applications.
- Radio infrastructure.
- Hardware platforms.

5. Define topological space.

A topological space, denoted(X, Ox) is a set X, and a family of subsets Ox , the "open sets", which include X and the empty set and π, and which are closed under union and finite intersection.

6. What are architecture goals of SDR?

- Compatibility.
- Controllability
- Predictability.

7. Mention some essential functions of the software radio.

- Source coding and decoding.
- Service and network support.
- Info sec.
- Modem.
- IF processing.
- RF/ channel access.

8. Define plug-and-play interface.

A plug-and-play interface defines an interoperable subset of the interface space. These subsets include physical and logical interfaces. The physical interface subspaces must change as a function of the hardware in which the service is delivered. The logical interface subspaces also may have to change as a function of the software modules configured to deliver the services.

9. Define software flexibility and affordability.

Software flexibility and affordability (SFA) characterizes the service providers ability to acquire plug and play software modules from a COTS market place. i.e software that runs on many platforms and is available from multiple vendors generally gives the service provider a better software product with more flexibility and at a lower cost over the lifecycle than the alternatives.

10. What are the acquisition parameters of software radios?

N: Number of channels
n: single channel or multiple channel(n<6)
PDA: programmable digital access – none (0), baseband(1), IF (2) ,RF(3)
HM - Hardware modularity.
SFA - software flexibility and affordability.

11. **List the analytical model of plug and play interface.**

- To identity top level plug and play interface;
- To predict and control system performance;
- To define a reference model that facilitates standards setting
- To derive architecture principles for product evolution strategies

12. **Define DAP**

The ADC and DAC define the point at which functions are potentially software-defined. We may call this point the digital access point. This point may occur anywhere in the architecture.

13. List some of the top level interface topologies.

- Analog bit stream
- Source bit stream
- Protected bit stream
- Clear bit stream

- Network interface
- Joint control etc..,

14. Why do we need SDR?

- Reconfiguration
- Easily upgradable
- Responds to the changes in the operating environment
- Lower maintenance cost

15. Define programmable digital radio (PDR)

The programmable digital radio (PDR) refers to those radios that use a hardware and software-intensive mix of hardware and software techniques to access more than one RF band with a choice of air interface modes. A PDR's programmability may be achieved using baseband digital signal processing (DSP).

PART B

1.(i)What is the software basic model of SDR? (8)

(ii) Outline the various functional allocation of software radio functional Model. (8)

2. (i) Explain the interfaces used in plug and play modules. (8)

(ii)What are the various levels of abstraction of the SW radio? Explain. (8)

3. (i) Write the various steps involved in the reception of the signal in SDR.(8)

ii) Show how a Linear and OOPS programming is used in the software architecture of SDR. (8)

4.(i) Mention about the Hardware architecture of SDR. (8)

(ii) What are the user applications of SDR? (8)

5.(i) Describe RF front end in SDR architecture. (8)

(ii) Identify the components of Digital back end in SDR and explain. (8)

6.Explain in detail about hardware SDR architecture.(8)

7. 6.Explain in detail about software SDR architecture.(8)

UNIT-III INTRODUCTION TO COGNITIVE RADIOS

PART A

1.Define Ideal Congitive radio(ICR).

An autonomous agent that perceives the user's situation to proactively assist the user with wireless information services ,particularly if the user is too busy or otherwise occupied,such as when in personal distress.

2. Define Self-aware cognitive radio?

In general, cognitive network is a type of network, wireless or not, that has a capability to think learn and remember. To add , cognitive networks are unique because of its capabilities such as self optimization , self monitoring, self repair, self protection, self adaptation and self healing. In order to optimize network operation, reconfiguration, management, and improving performance, a proposal to introduce self-awareness, self-management, and self-healing properties by bringing "intelligence" into the network.

3.Define are the tasks performed by cognition cycle?

The cognitive process starts with the passive sensing og RF stimuli and culminates with action. Three on-line cognitive tasks:

1.Radio –scene analysis, which encompasses the following:

- Estimation of interference temperature of the radio enviorment;
- Detection of spectrum holes.

2.Channel identification, which encompasses the following:

- Estimation of channel-state information(CSI);
- Prediction of channel capacity for use by the transmitter.

