Radio Diversity for Heterogeneous Communication with Wireless Sensors

Yuan Qin, David Boyle, Eric Yeatman
Department of Electrical & Electronic Engineering
Imperial College London, London, UK
Email: yuan.qin14@imperial.ac.uk
Presentation Layout

- Introduction
- UAV Integrated WSN Protocol Overview
- Timing of BLE and IEEE Mode Switching
- Implementation
- Case Study, Experiment Settings, and Evaluation
- Conclusion and Discussion
Why Multi-Radio Implementation

• UAV Integrated WSN System
• Potential Large Data Volume
• Data Rate Requirement
UAV Integrated WSN Protocol

- Characteristics
  - Channel switching
  - Priority based communication

- Protocol Architecture
  - 3 layer of protocol stacks
  - 4 states

Diagram:

1. Advertise Reception or Data Request Reception
2. UIWP Ack Sent or Data Sending Complete or $\geq t_{ade}$
Timing of BLE and IEEE Mode Switching

1. Advertise Reception or
2. Data Request Reception
1. UIWP Ack Sent or
2. Data Sending Complete or \( \geq t_{ade} \)
Timing of BLE and IEEE Mode Switching

- Advertise State $^a$
- UIWP Ack State $^u$
- Request State $^u$
- Data State $^d$
- Listening State $^l$
- Sending State $^s$
Implementation

- Embedded OS – Contiki OS
- Unmanned Aerial Vehicle – DJI M100
- Sensor Nodes – TI CC2650 Launchpad
## Scenario Analysis

<table>
<thead>
<tr>
<th>Items</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average no. of animal detection</td>
<td>2.8 times per day</td>
</tr>
<tr>
<td>Pictures took for each detection</td>
<td>3 pictures</td>
</tr>
<tr>
<td>Picture resolution</td>
<td>1 megapixel</td>
</tr>
<tr>
<td>Storage size</td>
<td>100 KB per picture</td>
</tr>
<tr>
<td>UAV visiting frequency</td>
<td>1 time per sensor per day</td>
</tr>
<tr>
<td>Average daily data size</td>
<td>840 KB</td>
</tr>
</tbody>
</table>
Experiment Settings
## Indoor Test

<table>
<thead>
<tr>
<th>Device</th>
<th>RAM (Bytes)</th>
<th>ROM (Bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UIWP Sink</td>
<td>344</td>
<td>692</td>
</tr>
<tr>
<td>UIWP Sensor</td>
<td>288</td>
<td>396</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mode</th>
<th>Energy in Joule</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLE Mode</td>
<td>2.05</td>
</tr>
<tr>
<td>IEEE Mode</td>
<td>3.62</td>
</tr>
</tbody>
</table>
Outdoor Test
Conclusion and Discussion

• BLE mode has data transfer rate of 59 kbps, which is about 6% of over the air bit rate

• BLE mode consumes 54% of time and 57% of energy

• Improve the data transfer rate

• Synchronization based BLE mode
Thank You!

Yuan Qin, David Boyle, Eric Yeatman
Department of Electrical & Electronic Engineering
Imperial College London, London, UK
Email: yuan.qin14@imperial.ac.uk