3. ARCHITECTURE

Cognitive Radio Network Architecture

Spectrum Band

Unlicensed Band

CR User

Spectrum Broker

Primary Network Access

Licensed Band I

Primary User

Primary Base-station

CR Base-station

Other Cognitive Radio Networks

Licensed Band II

CR Network Access

Primary Network

Cognitive Radio Network (With Infrastructure)
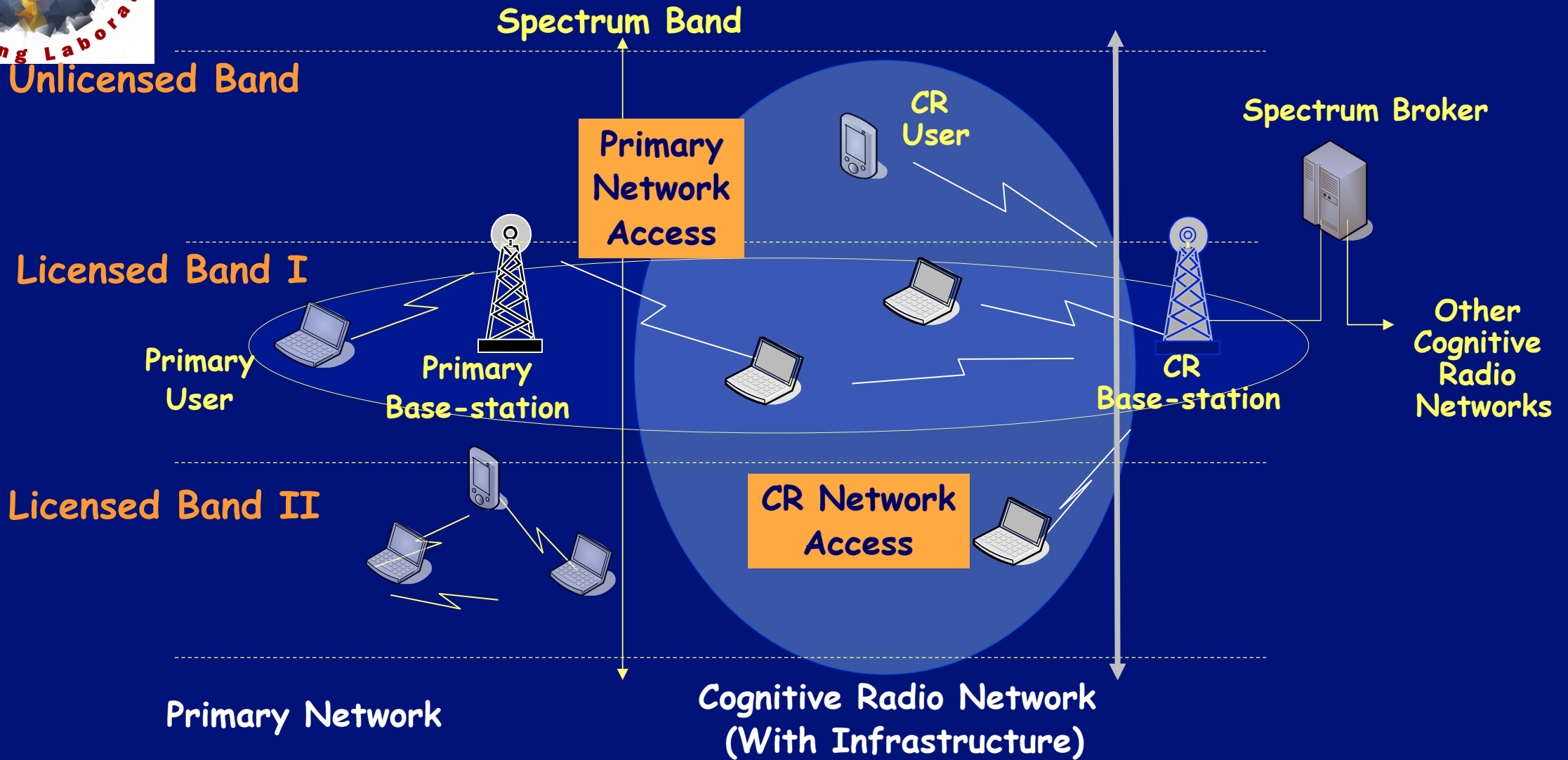
CR Ad Hoc Networks Architecture