3. Transmit-power control and dynamic spectrum management.

Tasks (1) and (2) are carried out in the receiver, and tasks (3) is carried out in the transmitter. Through interaction with the RF environment, these three tasks form a cognitive cycle.

4.List capabilities required for the CR Funtionality.

- Flexibility and agility
- Sensing
- Learning and adaptability
- Location and environment awarness

5.List some characteristics of Radio Cognitive Tasks?

The major tasks of the cognitive radio include:

- Radio-scene analysis

- Channel identification, and
- Dynamic spectrum management and transmit power control

6.What are the potential impacts areas of cognitive radio?

CR techniques are attracting interest in various areas

- Military
- TV white space
- Femtocells and cellular agility

7. What are the computational intelligence aspects of CR?

- Radio knowledge-RXML:RF
- User knowledge-RXML:USER
- Capacity to learn

8.what are disadvantages of radio vision method?

Main cons of radio vision method

- Requirement of image database
- Extensive image processing power

9.List some of the position sensing techniques.

- Radio sensing
- Radio vision
- Radio hearing methods

10.Define spectrum pooling?

The unused spectrum of primary user can be secondary users for high speed wireless communication while simultaneously ensuring that a primary user's right are not violated . This idea of using multiple noncontiguous portions of spectrum is called spectrum pooling.

11.List the types of ANN.

- **Multi layer linear perception networks**
- **Nonlinear perception networks although multilayer**
- **Radial basis function networks**

12.What are the application of ANN TO CR?

- CR has ability to dynamically adapt and be trained at any time, ANNs are able to 'learn' patterns, features, and attribute of system they describe.
- It has been adopted in spectrum sensing in CR

13.What is collaborative radio?

An intelligent radio which connects multiple nodes and work together to achieve common goal

14.What are the challenges of cognitive radio networks?

- Hiden primary user
- Spectrum primary user can distinguish a spread spectrum transmission from the background is to sample the entire bandwidth, which may impossible for CR, leads to false identification of empty spectrum**.**

PART B

1.Enumerate the Physical and Link layer parameters to improve the performance of communication link in CR. (7)

2. Draw and explain the generic transmitter for radio control in Cognitive radio.

3.Define MODM and its basic application in CR. Also describe the generic algorithmic approach to MODM. (13)

4.Device a Smart agent model in CR and explain how Artificial Intelligence is used in Radio environment map. (13)

5.Demonstrate the Conceptual model for cognitive radios with location and environment awareness cycles. (7)

6.Examine how signals are acquired in Cognitive radio, and explain about sensing mechanisms. (6)

7.Discuss about the Sensing interface and primary concepts of Position awareness cognitive radio with neat architecture. (13)

8.Explore the features of Location awareness engine. (7)

9.Determine the Adaptation features used in the conceptual model.

10.Interpret the Topographical information and Propagation characteristics related to environment awareness engine. (13)

11.Review the cognitive location and environment system based on the range accuracy metric. (7)

12.Explain the Transmitter impairment effects and Environmental effects. (6)

13.Analyze any two Artificial Intelligence techniques suitable for cognitive radio and its working principle with neat diagram. Point out the need for a higher layer intelligence (13)

14.Express the Multiobjective Optimization for radio resources interms of BER and bandwidth. (13)

UNIT IV COGNITIVE RADIO ARCHITECTURE

PART A

1.what are the primary functions of cognition?

The primary radio cognition function consists of:

1. 1.Regconize user communications context
2. 2.Mediate wireless information services as a function of context.

2.what is the objective of cognitive radio architecture?

Architecture for cognitive radio consists of the functions , components and design rules necessary to support the evolution of cognitive radio.The architecture integrates the contribution researchers focusing on the specific disciplines of software radio,network,natural language processing and machine learning.This architecture minimizes the dependence on knowledge-engineering through the integration of machine learning.

3.Define behavior epoch.Mention the modes of behavior .

Cognitive radio support functions include three modes of behavior ;waking,sleeping,and praying.Behavior that lasts for a specific time interval is called a behavioral epoch.

4.What is waking behavior?

The waking behavior is optimized for real-time interaction with the user ,isochronous control of software radio assets,and real-time sensing of the environment. The conduct of the waking behavior is informally reffered to as the awake –state ,although it is not a specific system state ,but a set of behaviours.

