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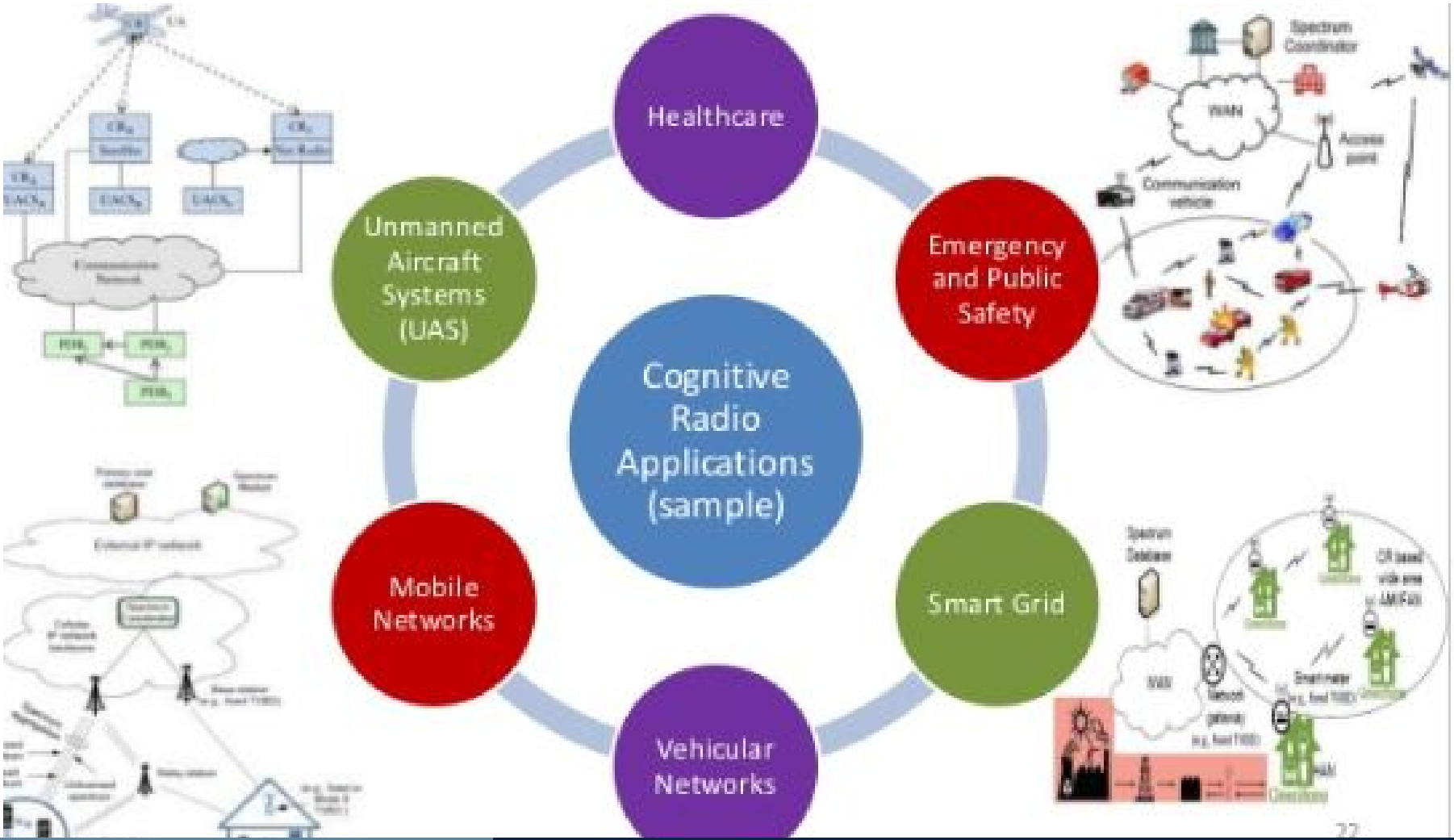

The Research of Cross-layer Architecture Design and Security for Cognitive Radio Network

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Presentation outline

ABSTRACT

- This paper elaborate the framework of cognitive radio network, analysis motivations for crosslayer design and security in cognitive radio network (CRN) first.
- The authors proposed a novel architecture in which the dynamic channel access is achieved by a cross-layer design between the PHY and MAC layers for cognitive radio network.
- The resolution of cross-layer security problem is proposed and analysis in mathematic.
- The security issues of spectrum sensing for Centralized CRN.
- A novel centralized dynamic channel access mechanism is proposed, simulation shows it can improve network performance.