BWN Lab — Broadband Wireless Networking Laboratory

Spectrum Band

Unlicensed Band

Licensed Band I

Primary User

Primary Base-station

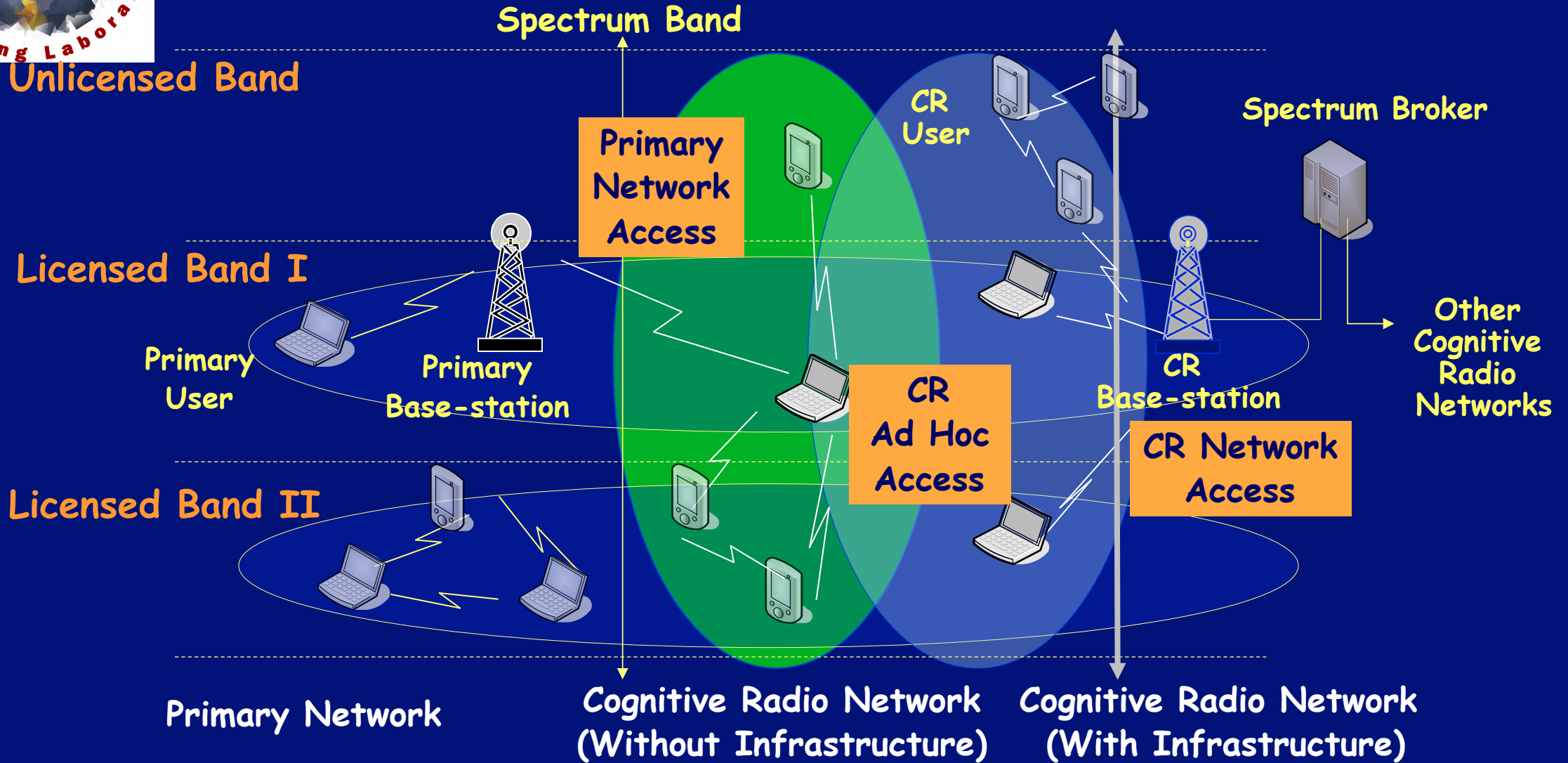**Licensed Band II**

CR User

CR Ad Hoc Access

Primary Network

Cognitive Radio Network (Without Infrastructure)

