Design of Dual Energy Harvesting Communication Links with Retransmission

Mohit K. Sharma and Chandra R. Murthy
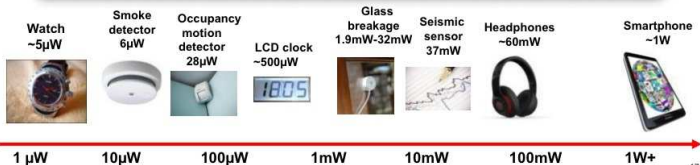
Signal Processing for Communications Lab.
Department of ECE, IISc

April 28, 2016

Introduction[1]

Power available from energy sources

Energy Source	Characteristics	Harvested Power
Light	Outdoor	100 mW/cm^2
	Indoor	100 μW/cm^2
Thermal	Human	60 μW/cm^2
	Industrial	~1-10 mW/cm^2
Vibration	~Hz–human	~4 μW/cm^3
	~kHz–machines	~800 μW/cm^3
RF	GSM 900 MHz	0.1 μW/cm^2
	WiFi	0.001 μW/cm^2

Watch ~5μW
Smoke detector 6μW
Occupancy motion detector 28μW
LCD clock ~500μW
Glass breakage 1.9mW-32mW
Seismic sensor 37mW
Headphones ~60mW
Smartphone ~1W

| 1 μW | 10μW | 100μW | 1mW | 10mW | 100mW | 1W+ |

17

TEXAS INSTRUMENTS

[1] Source:https://gigaom.com/2013/11/21/energy-harvesting-chips-the-next-big-thing-for-a-connected-world/

Introduction

- EH technology presents prospects of perpetual operation

- Energy availability is *sporadic*

- Energy buffer (e.g., battery) is used to mitigate the sporadicity

- *Energy neutrality constraint*: Cumulative energy used cannot exceed the total harvested energy

System Model
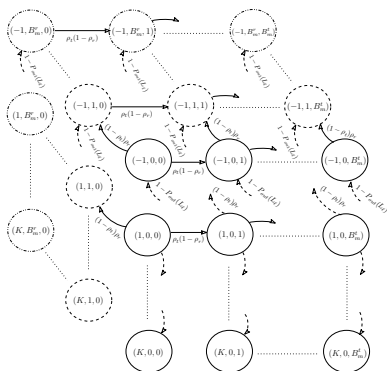
System Dynamics

Packet Drop Probability

Figure: DTMC Model

$$P_{\mathsf{D}} = \sum_{(i,j)=(0,0)}^{(B_{\max}^t, B_{\max}^r)} \pi(i,j) P_{\mathsf{D}}(K|i,j,U_n=1)$$

Contributions

- $P_{\mathsf{D}}^{\infty^*} \leq P_{\mathsf{D}} \leq P_{\mathsf{D}}^{\infty^*} + \mathcal{D}$
  where, $\mathcal{D} = \sum_{(i,j) \in \mathcal{I}_1} \pi(i,j)$

- For policies satisfying average power constraint

$$\mathcal{D} = \Theta(e^{r_*^t B_{\max}^t}) + \Theta(e^{r_*^r B_{\max}^r})$$

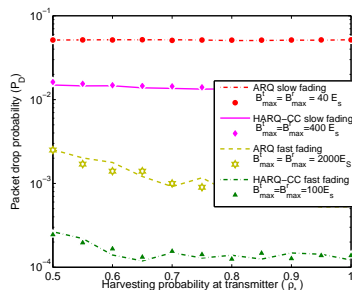- Size of battery depends on the drift induced by the policy.

Figure: Battery size

Contributions

- Lower bound is used as objective

- Resulting non-convex problems are solved using GP

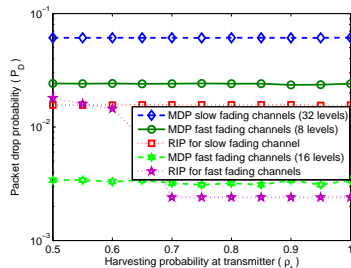- Obtained policies are near-optimal

Figure: Battery size

Future Work

- Design of near optimal policies for multi-hop EH links with retransmission.

- Design of optimal device discovery policy for energy harvesting D2D networks.