Feasibility Test for CR Networks

2009. 02. 23

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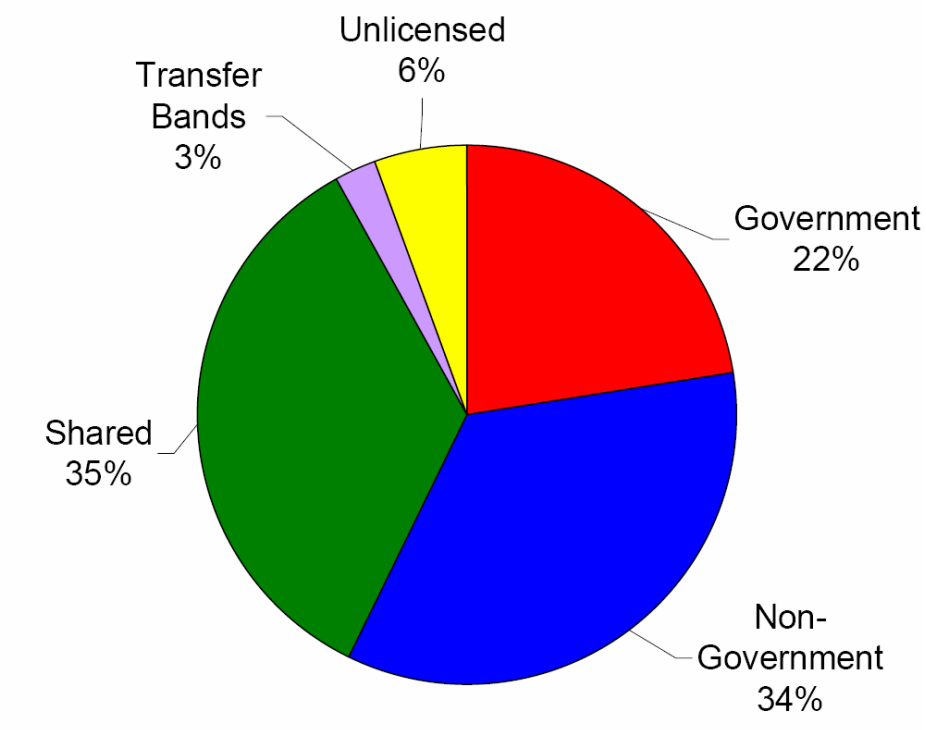
Contents

Spectrum Shortage Problem (1/2)

300-3000 MHz

Division of Spectrum Between Government and Non-Government

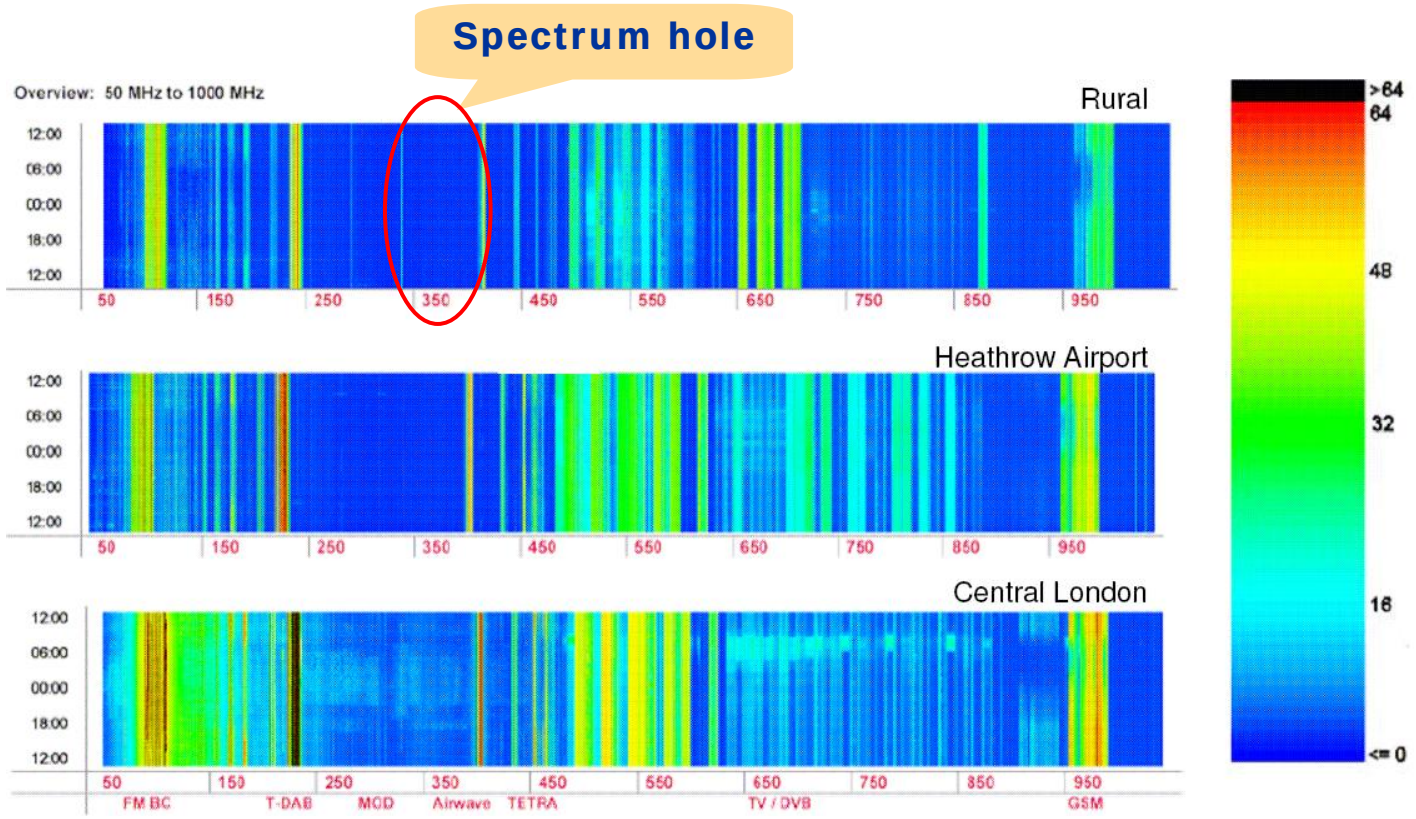
	G	NG	G/NG	T	UL
MHz	621.6	964.97	965.4	70	156
%	22.38	34.74	34.75	2.52	5.62
Total	2778				



