Chapter 21
An Adaptive Reasoning and Learning Framework for Mobile Cognitive Radio Systems

Chih-Sheng Lin
National Chung Cheng University, Taiwan, R.O.C.

Wei-Wen Lin
National Chung Cheng University, Taiwan, R.O.C.

Ken-Shin Huang
National Chung Cheng University, Taiwan, R.O.C.

Pao-Ann Hsiung
National Chung Cheng University, Taiwan, R.O.C.

Jih-Sheng Shen
National Chung Cheng University, Taiwan, R.O.C.

Mao-Hsu Yen
National Taiwan Ocean University, Taiwan, R.O.C.

Shen-Yang Pan
National Chung Cheng University, Taiwan, R.O.C.

Chu Yu
National Ilan University, Taiwan, R.O.C.

Shih-Shen Lu
National Chung Cheng University, Taiwan, R.O.C.

Sao-Jie Chen
National Taiwan University, Taiwan, R.O.C.

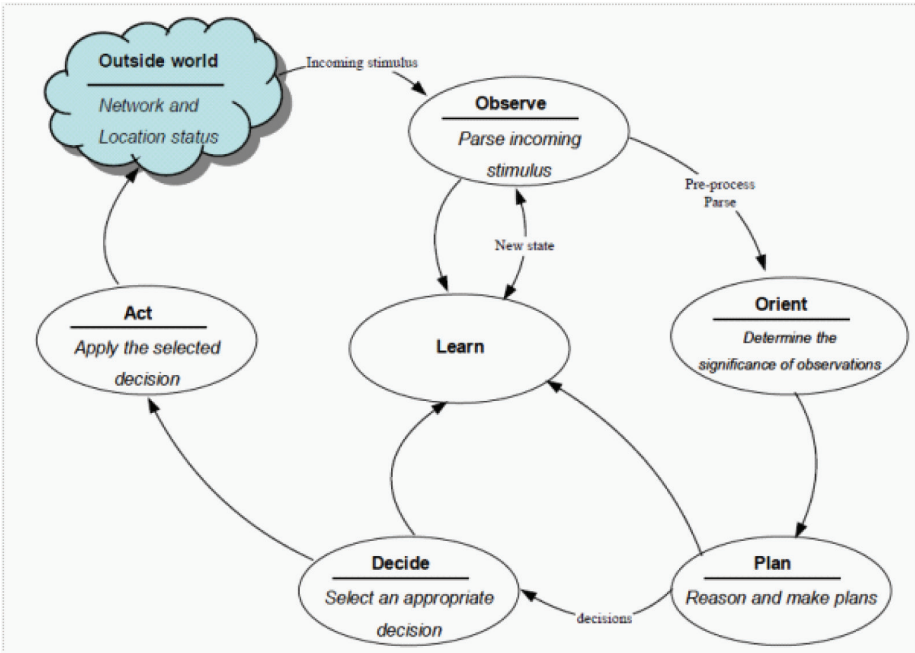
William Cheng-Chung Chu
Tunghai University, Taiwan, R.O.C.

ABSTRACT

Cognitive radios are intelligent mobile systems with self-adaptivity. Existing frameworks mainly focus on the radio aspects of system designs such as dynamic spectrum access and reduction of bit error rate. However, besides the radio aspects, cognitive radios also leverage other environmental data such as GPS location, system time, and user preferences. The authors propose an adaptive reasoning and learning framework (ARALF) for cognitive radio systems such that this gap between spectrum data and other environment data is bridged. The framework has a novel reasoning and learning mechanism that combines case-based reasoning and rule-based reasoning. Adaptivity and mobility are seamlessly blended into the framework so that users of cognitive radios are completely unaware of unexpected jitters due to environment changes.

DOI: 10.4018/978-1-61520-655-1.ch021

Figure 1. The cognition cycle in a CR system



INTRODUCTION

Today, most of us carry a portable device and use some services on wireless network over spectrum. However, the utilization of the wireless network spectrum is very low. A mechanism is thus needed to share the unused spectrum efficiently and adequately. Cognitive Radio (CR) was originally proposed to be a promising solution for the spectrum sharing problem. Joseph Mitola invented the basic CR concept in the 1990s (Mitola, 2000), (Mitola, 2001), (Mitola, 2006). The general definition of CR is a radio that can sense and adapt to its environment. For example, dynamically selecting channels to share spectrum and reuse is one of the applications of CR. To provide a better Quality of Service (QoS) such as maximizing the throughput for application over network, the design of CR may not only take into account radio aspects. Other environment related data such as geographical location, user preference, and system time should be considered because these contextual information data may actually alleviate the radio problems more efficiently.

The key idea of CR is a cognition cycle that implements the capabilities required of CR in a reactive sequence. There are six major stages of a cognition cycle as shown in Figure 1:

- **Observe**: The CR observes its surrounding environment by parsing incoming stimulus streams such as radio and location raw data.
- **Orient**: The Orient stage determines the significance of an observation by binding it to a previously known set of stimuli.
- **Plan**: The Plan stage constructs corresponding models with dealt stimuli and makes plans including reasoning.
- **Decide**: The Decide stage selects an appropriate decision among several candidate plans.
- **Act**: The Act stage applies the most appropriate decision made in the Decide stage.