Introduction

Cognitive Radio (CR)

- proposed as a technology to solve **the imbalance between spectrum scarcity and spectrum underutilization** [1].
- capable of scanning **the spectrum, negotiating the unused spectrum** with its primary users and spectrum bands.
- **The Cognitive Radio Network (CRN)** integrated radio technology and networking technology to provide efficient use of radio spectrum for advanced user services [2].
- **CR wireless network** is intended as an advanced technology integration environment with focus on building adaptive, spectrum-efficient systems with emerging programmable radios.

Conted..

- CRN employing adaptive and flexible communication techniques are prime candidates for the dynamic spectrum access (DSA).
- In DSA, CR used by unlicensed users need to be able to scan a certain spectrum range and intelligently decide.
- The process of handing off the licensed spectrum band to a primary user is called spectrum handoff.

objective

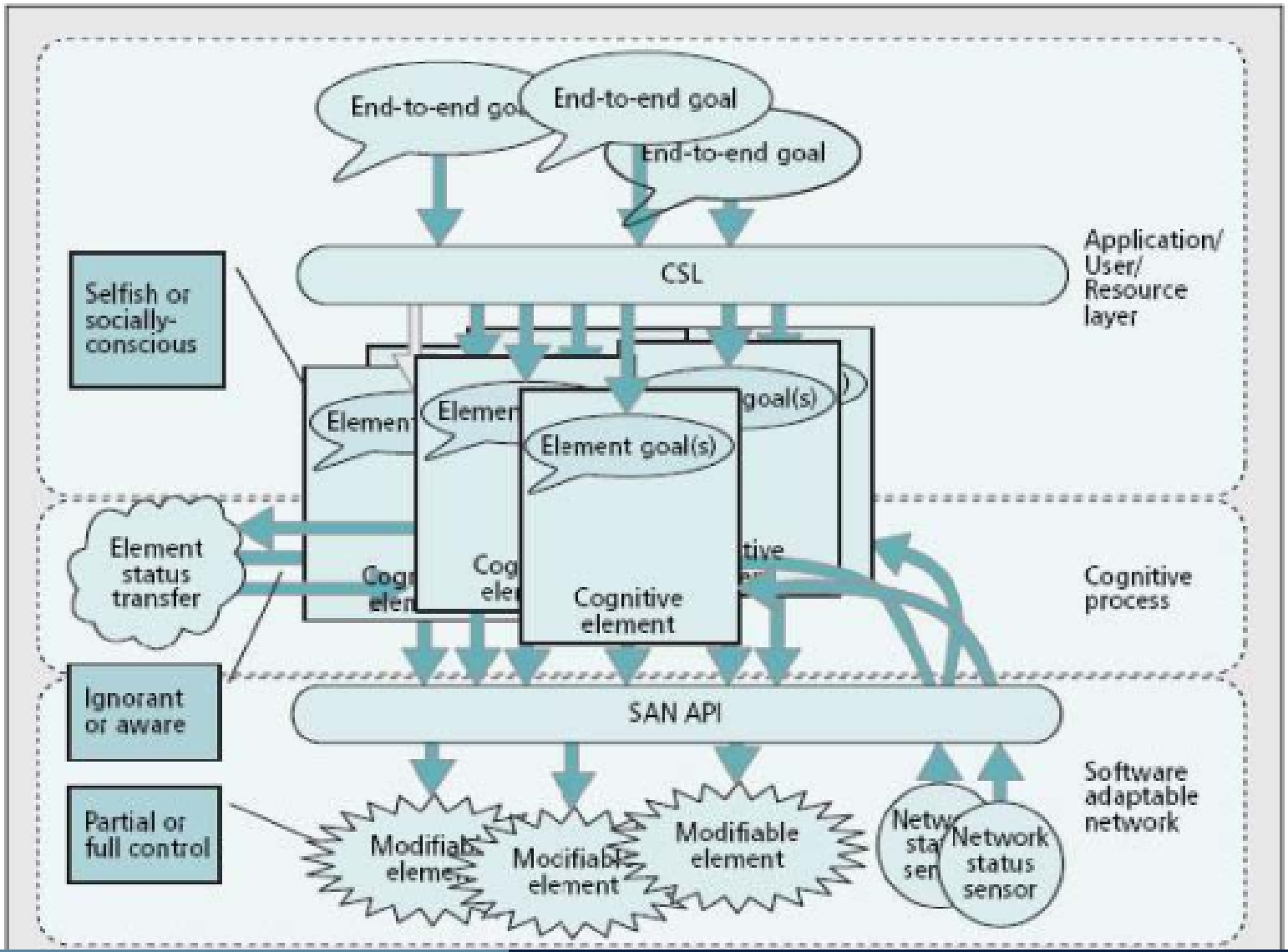
- **Analyzed and proposed a novel architecture and framework of cognitive radio network in which the dynamic channel access is achieved by a cross-layer design between the PHY and MAC layers for cognitive radio network using mathematical analysis.**

