Buffer-Stable Adaptive Per-Module Power Allocation for Energy-Efficient Millimeter-Wave Modular Antenna Array (MAA) Platforms

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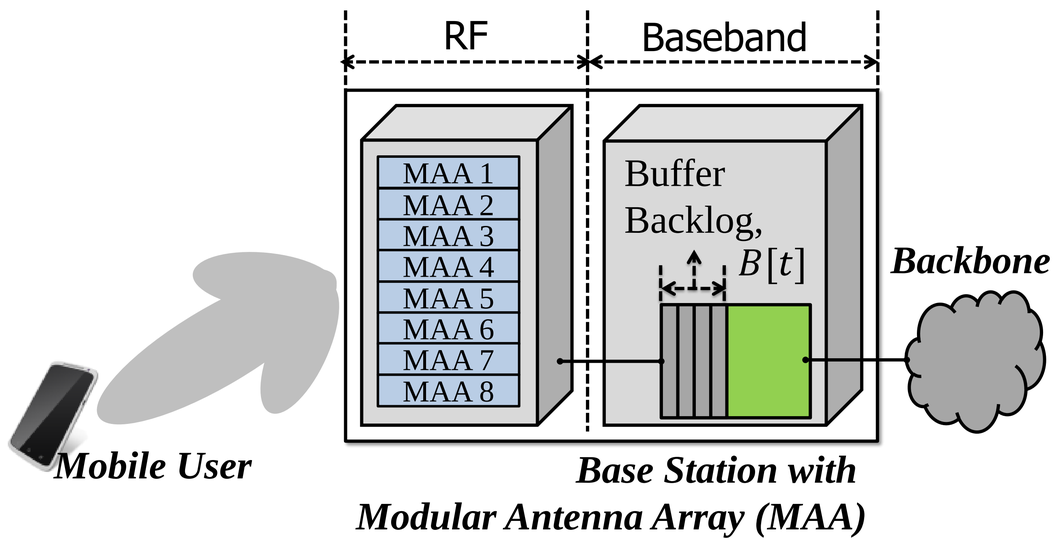
Introduction and Reference System Model

Introduction

- **Millimeter-Wave (mmWave) Wireless Communications**
  - → One of promising technologies for enabling 5G capacity improvements
  - → Can achieve multi-gigabit-per-second (multi-Gbps) rates with Ultra-wide channel bandwidth
  - → Candidate 5G mmWave frequencies are 28GHz, 38GHz, 60GHz, etc

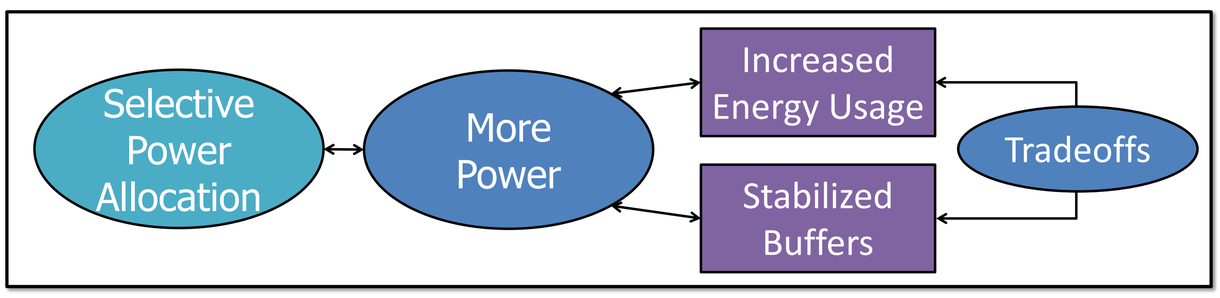
- **Modular Antenna Array (MAA) Platforms**
  - → Well-known solutions for mmWave in academia and industry
  - → Commercialized by Intel and HP for HP Tablets
  - → Enabling massive MIMO functionalities in mmWave Platforms