Cognitive Radio Network Architecture

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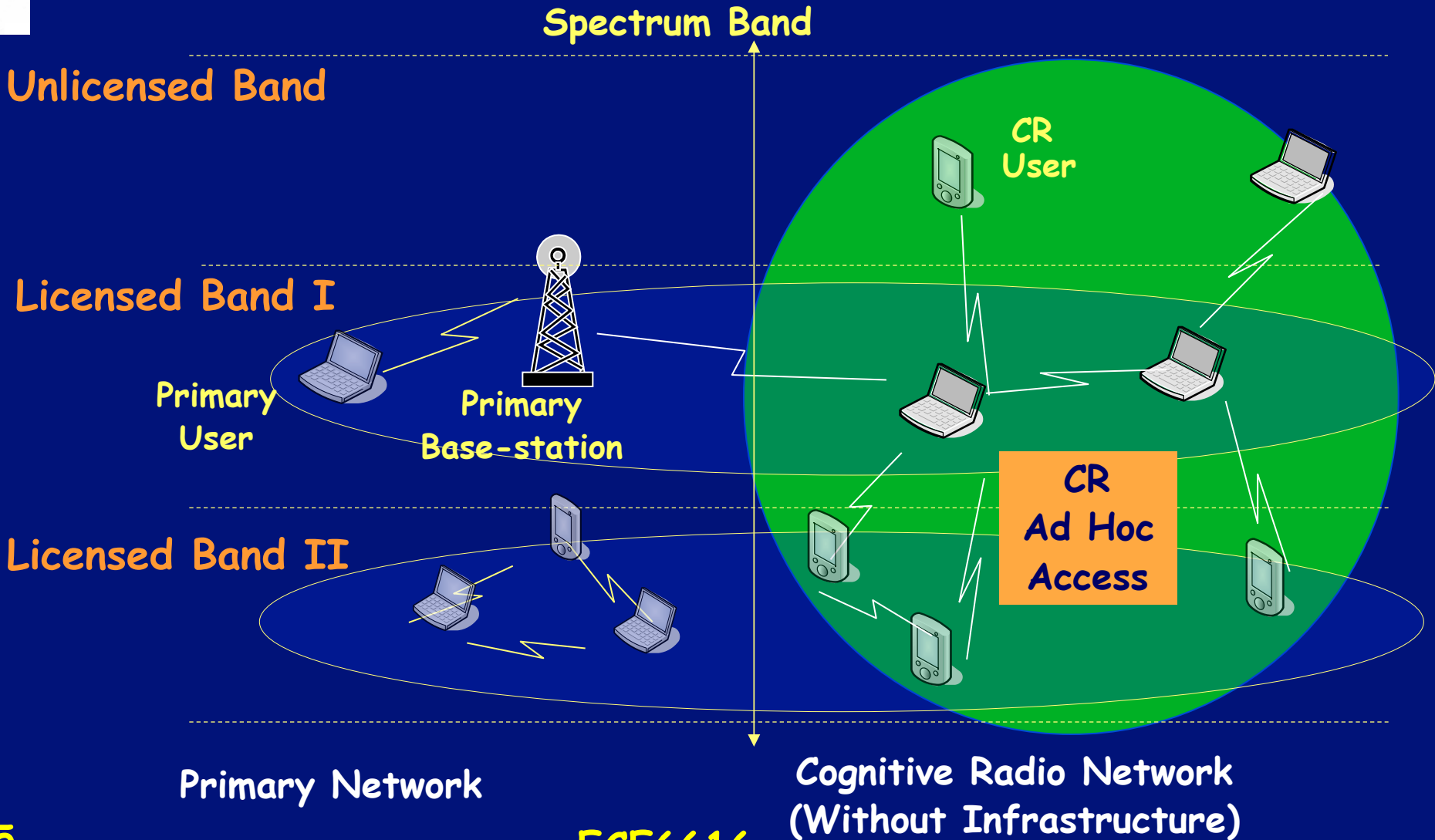
Architecture

- **Primary Network**
  (Primary User, Primary Base Station)

- **Cognitive Radio Network**
  (CR User, CR Base Station)

- **Spectrum Broker**

Primary Network

* An existing network infrastructure (or ad hoc network) which has an access right to a certain spectrum band.

Example:

Common cellular and TV broadcast networks.

Primary User
(or Licensed User)

*   Has a license to operate in a certain spectrum band.

*   This access can only be controlled by the primary base-station and should not be affected by the operations of any other unlicensed users.

REMARK:
PUs do not need any modification or additional functions for co-existence with CR base-stations and CR users.

Primary Base-Station
(or Licensed Base-Station)

- A fixed infrastructure network component which has a spectrum license such as BTS in a cellular system.

- Does not have any CR capability for sharing spectrum with CR users.

- It may be requested to have both legacy and CR protocols for the *primary network access* of CR users.

Cognitive Radio Network
(or Dynamic Spectrum Access Network, or Secondary Network or Unlicensed Network)

* **Does not have license to operate in a desired band.**

* **Hence, the spectrum access is allowed only in an opportunistic manner.**

* **CR networks can be deployed both as an infrastructure network and an ad hoc network**

Cognitive Radio User
(or Unlicensed User, Secondary User)

→ **has no spectrum license**

Hence, additional functionalities are required to share the licensed spectrum band.