CROSS-LAYER DSEIGN AND SECURITY FOR COGNITIVE RADIO NETWORK

A. The Framework of Cognitive Radio Network

- Cognitive radio networks are those that can dynamically alter their topology and/or operational parameters to respond to the needs of particular user.
- enforcing operating and regulatory policies and optimizing overall network performance.
- Cognitive radio networks are capable of perceiving current network conditions and then planning, learning, and acting according to end-to-end goals.
- network infrastructure is consisted of reconfigurable elements and intelligent management functionality that will progressively evolve the policies based on the past actions.

Figure.1 Representative cognitive radio network arch



B. Cross-layer Design for CRN

- Network functionalities are designed in isolation of each other (separate layers) and interfaces between layers.
- Each layer uses the services provided by the layer below it and provides services to the layer above it.
- Interlayer communication happens only between adjacent layers and is limited to procedure calls and responses.
- Examples of this are the seven-layer Open Systems Interconnection (OSI) and the four-layer TCP/IP model.
- There is a need for greater interaction between the different layers of the protocol stack in order to achieve the end-to-end goals and performance in terms of resource management, security.
- sharing of information between the physical and the MAC layers of the protocol stack.

Figure.2 Cross-layer design for Cognitive Radio Network

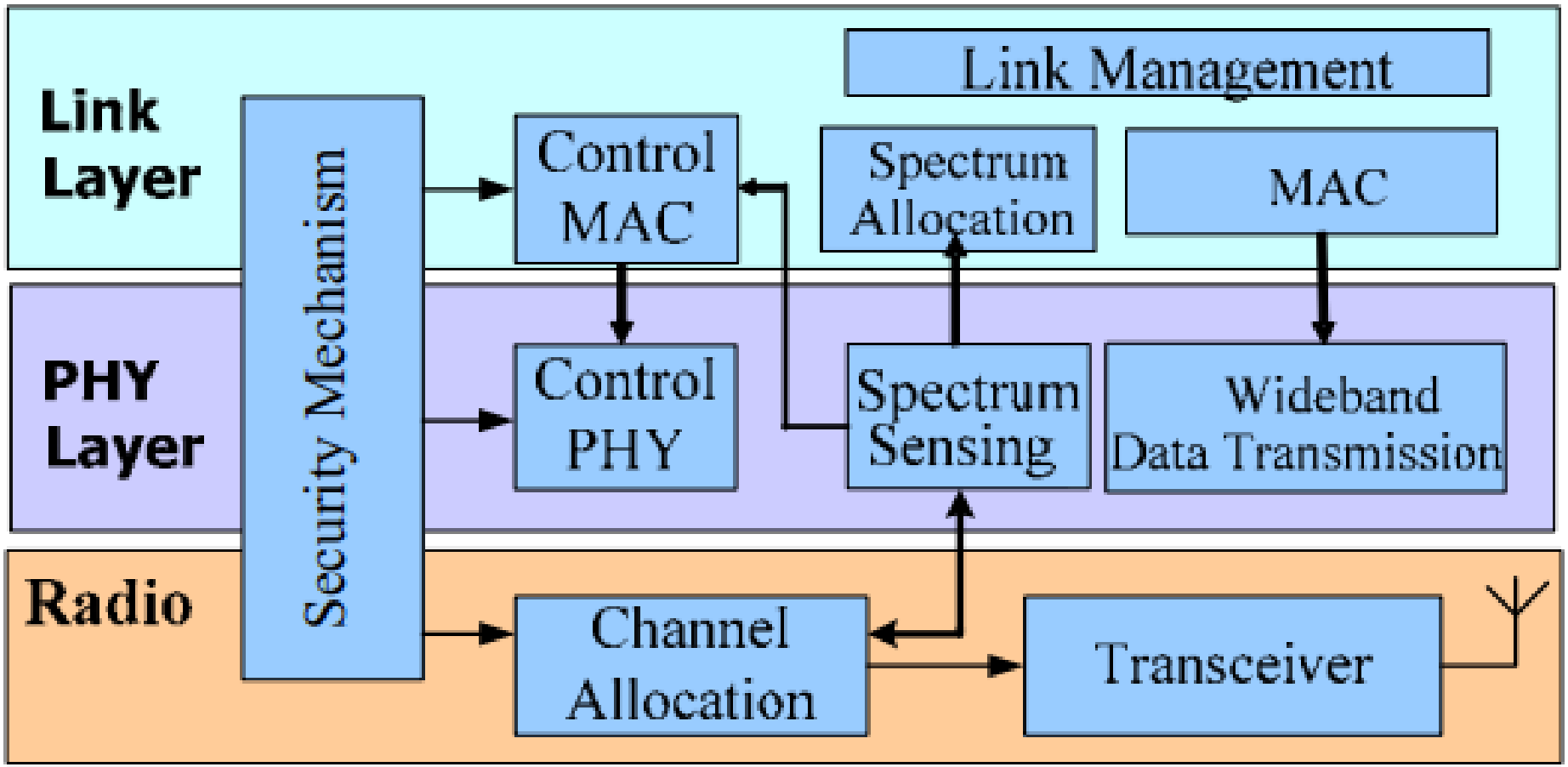


Figure.2 Cross-layer design for Cognitive Radio Network

C. The Research of Cross-layer Security Problem for CRN

Cross-layer Security Problem for CRN

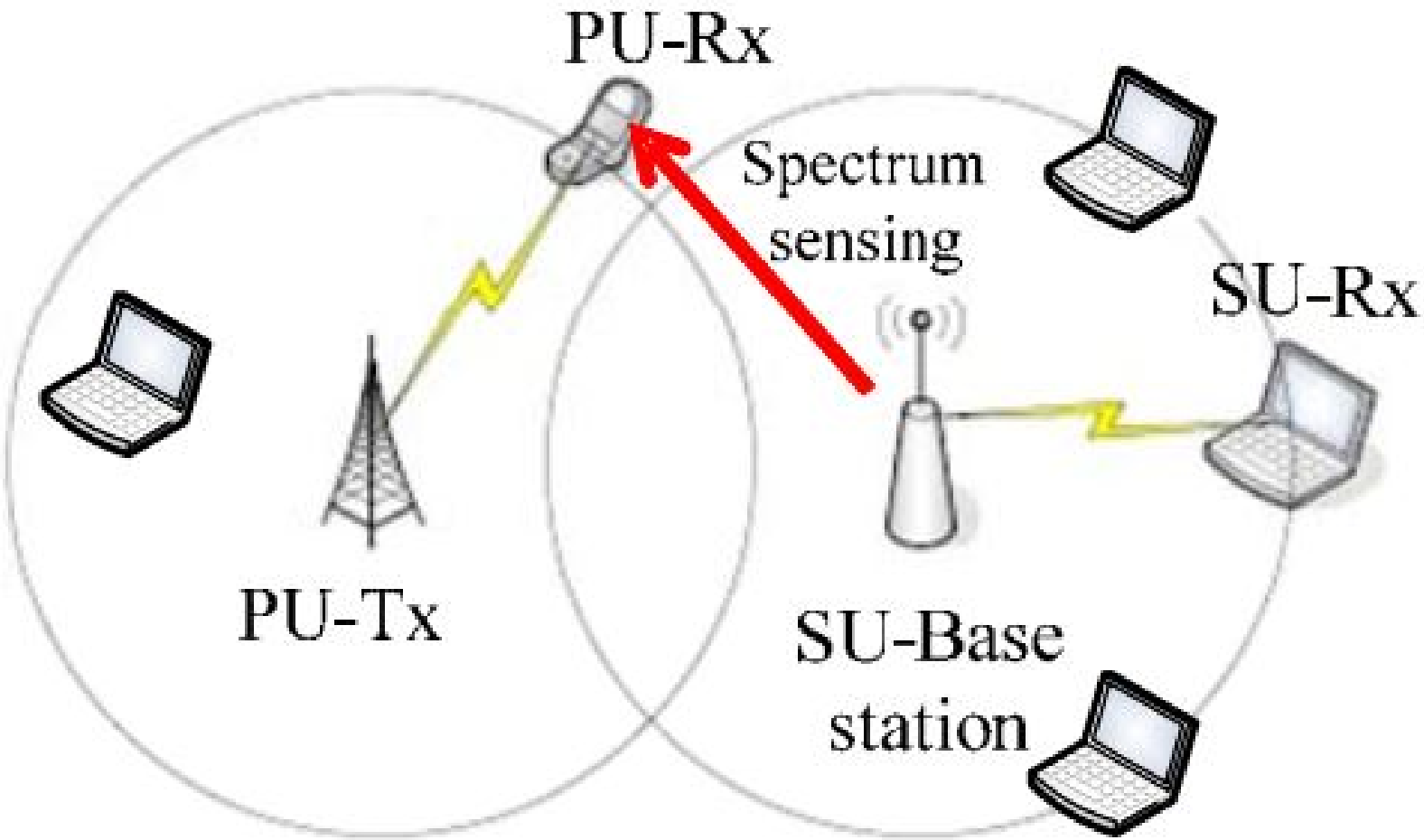
- The central idea of cross-layer design is to improve the overall performance of wireless network
- In cognitive radio networks, there is an inherent need for greater interaction between the different layers of the protocol stack
- In cognitive networks, the physical layer has the capability to transmit at various frequencies across most of the spectrum band.
- The interference temperature [5] due to the secondary transmissions on the primary receivers is below a given threshold.
- Mathematically, the interference temperature in a desired channel of width $\Delta f_i = f_{max}$ - f_{min} where f_{max} and f_{min} are the channel band edges