- Most of the frequency bands are allocated
- Insufficient wireless spectrum
  - Due to the increasing demand of wireless communication

Spectrum Shortage Problem (2/2)

- However, there are a lot of spectrum holes

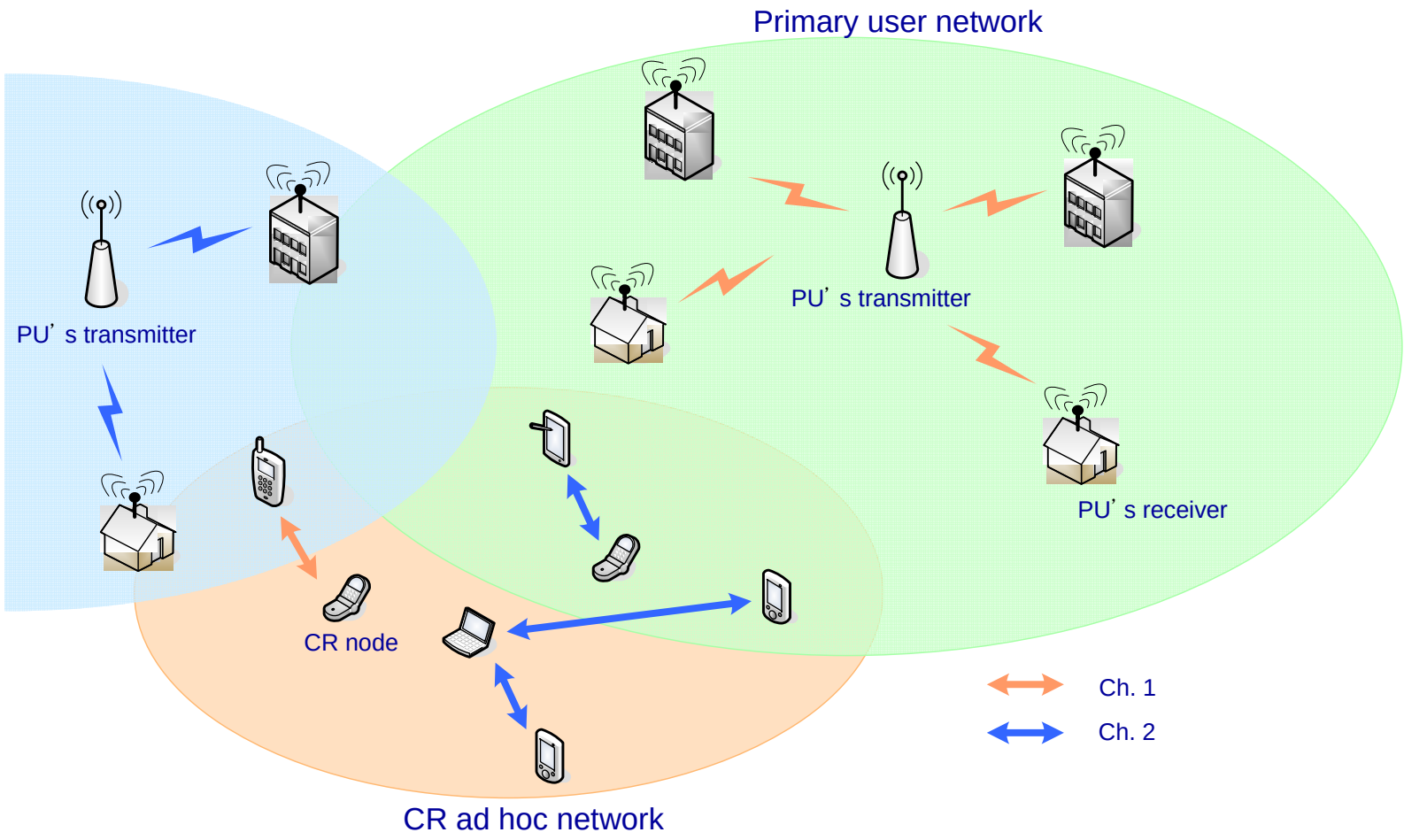


http://www.ofcom.org.uk/research/technology/research/emer_tech/cograd/

CR Networks

- Functional requirements of CR network
  - Finding and utilizing the spectrum holes
  - Should not impair the transmission of PU
    - Channel sensing: CR network should know the activation of PU within a certain duration
    - Channel switching: When PU is detected, a CR network should vacate the channel
  - Providing service for CR users
    - Channel sensing and switching should not deteriorate the QoS of CR users severely

Example of CR network



Feasibility Test for CR networks (1/2)

- Necessity of feasibility test
  - Most research results rely on theoretical analysis and computer simulation
  - To know the possibility of CR technology
  - To convince the regulators

  ➔ requires technical proof of feasibility for CR networks

- Focus on feasibility test
  - Channel switching without service disruption
  - Perfect channel sensing is assumed

Feasibility Test for CR networks (2/2)