5.Define sleeping behavior?

cognitive PDAs detect conditions that permit or require sleep.For example, if the PDA predicts or becomes aware of a long epoch of disuse (eg. overnight), then it PDA may autonomously initiate sleeping behavior .Otherwise, it would request permission to enter sleeping behavior from the waking behavior using non-incremental machine- learning algorithms. These algorithms map current cases and intergrated knowledge onto integrated knowledge (b).

6.what is a conflict ?

A conflict is a context where the user overrode a PDA decision about which the PDA had a little or no uncertainity. Map b may resolve the conflict. If not, then it will place the conflict on a list of unresolved conflicts (map g).

7. Define prayer behavior.

Attempts to resolve unresolved conflicts via the mediation of the PDA's home network may be called prayer behavior. The unresolved-conflicts-list is mapped(1) to RKRL XML queries to the PDA's home network expressed in KQML.

8.What are the components of cognitive functions?

Cognition functions implemented via cognition components. These include data structures and related processing components.

9.Define world model.

World Model, S, consists primarily of bindings between a-priori data structures and the current scene. These structrures are also associated with the observe phase.

10. What is the purpose of observe-phase data structures?

The observe phase components match new stimuli to known stimuli. When an exact match is not possible, the components may deliver one or more hypotheses. Hypotheses may consists of best-match, or a prioritized list of partial matches. Bindings may be computed as the interface from the observation phase hierarchy to the orient phase.

11.Define binding in observe-phase data structures?

Binding associates specific stimuli in the <scene/> with related internalized stimulus-experience-response sets that are abstractions of prior scenes. When identical items are bound in a scene, they form conceptual anchors.

12.Define decide-phase components.

The decide-phase selects among alternatives generated by the planning phase. Its knowledges representation depends on the radio procedure components. The decide-phase allocates computational and radio-resources to subordinate software, based on the activation ofa plan.

13.What do you infer from radio procedure knowledge encapsulation?

Radio knowledge may be embodied in components called radio knowledge sources. If so, they are organized as set-theoretic maps among wake-cycle phases (observe, orient, plan. Decide, act).

14.What is the use of plan phase components?

The plan phase represents plans for the control of the software radio personalities. The plan phase may include a plan calculus.

15.How CR can be realized using SDR.

Cognitive radio may be realized via software-defined radio (SDR) with sensory perception, RF autonomy, and integrated machine learning of the self, the user, the environment, and the "situation".

PART B

1.Examine how emerging CR services will differentiate products.(5)
2.Analyze the benefits of CR to users on the way to a vision of the future. (8)
3.Determine the simplest CRA? How could the architecture evolve through initiatives such as the SDR Forum's CR special- interest group? (6)
4.Interpret the natural language encapsulation. (7)
5.Demonstrate how is regulatory rule making shaping CR markets? Express how will today's discrete cell phone, PDA, and laptops merge into theiCR wardrobe? (13)
6.When does AAR have sufficient sensor perception for dynamic Spectrum? (7)
7.What does the term Self Referential Inconsistency refer to? Explain in detail. (6)
8.Explore how CRA identifies self, owner and home network. (7)
9.Probe on the Industrial strength interference hierarchy. (6)
10.Discuss the components of orient, plan and decide phases in detail with flow diagrams.
11.Point out the Modeled topological maps of CRA. (13)
(i) Categorize the Cognition Components based on the computational Intelligence and explain the components. (7)
12.Devise the flexible functions of the component Architecture in Cognitive radio. (6)
13.Elaborate the primary functions, components and design rules of cognitive Radio. (13)
14.What is Cognition Cycle? Discuss the various phases involved in cognition cycle with neat diagram. (13)
15.Explain in detail about architectural maps with neat diagrams. Also classify the modes of behaviors in CRA, explain the modes. (13)
16.Outline the building of CRA on SDR architectures. (7)
17.Sketch the functions-Transforms Model of Radio with appropriate diagram (6)
18.How cognitive radio functions are mapped to the components of a Wireless PDA within the environment architecture? (8)
19.Review the SWR and SDR principles. (5)
20. Show the reinforces hierarchical sequences and NLE. Also exhibit the primary functions of Cognitive radio with neat diagram. (13)

UNIT V NEXT GENERATION WIRELESS NETWORKS

PART A

1 .Define XG? What is the need of it?