THE SECURITY ISSUES OF SPECTRUM SENSIING FOR CENTRALIZED COGNITIVE RADIO NETWORK

A. Centralized Cognitive Radio Networks

1. CIn a CR system, some spectrum bands can be shared by primary users (PU) and secondary users (SU).
2. By spectrum sensing, secondary users are able to request the opportunistic usage of these spectrums from the primary users.
3. There are two basic types of cognitive radio networks: centralized and distributed.
4. The centralized network is an infrastructure-based network, where the secondary users are managed by secondary base stations which are in turn connected by a wired backbone.
5. In a decentralized architecture, the secondary users communicate with each other in an ad hoc manner.

figure Centralized cognitive radio network



B. Spectrum Sensing and Interference

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- In a multi-hop CR network, correct spectrum sensing is crucial.
- Inaccurate sensing may cause either interference to primary user communications or spectrum under-utilization.

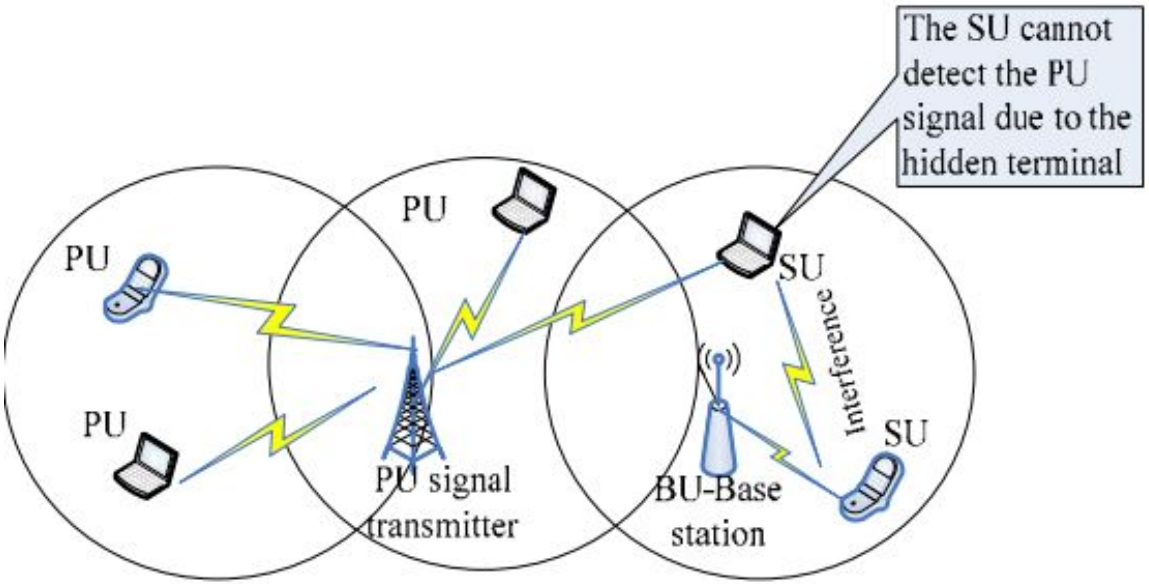

Figure.4 The hidden terminal problem for CRN

C. centralized dynamic channel access

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The essential of CRN spectrum sensing system is opportunistic spectrum access, which allows secondary users to identify available spectrum resources that not occupied by primary users and communicate in a manner that limits the level of interference perceived by the primary users.