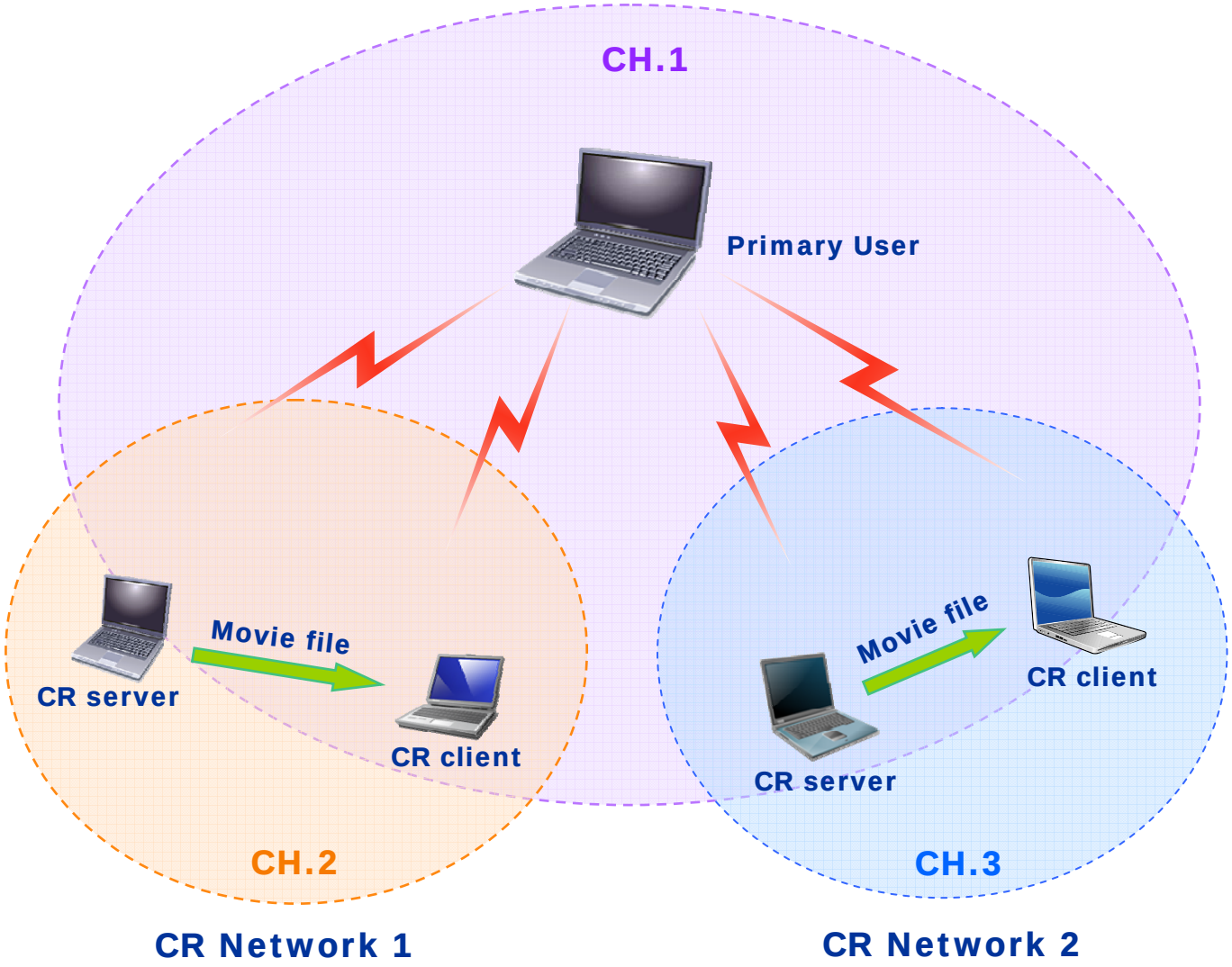
❖ Related works

- Open access research test-bed for next-generation wireless networks (ORBIT)
  - General test-bed for ad hoc and mesh networks
  - No channel sensing
  - ORBIT can be used for CR network test-bed

