

## Cognitive radio-based transmission energy management in Wi-Fi nodes

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### INTRODUCTION

The recent increased demand for various internet services, shown in **Figure 1**, to be delivered through energy-efficient wireless infrastructures such as Wi-Fi routers has compelled the need for a new research & development (R&D) paradigm. Although most South African rural villages have access to the rural electrical energy grids, many key issues such as the affordability, reliability, sustainability and environmental CO<sub>2</sub> carbon footprinting concerning the use of conventional electric power supplies continue to be research problems beyond the South African borders. With the rising uptake of the limited, clean and renewable sources of energy in ICT domains, better energy-efficient mechanisms that utilise stimuli from the random environment become sustainable solutions in most developing regions. The truth is that most rural and remotely located communities desire to have high capacity multimedia services, sustainable and affordable internet e-infrastructure and e-services. To solve such problems, in part, this study addresses the transmission energy management in Wi-Fi networks.

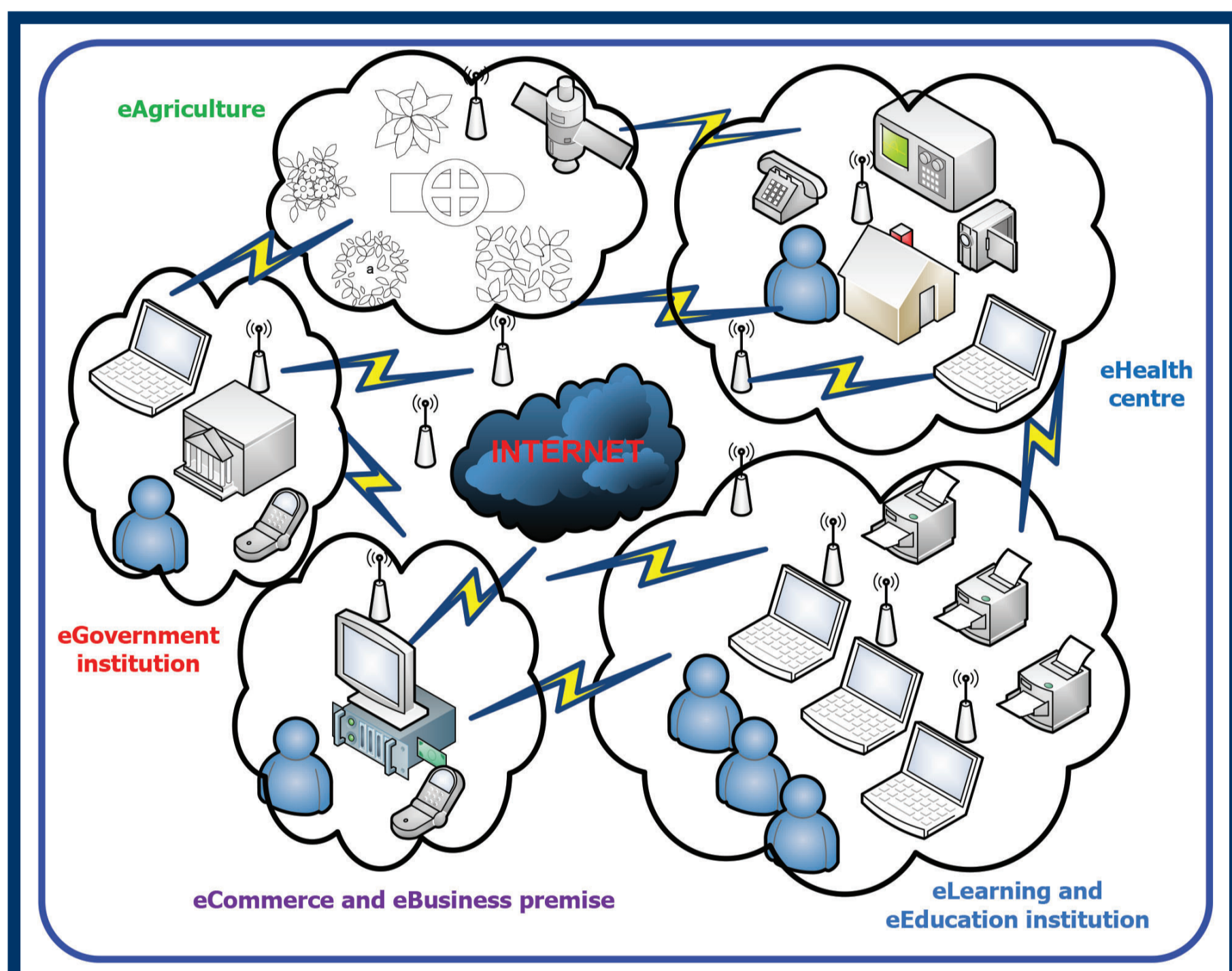


Figure 1: Internet needs of rural communities

### PROPOSAL

A cognitive radio-based transmission energy management (CR-TEM) solution for Wi-Fi applications is currently being developed. In this approach, realistic energy consumption models for Wi-Fi devices are designed. Wi-Fi devices consume energy when in various modes of operation such as transmission, reception, idle listening, overhearing, roaming and switching. To cater for the wireless link energy losses, realistic physical link path loss models are devised that capture effects of rural terrain on the transmission energy losses. Then, a low power cognitive radio hardware sensor is incorporated into the Wi-Fi device to monitor the operation environments. Based on the environmental data, the transmission energy is adaptively adjusted until optimal conditions are achieved. **Figure 2** illustrates the fundamentals of the cognitive radio operation.