Reference System Model

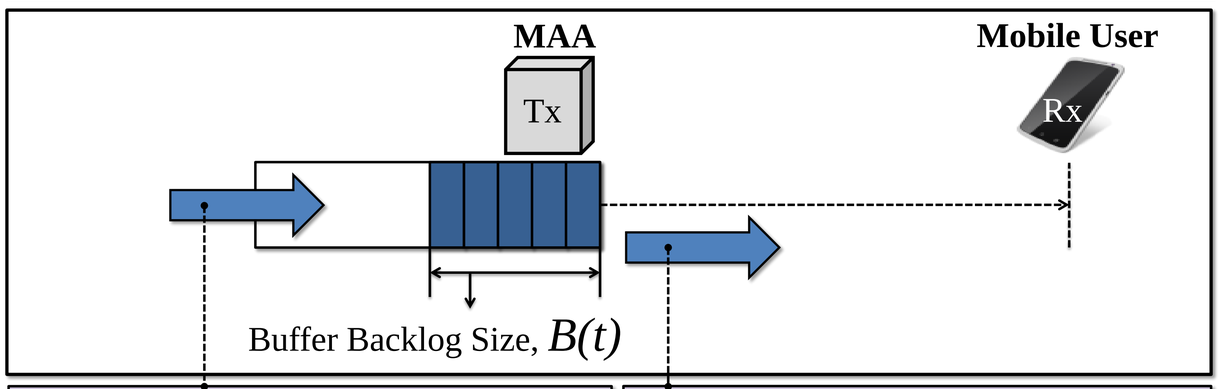


Buffer-Stable Adaptive Per-Module Power Allocation

Tradeoffs



Queueing Model



Arrival Process:
Packet Incoming from Backbone

Departure Process (Control Action):
Packet Transmission

Drift-Plus-Penalty (DPP) Approach

Objective Function:
Minimization of time average expected power consumption

$$\min : \lim_{t\to\infty} \frac{1}{t} \sum_{\tau=0}^{t-1} \mathcal{P}[\tau]$$

$$\lim_{t\to\infty} \frac{1}{t} \sum_{\tau=0}^{t-1} \mathbb{E}\left[B[\tau]\right] < \infty$$

$$\mathcal{P}[\tau] \triangleq f_p(k)$$

$$f_p(k) = p_{\mathrm{mW}}^{\mathrm{TX}} \cdot k$$

$$B[t+1] = \left(B[t] + \lambda[t] - \mu[t]\right)^+$$

Stochastic Optimization

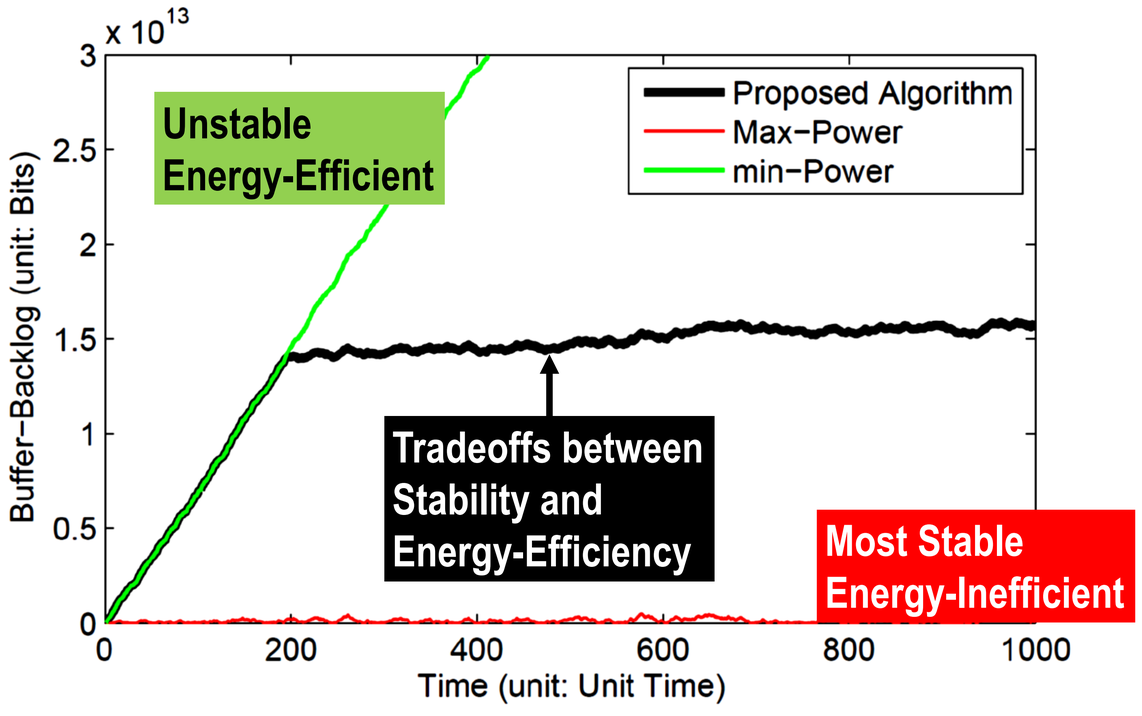
$$\mu[t] = f_r\left(\sum_{i=1}^{8} p_i[t]\right)$$

$$f_r(k) = \mathsf{BW} \cdot \log_2\left(1 + \frac{e_{\mathrm{mW}}^{\mathrm{TX}} \cdot k}{n_{\mathrm{mW}}}\right)$$

$$\mathcal{F}[t] = f_p(k) + VB[t]\lambda[t] - VB[t]f_r(k)$$

Performance Evaluation and Concluding Remarks

Performance Evaluation



Concluding Remarks

- **Concluding Remarks**
  - → Adaptive per-module power allocation for mmWave MAA platforms.
  - → Jointly optimizing energy-efficiency and buffer-stability depending on buffer-backlog sizes.

- **Future Research Directions**
  - → The other mmWave systems can be considered for feasibility study
  - → Precise antenna patterns can be considered

- **References**

J. Kim, L. Xian, R. Arefi, and A.S. Sadri, ``60 GHz Frequency Sharing Study between Fixed Service Systems and Small-Cell Systems with Modular Antenna Arrays," in *Proc. IEEE GLOBECOM Workshop on Millimeter-Wave Backhaul and Access: From Propagation to Prototyping (mmWave)*, December 2015.
M. J. Neely. *Stochastic Network Optimization with Application to Communication and Queueing Systems*. Morgan & Claypool, 2010.

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