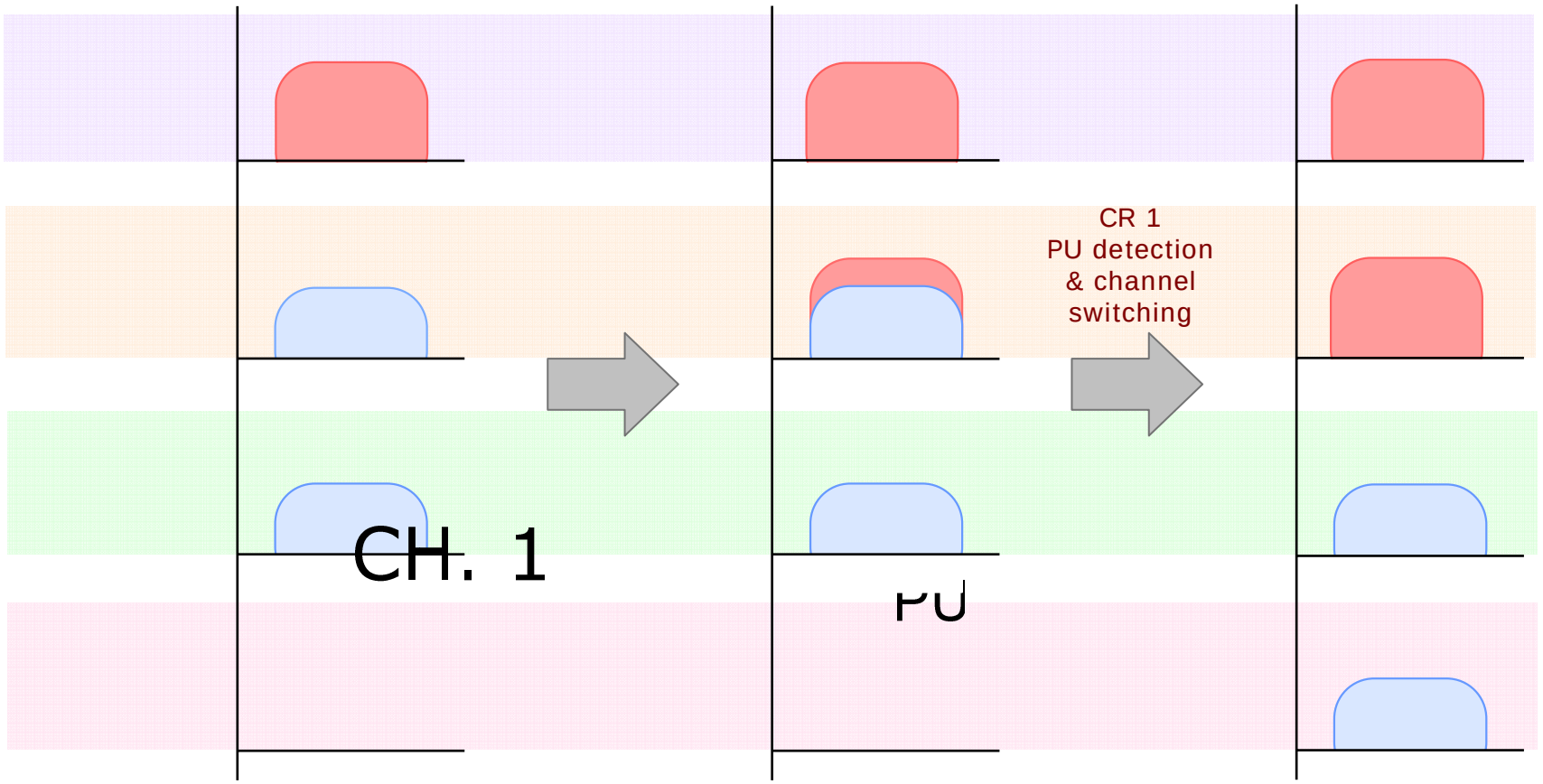
- MIRAI cognitive radio execution framework (MIRAI-CREF)
  - General test-bed
  - CR manager
    - Spectrum allocation including channel switching
    - SNR ratio detection for channel sensing