Cognitive Radio *Base-Station*
(or Unlicensed Base-Station or Secondary Base-Station)

- – A fixed infrastructure component with CR capabilities.

- – CR base-station provides single hop connection to CR users without spectrum access license.

- – Through this connection, a CR user can access other networks.

Spectrum Broker
(or Scheduling Server)

- – A central network entity that plays a role in sharing the spectrum resources among different CR networks.

- – It can be connected to each network and can serve as a spectrum information manager to enable co-existence of multiple CR networks.

Architecture

- **CR Network Access:**

  CR users can access their own CR base-station both on licensed and unlicensed spectrum bands.

- **CR Ad Hoc Access:**

  CR users can communicate with other CR users through ad hoc connection on both licensed and unlicensed spectrum bands.

- **Primary Network Access:**

  CR users can also access the primary base-station through the licensed band.

Classifications
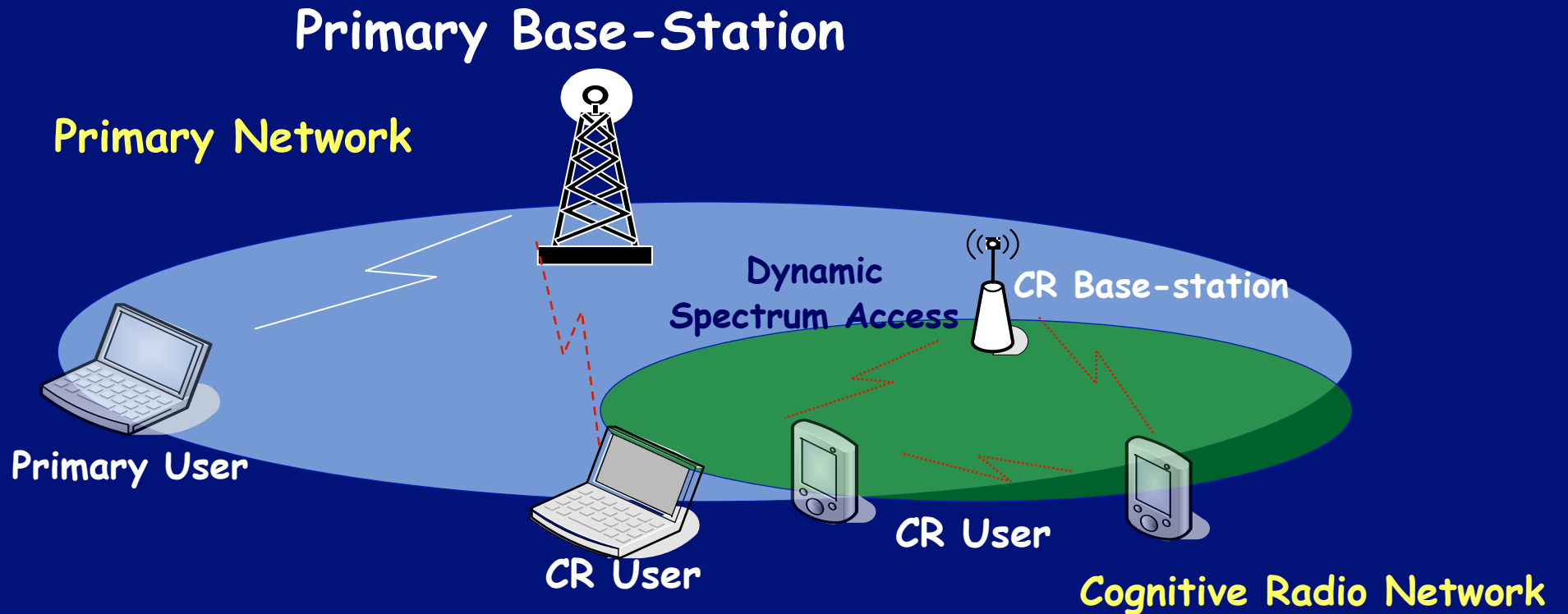
■ **CR Network on Licensed Band**

CR user is capable of using bands assigned to licensed users, apart from unlicensed bands, such as ISM band.

■ **CR Network on Unlicensed Band**

CR can only utilize unlicensed parts of radio frequency spectrum.