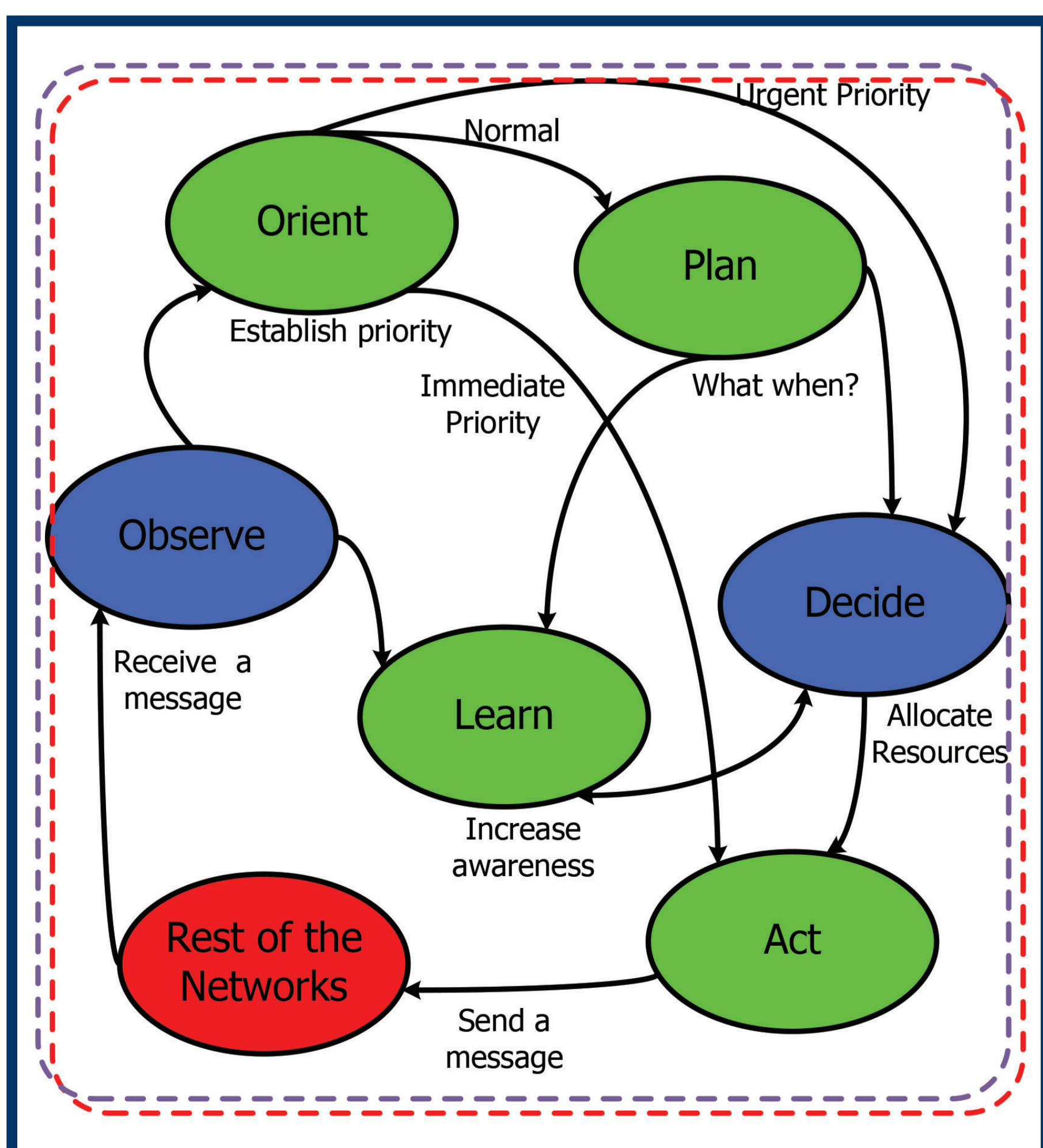


Figure 2: Cognitive radio cycle

### METHODOLOGY

The study proposes a mathematical CR-TEM model in **Figure 3** that generates a simple CR-TEM algorithm. The algorithm is currently being validated using several computer simulations. The work will then construct an energy monitoring and management experimental setup, illustrated in **Figure 4**, for testing the performance (**Figure 5**) in a test-bed laboratory at the CSIR Meraka Institute. The real