- Cognitive transceiver unit (CTU)
  - Network interface card
  - Monitoring the available channels(54 MHz – 6 GHz)
  - Switching a channel

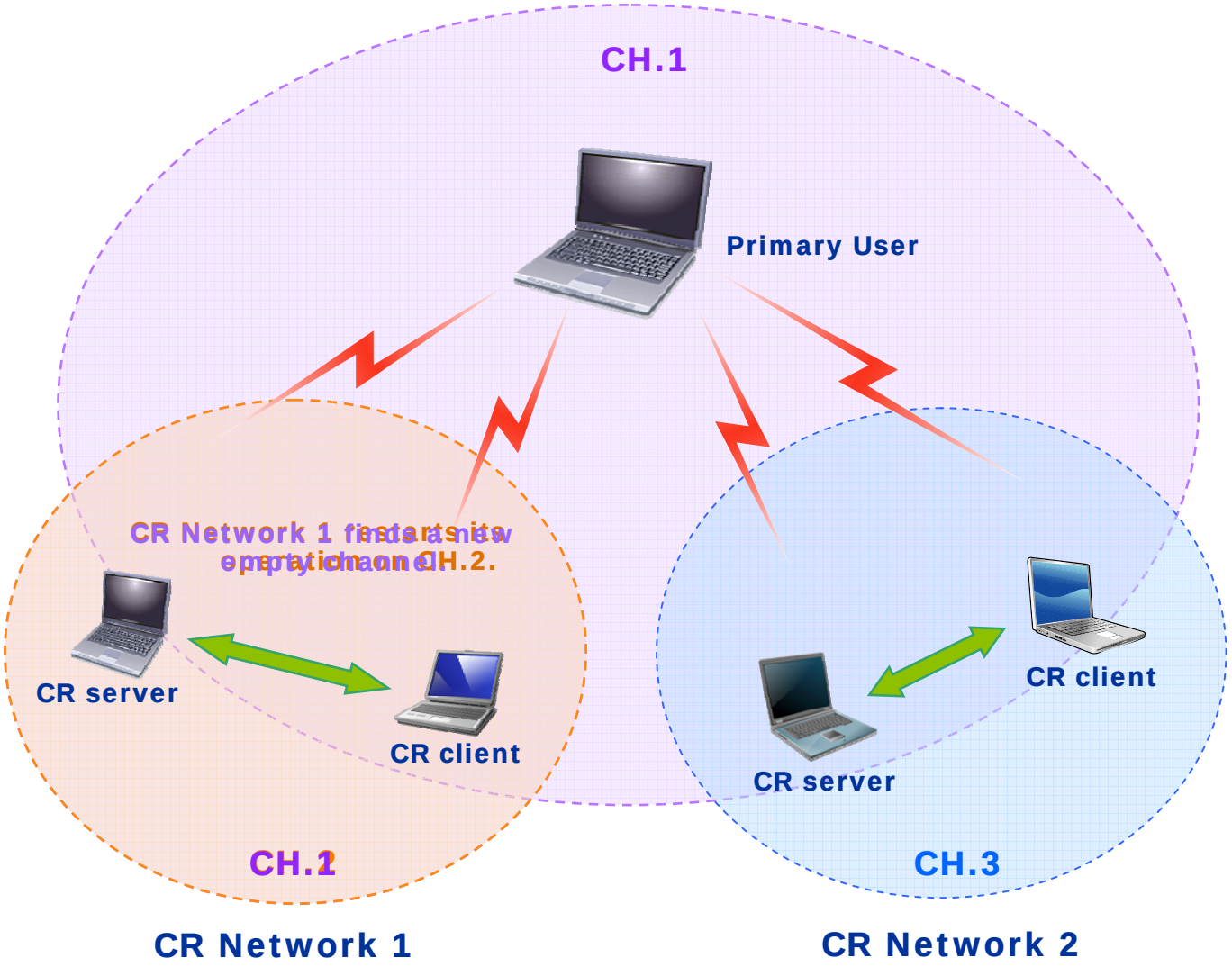
Network Configuration



Scenario of Our Demonstration



Network Overall Operation



CR Network Configuration (1/3)

