Executive Summary

1) ความสำคัญและที่มาของปัญหา

In general, the traditional power grids are used to carry power from a few central generators to a large number of users or customers. In contrast, Smart grid (SG) uses two-way flows of electricity and information to create an automated and distributed advanced energy delivery network. SG is the integration of secure, high-speed and reliable data communication networks to manage the complex power systems intelligently and effectively. Thus, SG has harsh and complex environmental conditions, connectivity problems, dynamic topology changes, and interference and fading issues during wireless communication. It is difficult to design the information and communication technologies (ICTs) system for the overall power grid. Thus, the choice of communication infrastructure for SG is highly critical to provide reliable, secure, and efficient data delivery between SG components. For solving these problems, Cognitive radio (CR) networks can be benefited to address the unique challenges of SG, such as multipath fading, reliability and delay requirements, different spectrum characteristics changing over location and time, noise, and harsh environmental conditions.

Cognitive radio (CR) network is proposed for overcome the “Spectrum crisis” problem by offering several advantages to utilize spectrum opportunistically with dynamic spectrum management techniques. CR network has two important actors: 1) primary user (PU) and 2) secondary user (SU). PU is the owner of a licensed channel that has the priority to user the spectrum. SU is the occasional user that is responsible for sensing the licensed spectrum, identifying the unused channels in the absence of PU and a SU is called a CR user. CR system has four main functions including spectrum sensing, spectrum management, spectrum mobility, and spectrum sharing. The spectrum sensing detects unused spectrum and sharing the spectrum without harmful interference with other users. The spectrum management captures the best available spectrum to meet user communication requirements. The spectrum mobility maintains seamless communication requirements during the transition to better spectrum. The spectrum sharing provides the fair spectrum scheduling method among coexisting other uses. Due to the legacy rights in spectrum band of PU, the SU must vacate the band whenever the PU need to reclaim the spectrum usage rights. To achieve this requirement, the SU need to have the capability to detect the availability of spectrum bands for possible utilize and aware of the PU reclaim rights of usage which is referred to “spectrum sensing”. Thus, spectrum sensing is the function of cognitive radio that is playing a major role for efficiency spectrum usage.

In this research, we propose four spectrum sensing schemes in CR network for SG communication system. First, we propose fast spectrum sensing with coordinate system (FSC). FSC is knowledge-based spectrum sensing method. This novel technique decomposes a spectrum with high complexity into a new coordinate system of salient features and it uses these features in its PU detection process. Not only is the space of a buffer that is used to store information about a PU reduced, but also the sensing process is fast. Second, we propose double constraints adaptive energy detection (DCAED) for spectrum sensing. DCAED is blind spectrum sensing technique. This method adapts the threshold based on 2 accuracy of performance metrics. By using probability of detection and probability of false alarm as the target accuracy performance metrics, DCAED overcomes a demerit of ED in tradeoff between probability of detection and probability of false alarm when the system threshold is set by selecting only probability of detection or probability of false alarm. Third, we proposed two-stage spectrum sensing scheme exploits the merits of ED, MME and CAV techniques to determine the existence of the primary user. The ED performs spectrum sensing within a short time and offers a reliable detection at high SNRs condition. MME and CAV are robust to noise power uncertainty. Due to the combination of these techniques, the proposed schemes offer much more reliable detection when the uncertainty of noise power occurs. Finally, we propose modified- fast spectrum sensing with coordinate system (MFSC), to perform spectrum sensing under path loss effect and noise uncertainty.

2) วัตถุประสงค์

This project proposes the novel spectrum sensing techniques in CR network for SG communication. The proposed techniques have a minimum time requirement and give a better performance than the conventional spectrum sensing methods. Moreover, we consider two channel environments including AWGN channel and the channel that consider the noise uncertainty and path loss effect.

3) ระเบียบวิธีวิจัย

1. Literature review of the spectrum sensing algorithms of cognitive radio (CR) networks: Study research papers relevant to the research works of the research.
    1.1 Study research papers relevant to spectrum sensing algorithms.
    1.2 Study research papers concerning with improving the spectrum sensing algorithms.
    1.3 Study research papers regarding the time requirement of the spectrum sensing algorithms.
2. Simulation software implementation of the spectrum sensing algorithms

2.1 Consider and compare the time requirement of each of spectrum sensing techniques from literature reviews.

2.2 Provide time delay mathematical model of the spectrum sensing algorithm for CR network.

2.2 Develop the time reduction of the spectrum sensing algorithm for CR network.

3. Simulation software implementation of the proposed technique

3.1 Develop the proposed technique for the spectrum sensing algorithm simulation program.

3.2 Test the time requirement of the proposed spectrum sensing algorithm for CR network.

4. Project summary

4.1 Summarize the major finding as we found in step 3 and conclude the performance of the proposed time reduction in all concerned aspects.

4.2 Check whether the conclusions meet all the objectives of the research work of the research.

4.3 Write the research report.

4) แผนการดำเนินงานวิจัยตลอดโครงการในแต่ละช่วง 6 เดือน

1st year of the project

Months 1-3	Literature review of Spectrum sensing algorithm of Cognitive radio networks.
Months 4-6	Improved observation model for spectrum sensing algorithm.
Months 7-10	Simulation software implementation of improved observation model.
Months 11-12	Literature review of communication protocol for smart grid.

2nd year of the project

Months 13-15	Improved observation model for spectrum sensing algorithm that can be used under noise uncertainty and path loss effect.
Months 16-18	Simulation software implementation of improved observation model.
Months 19-21	Evaluation of developed model and algorithm and write the journal.
Months 22-24	Project summary.