testing will confirm the efficacy of the proposed solution in realistic Wi-Fi networks.

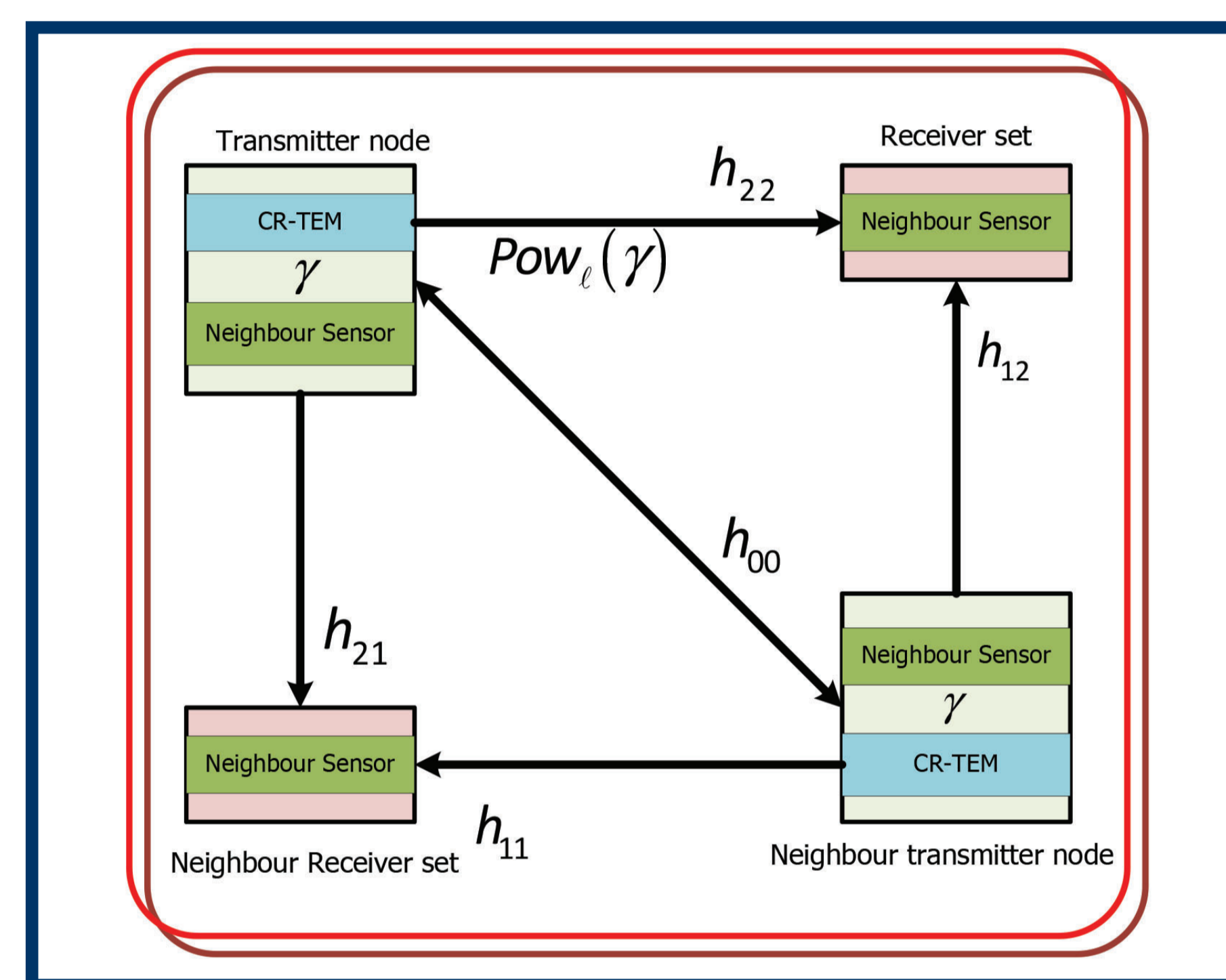


Figure 3: Model of CR-TEM in Wi-Fi nodes

### ENERGY MONITORING AND MANAGEMENT EXPERIMENT

**Figure 4** shows the experimental set-up for transmission energy monitoring and management in a Wi-Fi network. The Wi-Fi device executes the CR-TEM mechanism as stimulated by the network conditions. Energy consumption is measured and data recorded at the desktop for analysis.