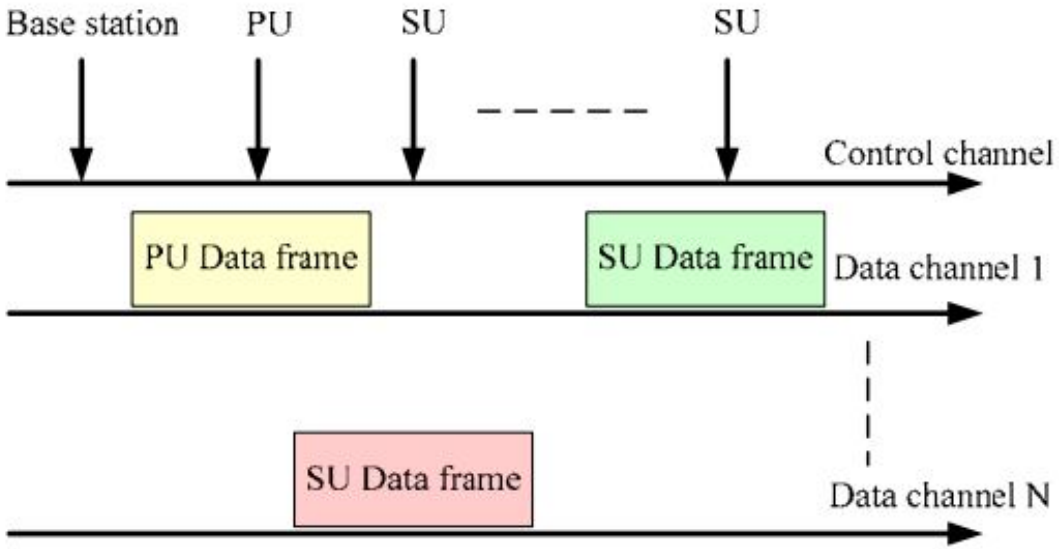


Figure.6 The operation of secondary users in DCA

- Typically in both the models, the operations of secondary devices usually have two stages: sensing and transmission.
- During sensing stages, PHY-layer sensing and MAC-layer sensing are used to detect the primary users and protect their service quality.
- PHY-layer sensing adapts modulation schemes and parameters to measure and detect the primary users signals on different channels.
- actual data transmission can be conducted on the channels underutilized by primary users during the transmission stage.

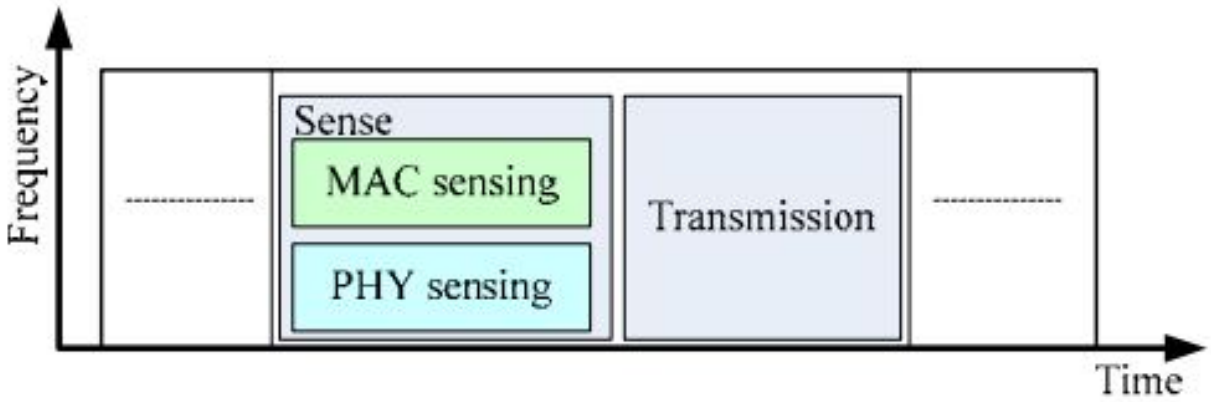


Figure.6 The operation of secondary users in DCA

D. Performance Analysis and Simulation

- To evaluate the effectiveness of the proposed Centralized DCA, authors simulate a cognitive radio network which a base station (BS) controls and supports a set of fixed wireless subscribers.
- Nodes in the network are randomly distributed over a square area of length 1000 meters. **The System Model Considered**:
  - The spectrum of interest is divided into K channels that are licensed to a primary network of M primary user transmitter-receiver (PU-TX, PU-RX) pairs;
  - Each (PU-TX, PU-RX) transmission occupies one of the K channels;
  - This cognitive network consists of a Base station (BS) serving a set of N secondary user (SU) by opportunistically making use of the K channels.

