**USING AntMonitor FOR CROWDSOURCING PASSIVE MOBILE NETWORK MEASUREMENTS**

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**REFERENCES**


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**NETWORK PERFORMANCE MONITORING APPROACHES**

<table>
<thead>
<tr>
<th><strong>Approach</strong></th>
<th><strong>Network Infrastructure</strong></th>
<th><strong>Packets/Headers</strong></th>
<th><strong>Source/Target</strong></th>
<th><strong>Data/Time</strong></th>
<th><strong>User Preferences</strong></th>
<th><strong>Grainularity</strong></th>
<th><strong>Passive Monitoring</strong></th>
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</thead>
<tbody>
<tr>
<td>i. Pastively Monitor</td>
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**APPLICATION-1: NETWORK PASSIVE PERFORMANCE MEASUREMENTS & METRICS**

**AntMonitor Application for Crowdsourcing Passive Mobile Network Measurements**

**Motivation:** Internet of Things (IoT) Era. Batteryless Sensors via RF Harvesting.

**Question:** What is the energy outage probability, i.e., is 25% possible?

**Efficiency:**

\[ \text{Efficiency} = \frac{\text{Energy Outage}}{\text{Total Energy}} \]

**Example:**

\[ \text{Efficiency} = \frac{0.25}{1} = 0.25 \]

**Our RF Harvesting Assessment Approach:**

1. **Sensor’s Power Load Markov Process:** \( p_e = 0 \).
2. **Shadowing Markov Process:** \( p_s^0 = 0 \), \( p_s^1 = 1 - 0.1 - 0.1 \).
3. **Cellular Load Random Process:** \( N_c(t) \).
4. **Super Cap Energy:** \( \phi = (1 - 0.1) e^{-t} + 0.1 e^{-t} \).
5. **Transitions Matrix:** \( P_{e,s} \).
6. **Output:** Energy Outage Probability, \( P_{outage} = p_e + p_s \).

**APPLICATION 2: RF HARVESTING POTENTIAL**

**RF Harvesting Overview & System Model:**

**Figure 11:** RF Harvesting Overview & System Model.

**Figure 12:** Energy Outage (Probability).

**RF Harvesting in Downlink can work only near Base Stations.**

**TABLE 1: NETWORK PERFORMANCE MONITORING APPROACHES COMPARED WITH OUR WORK**

<table>
<thead>
<tr>
<th><strong>Network Monitoring Approaches</strong></th>
<th><strong>Collected Data</strong></th>
<th><strong>Throughput</strong></th>
<th><strong>Network Coverage</strong></th>
<th><strong>Energy Consumption</strong></th>
<th><strong>Data Integrity</strong></th>
<th><strong>Data Storage</strong></th>
<th><strong>Data Processing</strong></th>
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**TABLE 2: THROUGHPUT (DOWNLOAD MBPS): ACTIVE (USING SLEEPDEAD) VS PASSIVE (USING ANTMONITOR: AMI MEASUREMENTS) OUR APPROACH IS CLOSE TO SLEEPDEAD BUT DOES NOT INCUR ANY MEASUREMENT OVERHEAD.**

<table>
<thead>
<tr>
<th><strong>Experiments</strong></th>
<th><strong>Active (Sleepdead)</strong></th>
<th><strong>Passive (AntMonitor)</strong></th>
<th><strong>Measurement Overhead</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp 1</td>
<td>120</td>
<td>120</td>
<td>✔</td>
</tr>
<tr>
<td>Exp 2</td>
<td>120</td>
<td>120</td>
<td>✔</td>
</tr>
<tr>
<td>Exp 3</td>
<td>120</td>
<td>120</td>
<td>✔</td>
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</tbody>
</table>

**TABLE 3: RESOURCES UTILIZATION FOR ANTMONITOR AND SLEEPDEAD PER EXP.**

<table>
<thead>
<tr>
<th><strong>Metric</strong></th>
<th><strong>Data Overhead</strong></th>
<th><strong>Energy</strong></th>
<th><strong>Battery</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleepdead</td>
<td>10 MB</td>
<td>100 mW</td>
<td>10 µW</td>
</tr>
<tr>
<td>AntMonitor</td>
<td>10 MB</td>
<td>100 mW</td>
<td>10 µW</td>
</tr>
</tbody>
</table>

**AntMonitor Project:** http://antmonitor.calit2.uci.edu