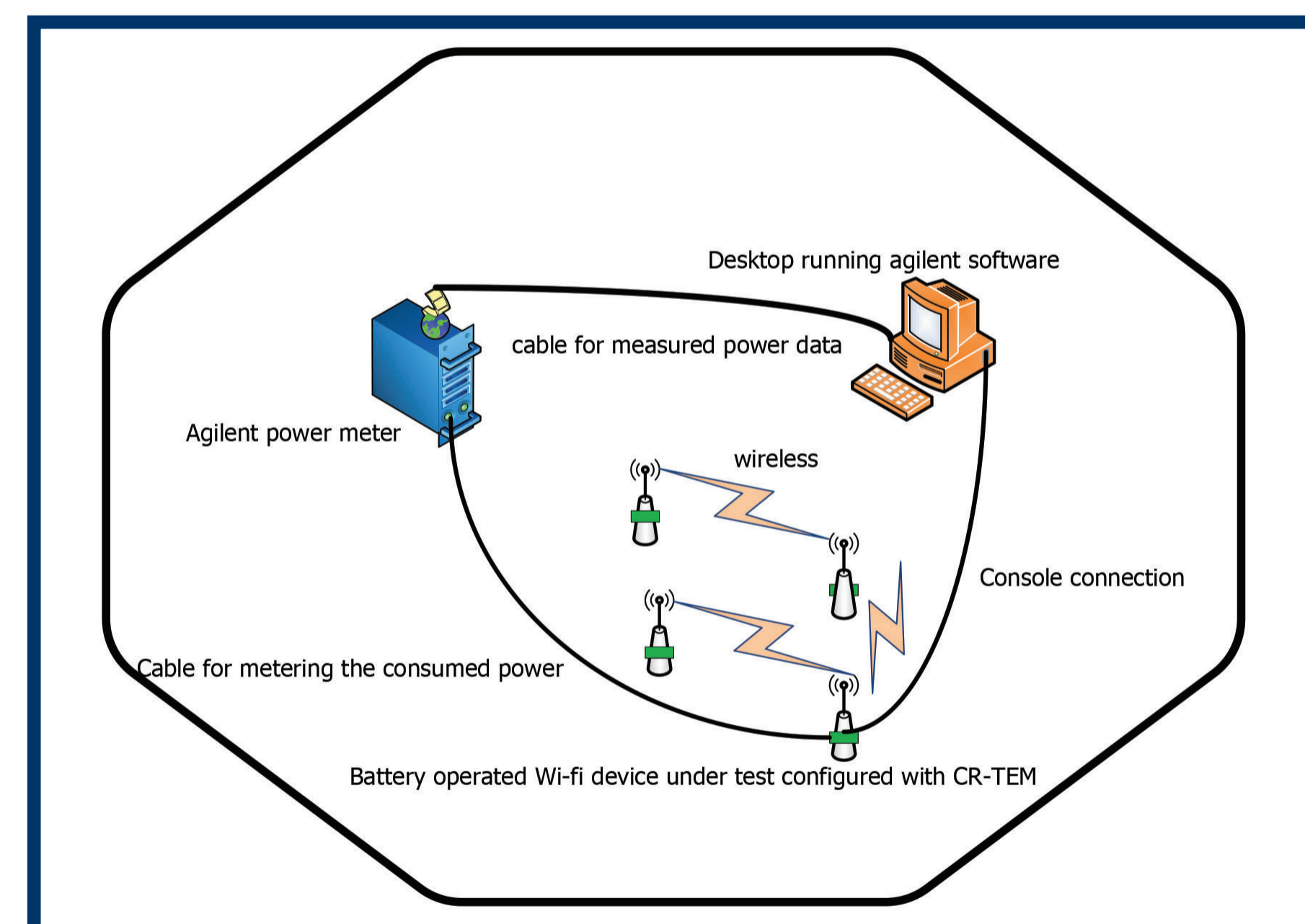


Figure 4: Monitoring and management set-up

**Figure 5** provides the relationship between the scaling number of internet users and the expected network gain following the adoption of the proposed CR-TEM method. The execution of the CR-TEM fosters more users' adoption of the internet services and a corresponding network gain.