- CR system
  - Two IEEE 802.11a ad hoc networks
  - Each CR network detects PU independently
  - When PU is activated on its channel
    - CR network switches to other empty channel
    - Do not switches to the channel where another CR network exists
  - Two CR networks belong to the PU's transmission area
  - Each CR client downloads and plays a movie file
- PU
  - One IEEE 802.11a device
  - PU changes its channel randomly
    - Imitating several PUs
  - PU operates in one channel at a time

CR Network configuration (2/3)

- Hardware configuration
  - 5 laptop computers
  - Using IEEE 802.11a
    - Cisco Aironet wireless adapter
    - IEEE 802.11b/g is also available
    - Off-the-shelf devices
      - http://madwifi-project.org/wiki/Compatibility/
  - 4 channels in 5 GHz band is used
    - Central frequency of each channel
      - 5.22 GHz, 5.24 GHz, 5.26 GHz, and 5.28 GHz

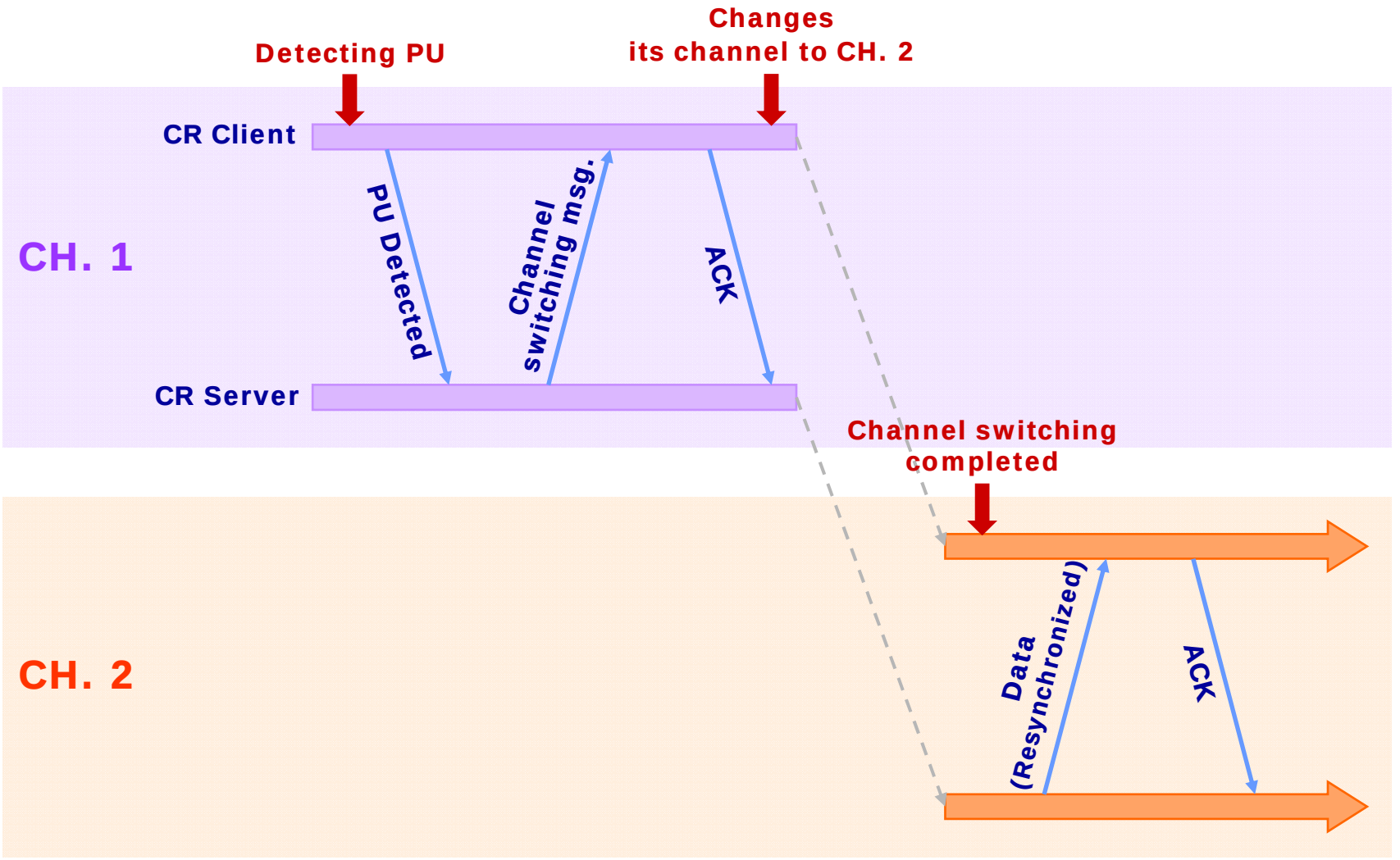
CR Network configuration (3/3)

