IoT Bench: Towards a Benchmark for Low-power Wireless Networking

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on behalf of the
IoT Benchmarking consortium

CPSBench Workshop
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There is a **lack of confidence** in the results despite tremendous efforts put in the evaluation.

- **2016**
  - Data Prediction + Synchronous Transmissions = Ultra-low Power Wireless Sensor Networks
- **2017**
  - Five-Nines Reliable Downward Routing in RPL
- **2017**
  - RedFixHop with Channel Hopping: Reliable Ultra-Low-Latency Network Flooding
... because there is still no standard way to evaluate low-power wireless protocols

Huge variety of settings

Inter-packet interval (s)

0 100 200 300 400

Testbed size (# nodes)

Experimental setup

2010 to 2015
Periodic data collection only
... because there is still **no standard way** to evaluate low-power wireless protocols

Huge variety of settings

- **Hard to compare against references**
  - Sources not available
  - Experiment not reproducible
... because there is still no standard way to evaluate low-power wireless protocols

- Huge variety of settings
- Hard to compare against references

**Heterogeneous comparisons**

- Protocol only
- Protocol + Platform
A common benchmark is desperately needed

The benchmark should...

- be **reproducible** across different settings
- be **simple** and minimalistic
- allow **consistent** comparisons
- suggest the **appropriate experiments** to perform
A common benchmark is desperately needed

Researchers want to evaluate new protocols
A common benchmark is desperately needed ...
... by everyone!

Researchers evaluate new protocols

Companies want to showcase the advantage of their products
A common benchmark is desperately needed ... by everyone!

<table>
<thead>
<tr>
<th>Researcher</th>
<th>evaluates new protocols</th>
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<tbody>
<tr>
<td>Companies</td>
<td>showcases the advantage of their products</td>
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<tr>
<td>Customers</td>
<td>want to objectively compare protocol strengths</td>
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</tbody>
</table>
The community is getting together to tackle this challenge

<table>
<thead>
<tr>
<th>Date</th>
<th>Event/Meeting</th>
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<tbody>
<tr>
<td>Aug. 2016</td>
<td>Poster at SenSys</td>
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<td>May 2017</td>
<td>1st Meeting in Milan</td>
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<td>Oct. 2017</td>
<td>2nd Meeting in Stockholm</td>
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<tr>
<td>Feb. 2018</td>
<td>Poster and presentation at EWSN</td>
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<tr>
<td>Today</td>
<td>CPSBench Workshop at CPSWeek</td>
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Benchmarking is fundamentally a tradeoff between generality and accuracy.
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Step 1 Define a common conceptual framework

Parameters Input

e.g. number of nodes
traffic load ...

Controlled by the user
Step 1 Define a common conceptual framework

Parameters

Output

Determined by the protocol behavior

*e.g.* packet reception rate
energy consumption

Metrics

Observed

Characterize the environment

*e.g.* level of external interference
Step 1 Define a common conceptual framework

Parameters
- System: Topology, link quality, mobility...
- Traffic: Traffic load and pattern
- Experiment: Number of runs, acceptable deviation...
- Environment: Interference, people’s presence...
- Performance: Delivery, latency, energy...
### Step 1 Define a common conceptual framework

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Metrics</th>
<th>Profiles</th>
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<tbody>
<tr>
<td>“assignment of concrete values to input parameters, and a precise definition of observed and output metrics to be measured”</td>
<td>e.g. Low-rate data collection</td>
<td></td>
</tr>
<tr>
<td>- Input parameters</td>
<td>- Observed metrics</td>
<td>- Output metrics</td>
</tr>
</tbody>
</table>
| #nodes: 100, #sources: 99, #destinations: 1, traffic load: from .1 msg/min to 1 msg/min. | link qualities and external interference. | packet delivery rate, end-to-end packet latency, and average energy consumption.
Benchmarking is fundamentally a tradeoff between generality and accuracy.

- **Accuracy**: Step 1 Common Conceptual Framework
  - Same experimental conditions
  - High accuracy
  - Poor usability
- **Generality**: Perfect Comparison

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Benchmarking is fundamentally a tradeoff between generality and accuracy.
Step 2  
Setup a common experimental infrastructure

Key Idea

Separate networking code from experiment scenario

1. Node runs networking code
2. Testbed/Simulator runs the experiment
   e.g. using GPIO/serial to instruct nodes and measure the profile’s metrics
   similar to the 2018 EWSN Competition
Step 2  Setup a common experimental infrastructure

Key Idea  Separate networking code from experiment scenario

Benefits  Fully automated
Rules out mis-interpretation of profiles

Drawbacks  More complex
Stricter
More infrastructure maintenance
A lot of remains to be done!

Define useful profiles

Improve the testbeds

Improve the simulators
To make IoT Bench a reality, we have...

- A team
- Communication channels
- A plan
- 20 years of experience in wireless protocols
What we don’t have, *yet*

Industry support and partners

Experience about benchmarking

nor

Time!  

Need to tackle this problem
- quickly
- efficiently
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Stay tuned!
and get involved 😊

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Icons from thenounproject.com