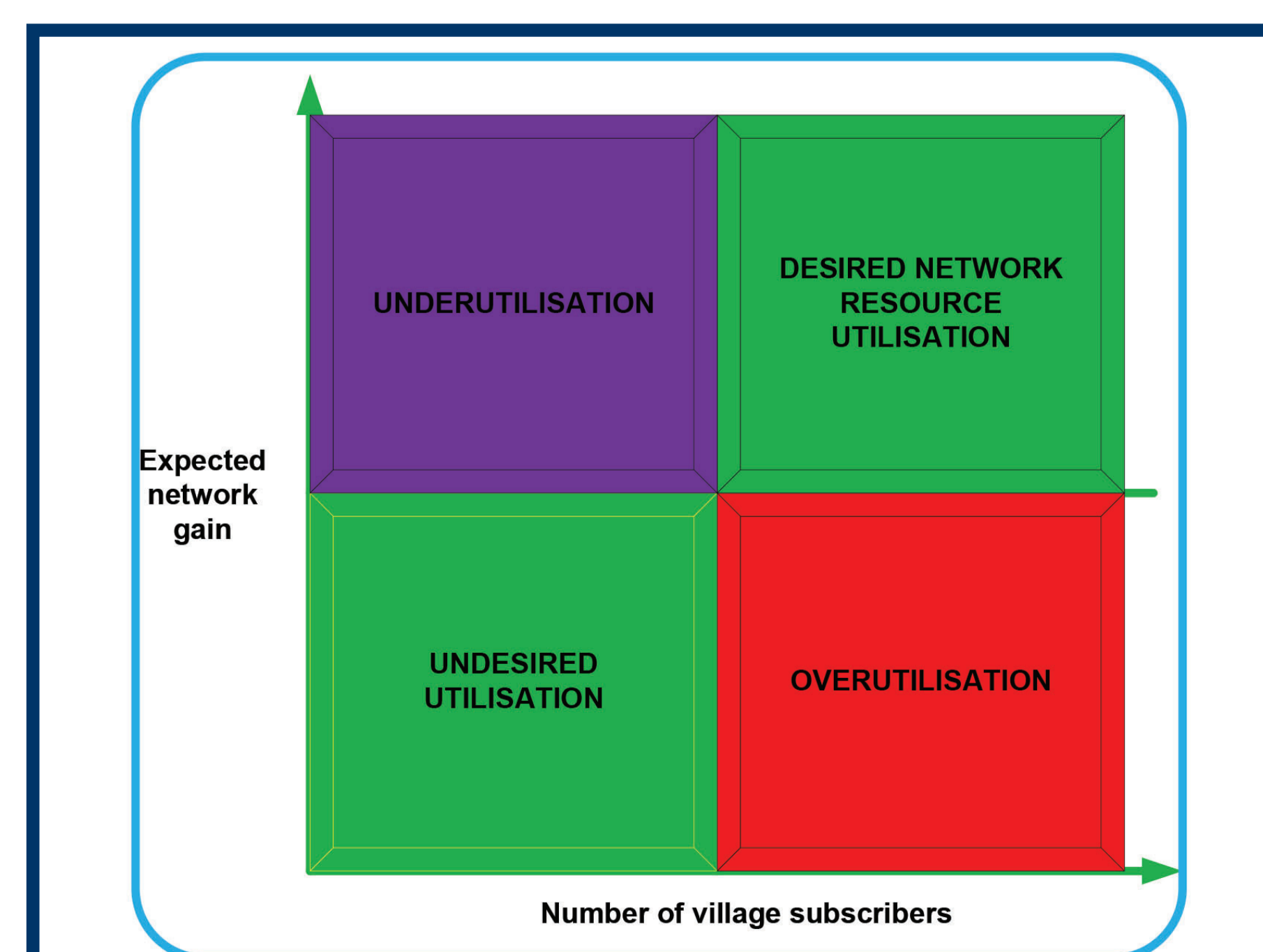


Figure 5: Expected network performance

*The CSIR has developed a cognitive radio-based transmission energy management algorithm that can be used to manage the energy consumption of Wi-Fi networks in rural and remote communities in South Africa. The project demonstrates the application of sustainable and affordable internet e-infrastructures and e-services in improving the lives of ordinary South Africans.*