- Software configuration
  - Operating system: Linux Ubunto
  - Madwifi
    - Linux device driver
    - For 802.11a/b/g universal NICs
  - JAVA for controlling the CR functionalities
- Monitoring Program
  - GUI is implemented with JAVA Swing
  - Movie player is embedded by using JMF
    - MPEG-1 video file is played

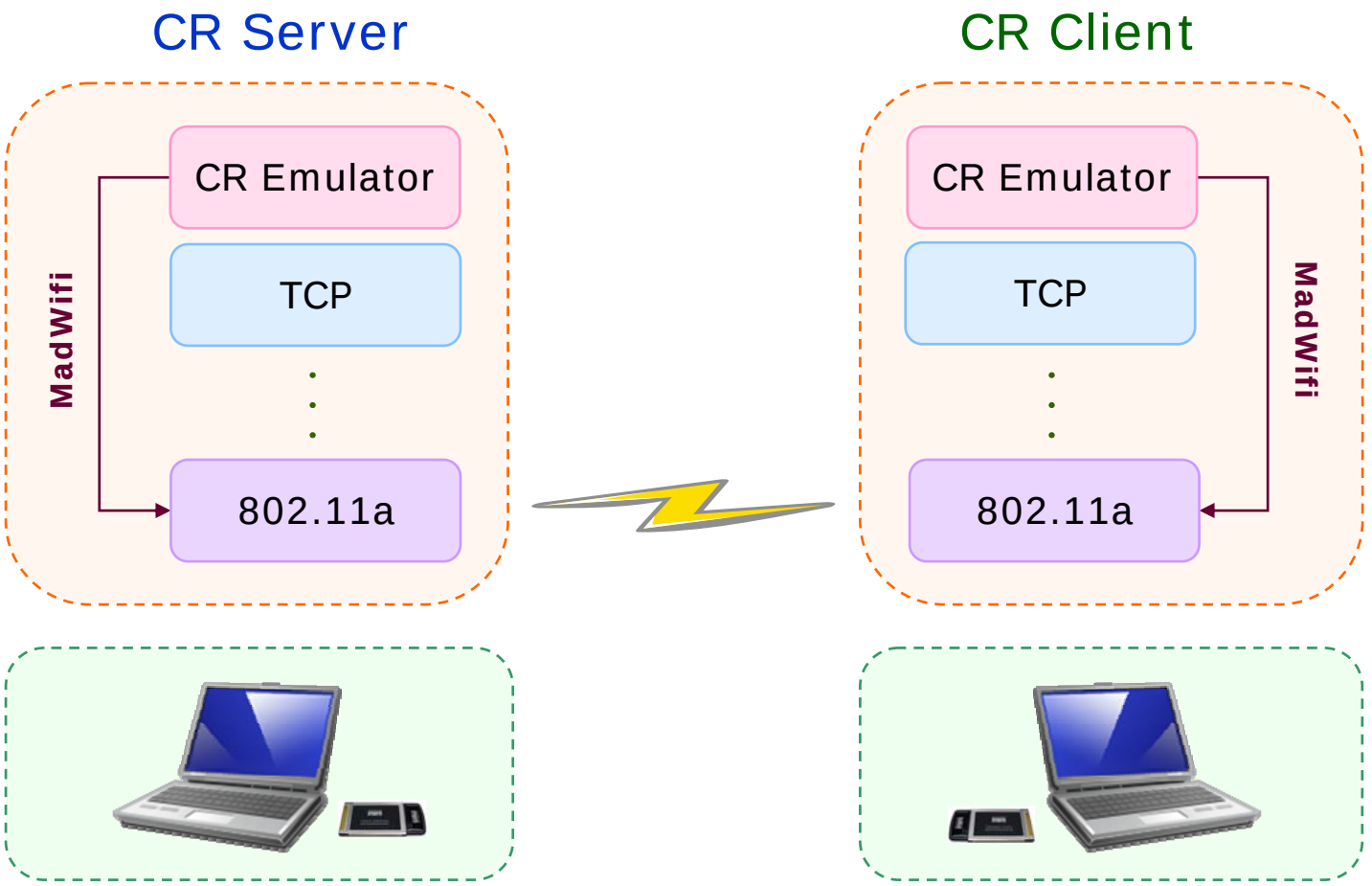
CR functionality

- Channel sensing
  - PU transmits a known signal
  - CR network can recognize the pre-defined PU signal
  - Each CR network selects one empty channel as a backup channel
- Channel switching
  - Recognizing the arrival of PU
  - Selecting the one of empty channels
  - Re-synchronizing in the new channel