In Simulation Model, the parameter setting as follows:

- The total number of SU is N = 10, the number of PUTX-PURX links is set to 1 and 20; Spectrum is divided into 48 channels, i.e. K=48, etc.

Result the study shown on Figure.7 The throughput VS number of connection with DCA and GCA

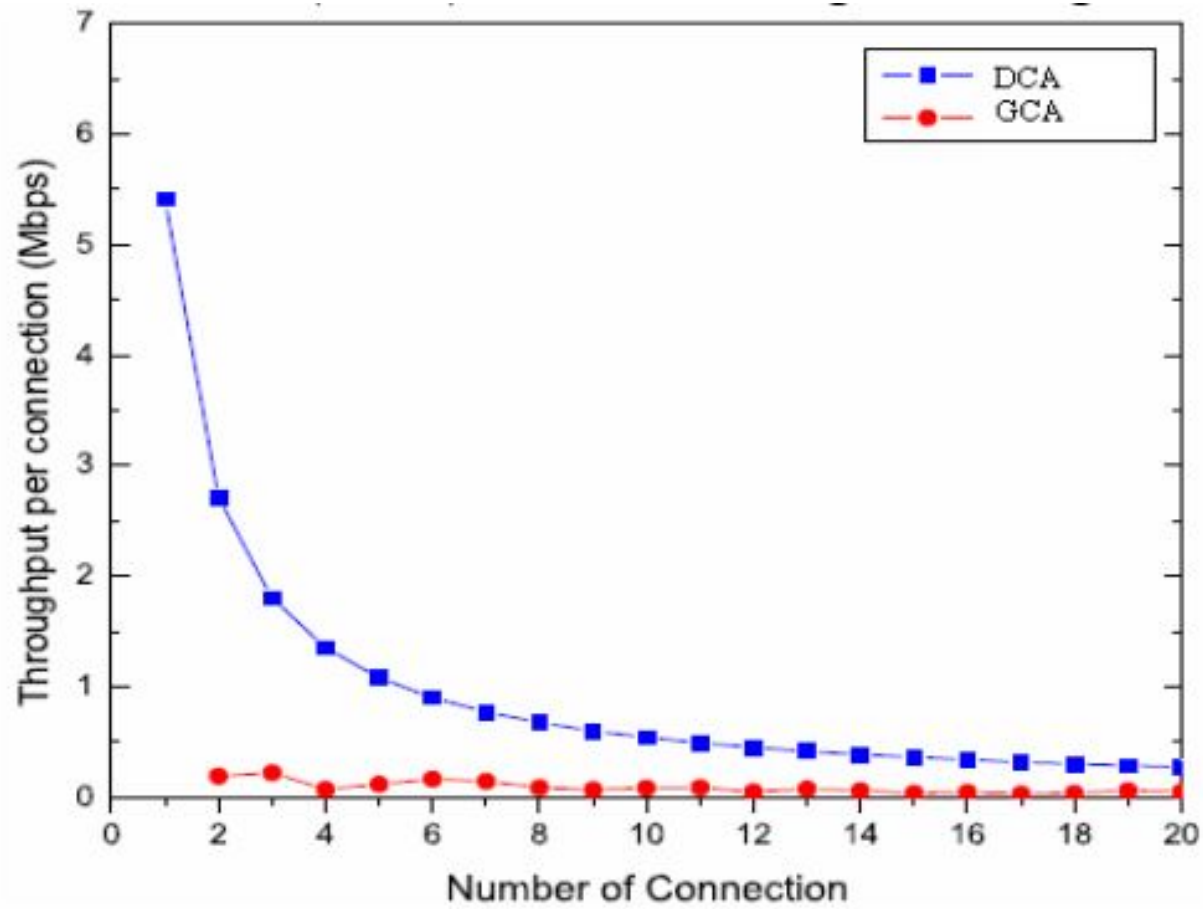
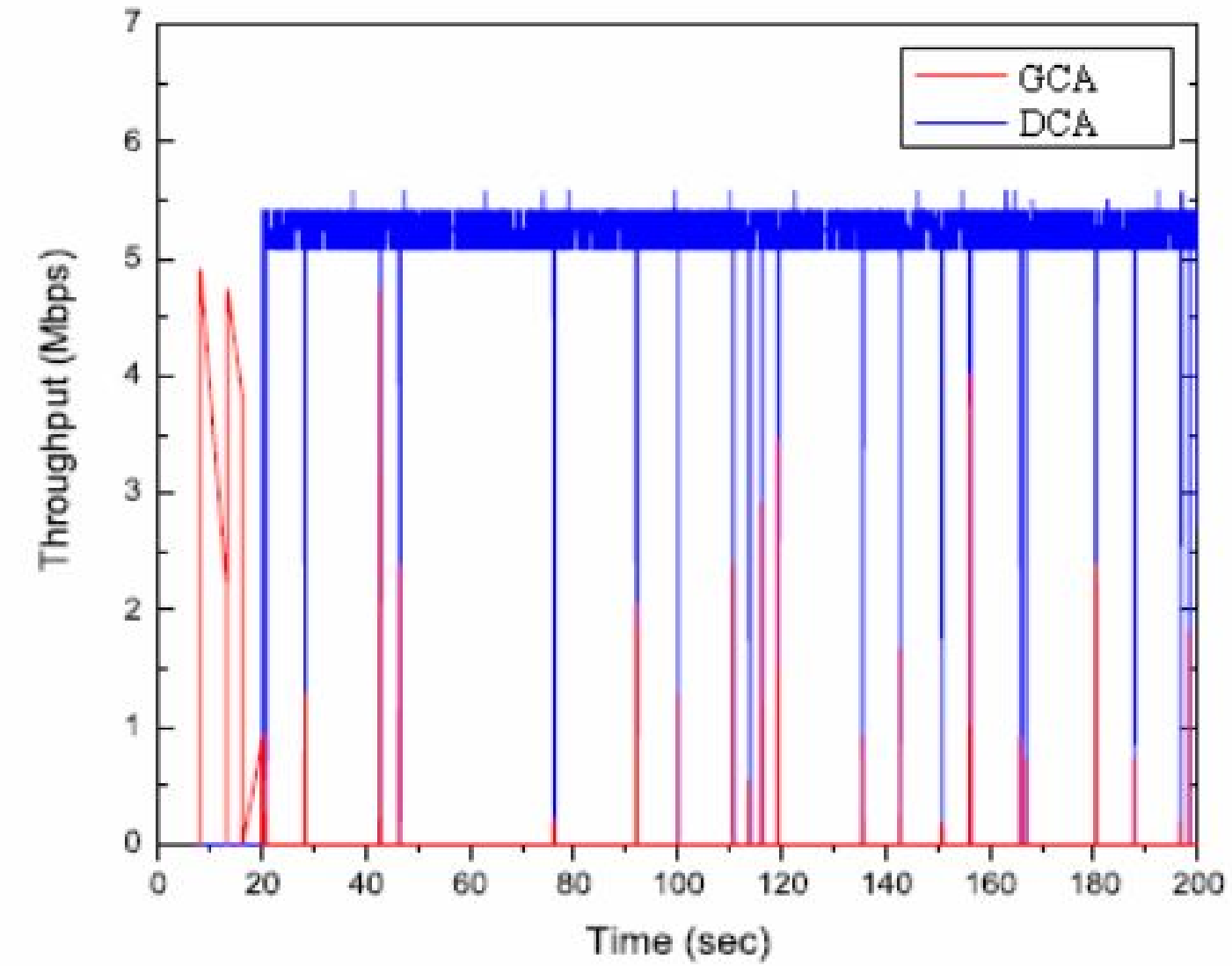


Figure.7 The throughput VS number of connection with DCA and GCA

The simulation result shown the CRN network performance can improve remarkably by use Centralized DCA technology.



Conclusion and future works

Conclusion

- **In general this paper discussed**
  - The framework of cognitive radio network
  - analysis motivations for cross-layer design and security in CRN.
- **Authors proposed**
  - a novel architecture in which the Moreover the resolution of cross-layer
  - security problem is proposed and analysis in mathematics.
- **The security issues**
  - spectrum sensing for Centralized CRN and
  - a novel centralized dynamic channel access mechanism is
    - proposed by authors
    - simulation shows that can improve network performance.

Reference

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