Next Generation (xG) communication networks, also know as dynamic spectrum access network(DSAN) as well as cognitive radio network, will provide high bandwidth to mobile users via hetrogeneous wireless architecture and dynamic spectrum access techniques .The inefficient usage of existing spectrum can be improved through opportunistic access to licensed band without interfering existing users.

2.Define Spectrum Broker?

Spectrum broker (scheduling server) is a central network entity that plays a role in sharing the spectrum resources among different XG networks. Spectrum broker can be connected to each network and can serve as a spectrum information manager to enable coexistence of multiple XG network.

3.Mention the function of cognitive radio of XG network?

The main function of cognitive radio in XG network is:

- Spectrum sensing
- Spectrum management
- Spectrum mobility
- Spectrum sharing.

4. what is Spectrum Sensing?

Spectrum sensing: Detecting unused spectrum and sharing the spectrum without harmful interference with other users.

5. what is Spectrum mobility?

Spectrum mobility : maintaining seamless communication requirements during transition to better spectrum.

6. What is Spectrum Management?

Spectrum Management: Capturing the best available spectrum to meet the user communication requirements.

7. What is spectrum sharing?

Spectrum sharing: providing the fair spectrum scheduling method among coexisting XG users.

8. What are the applications of xG network?

- Leased network
- Cognitive mesh network
- Emergency & Military network.

9.Defne the objective of CR?

The ultimate objective of the cognitive radio is to obtain the best available spectrum through cognitive capability and reconfigurability .

10. Define cognitive capability.

Cognitive capability refers to the ability of the radio technology to capture or sense the information from its radio environment. This capability can’t simply be realized by monitoring the power in some frequency band of interest but more sophisticated techniques

are required in order to capture the temporal and spatial variations in the radio environment and avoid interference to other users.

11.Define reconfigurability?

Reconfigurability enables the radio to be dynamically programmed according to radio environment. More specifically, the cognitive radio can be programmed to transmit and receive on a variety of frequencies and to use different transmission access technologies supported by its hardware design.

12. List out some main components of wideband RF front-end architecture.

Wideband antenna, RF filter, LNA, PLL, Mixer, Channel selection filter, AGC, ADC.

13. what are the reconfigurable parameters in cognitive radio?

There are several reconfigurable parameters that can be incorporated into cognitive radio

1. Operating frequency
2. Modulation
3. Transmission power
4. Communication technology

14. List out the challenges of spectrum sensing.

- Interference temperature measurement
- Spectrum sensing in multi user networks
- Detection capability

15. what are the parameters of spectrum management?

- Path loss
- Interference
- Wireless link errors
- Link layer delay and holding time

PART B

1.Explain each components and its functionality of XG network architecture with neat diagram. (7)

2.Describe the physical architecture of the cognitive radio. (6)

3.Assess the XG network functions with diagram. Evaluate the cases on which XG networks can be applied.

4.Classify the Spectrum Sensing techniques , explain how it is utilized in transmitter detection. (7)

5.Analyze the spectrum analyzing techniques used in XG networks.

6.What are the challenges faced by spectrum sensing? Explain about Interference temperature model. (13)

7.Elaborate the spectrum management challenges and the Spectrum analysis. (7)
8.Propose a XG network considering architecture, spectrum allocation behavior and spectrum access techniques. (6)
9.Cite examples for Existing architectures for XG networks and write a brief note on it. (6)
10.Show the classification of next generation networks based on the access technology. (7)
11.Relate the concept of cooperative in spectrum sharing. (8)
12.Use Virtual Cube model for modelling the network resources.
13.Demonstrate the representative examples of the XG network Architectures. List out the features of primary network. (13)
14.Show how spectrum hand off occurs in XG networks. (7)
15.Interpret the Centralized spectrum sharing and Distributed Spectrum sharing in XG networks. (6)
16.Outline the cross layer design in XG networks with diagrams .(13)
17.Categorize the upper layer issues in XG networks. (7)
18.Examine the Cross layer challenges in spectrum management. (6)
19. Illustrate the Inter network sharing in XG networks. Compare the Inter-network and intra-network sharing in XG networks. (13)
20.Examine the steps involved in spectrum sharing in XG networks. (6)
21.Review the parameters involved in Spectrum analysis of XG networks. (7)
22.How transmitter detection takes place in XG networks based on energy. Explain how receiver uncertainty and shadowing uncertainty occurs?(13)