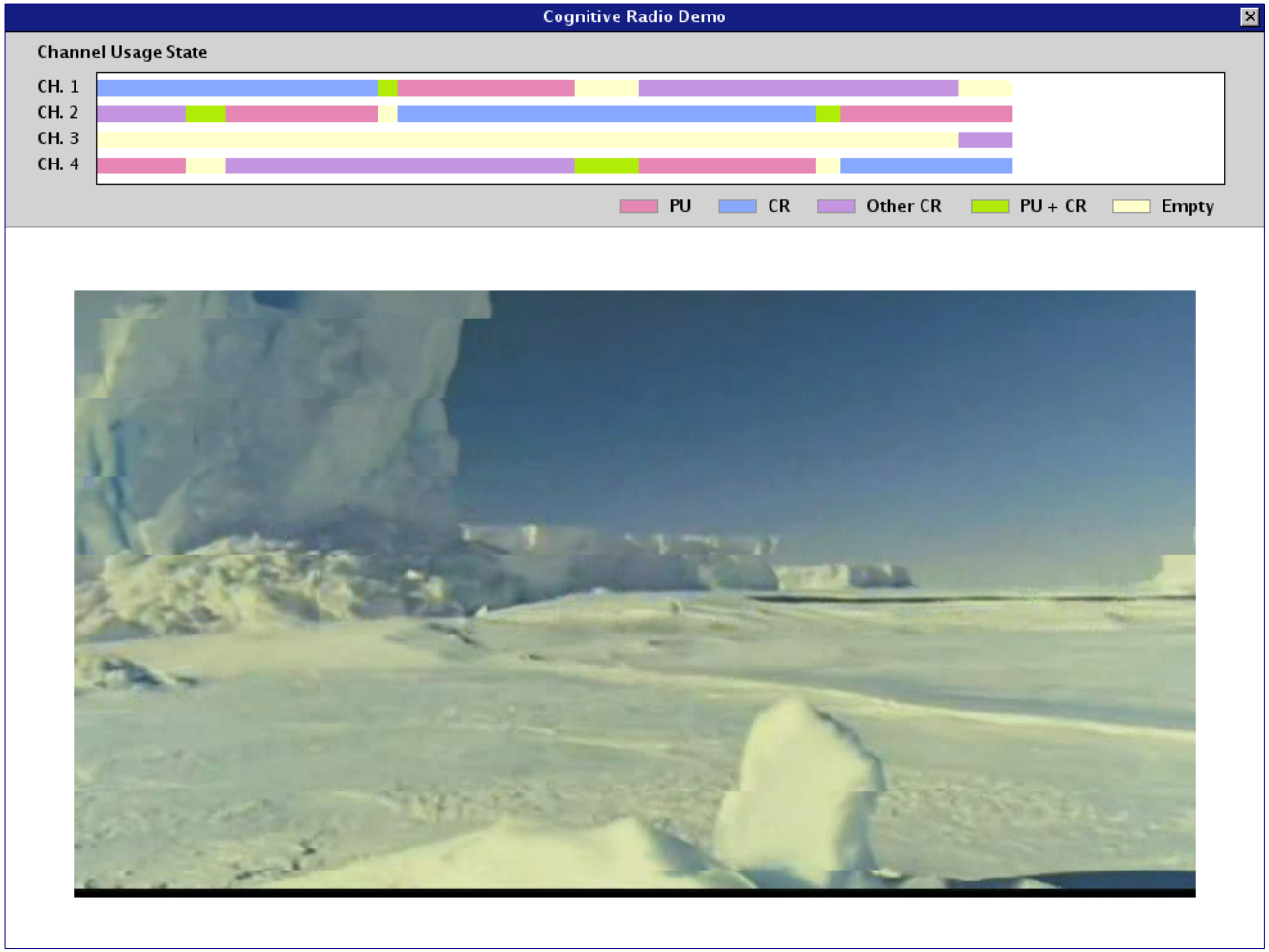
Example of Channel Switching



CR Server-Client Communication



A Screenshot of Monitoring Program



- CR network can switch its channel when PU is activated
- Also, CR client can show movie file without disruption

Conclusion

- Feasibility of CR
  - CR functionality can be implemented by the concurrent technique
  - Our feasibility test shows
    - CR network switched its channel successfully
    - Service disruption by channel switching is not severe