Cognitive Radio Network on Licensed Band

Primary Base-Station

Primary Network

Dynamic Spectrum Access

CR Base-station

Primary User

CR User

CR User

Cognitive Radio Network

CR Network on Licensed Band

- **Temporally unused spectrum holes exist in the licensed spectrum band.**

- **CR networks can exploit these spectrum holes through cognitive communication techniques.**

- **In Figure, CR network coexists with the primary network at the same location and on the same spectrum band**

CR Network on Licensed Band

- **Main purpose of the CR network is to determine** the best available spectrum

- **Here in the licensed band, CR functions are aimed** at the detection of the presence of PUs

- **Channel capacity of the spectrum holes depends on the** interference at the nearby PUs
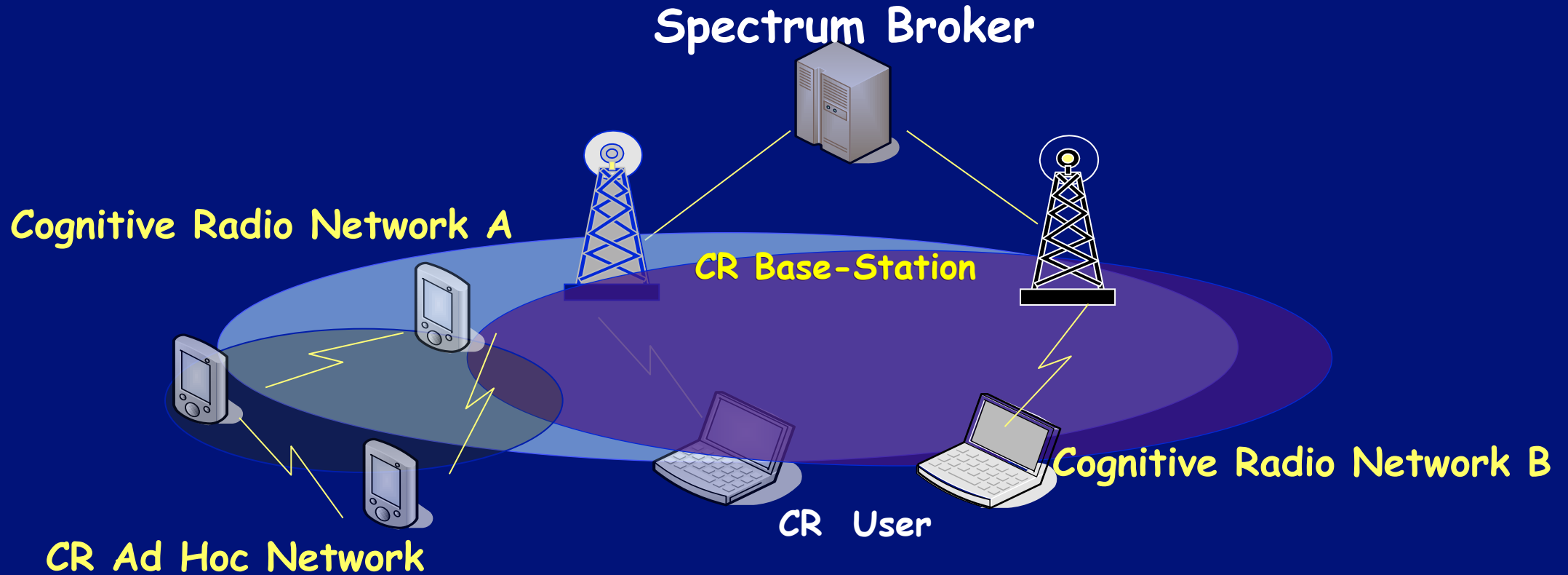
CR Network on Licensed Band

- **Interference avoidance with PUs is the most important issue here**

- **Also if PUs appear in the spectrum band occupied by CR users, they should vacate the current spectrum band and move to the new available spectrum immediately →*spectrum handoff*.**

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Cognitive Radio Network on Unlicensed Band

Spectrum Broker

Cognitive Radio Network A

CR Base-Station

Cognitive Radio Network B

CR User

CR Ad Hoc Network

CR Network on Unlicensed Band

- Since there are no license holders, all network entities have the same right to access the spectrum bands.

- Multiple CR networks co-exist in the same area and communicate using the same portion of the spectrum.

- Intelligent spectrum sharing algorithms can improve the efficiency of spectrum usage and support high QoS.

CR Network on Unlicensed Band

- CR users focus on detecting the transmissions of other CR users.

- Since all CR users have the same right to access the spectrum, CR users should compete with each other for the same unlicensed band.

CR Network on Unlicensed Band

REQUIREMENTS:

1. Sophisticated spectrum sharing methods among CR users

2. Fair spectrum sharing among networks if multiple CR network operators reside in the same unlicensed band.