RF Energy Harvesting

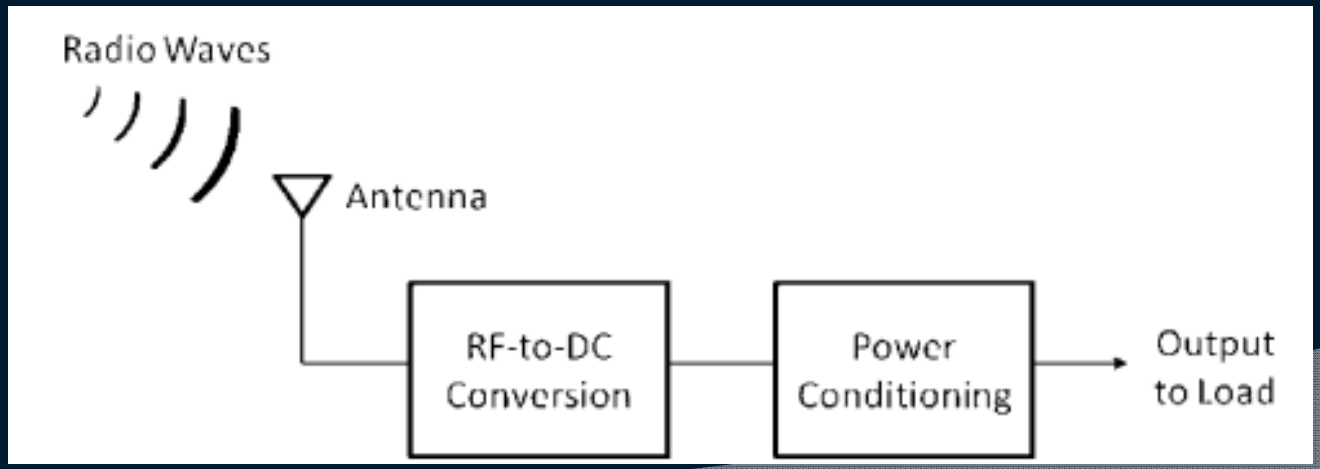
Presented by: James Ferguson

Overview

- Concept
- Advantages and Disadvantages
- Anatomy
  - Antenna
  - Matching Circuit
  - Rectifier
  - Charging

RF Harvesting Concept

- RF waves contain energy
- Convert RF energy into DC power
- Low power applications



Advantages / Disadvantages

ADVANTAGES

- Abundance
- Independent of weather
- Indoors capability
- Small footprint
- No blackout period

DISADVANTAGES

- Low power
- Frequency dependent
- Line of Sight

RF Sources

- Intentional Sources
- Anticipated Ambient Sources
- Unknown Ambient Sources

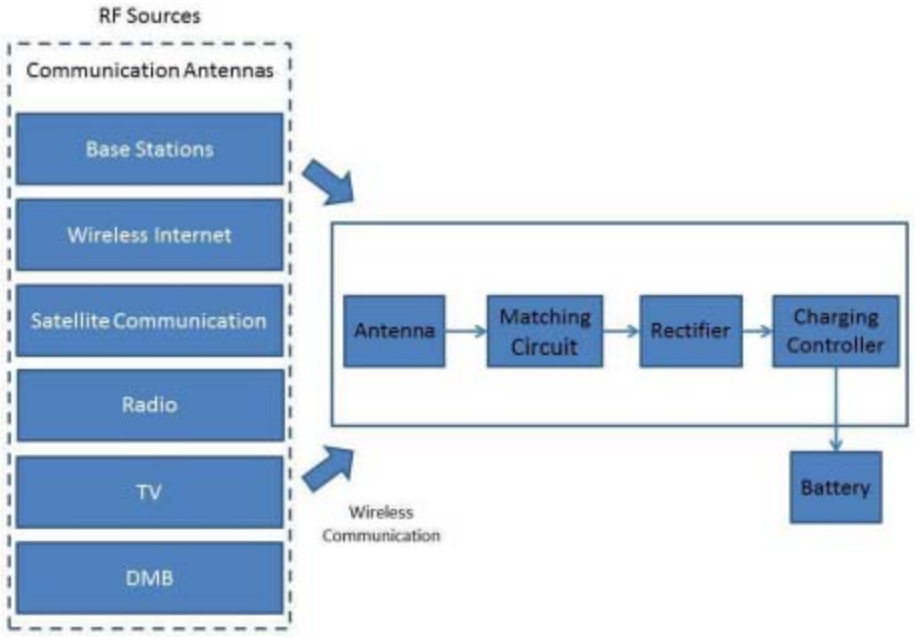


Figure 1.6: RF energy harvesting system architecture

Georgia Tech

Power and Efficiency

Friss Equation: Free space path loss of TX sig

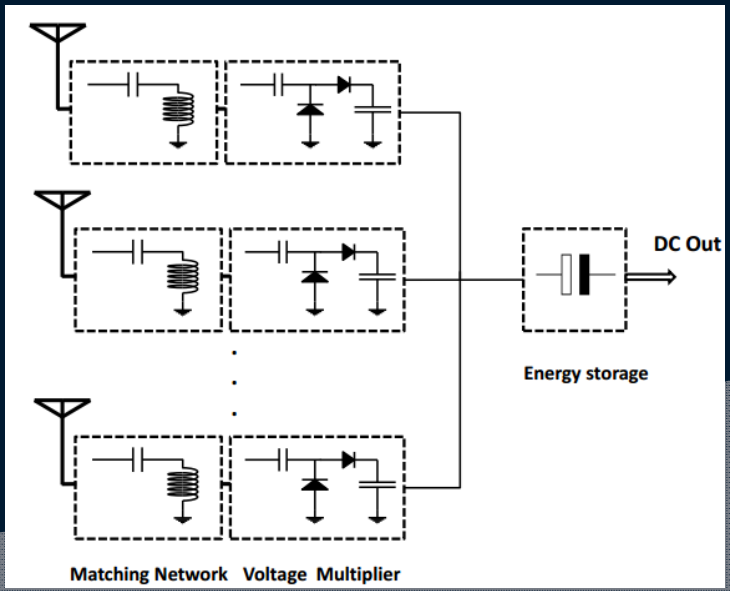
$$P_R = P_T \frac{G_T G_R \lambda^2}{(4\pi d)^2 L},$$

Efficiency of Havesting

$$\eta = \frac{P_{dc}}{P_r} * 100$$

Antenna

- Capturing RF signals
- Miniaturized size and high antenna gain
- Sensitivity
- Multiple Antennas



Georgia Tech

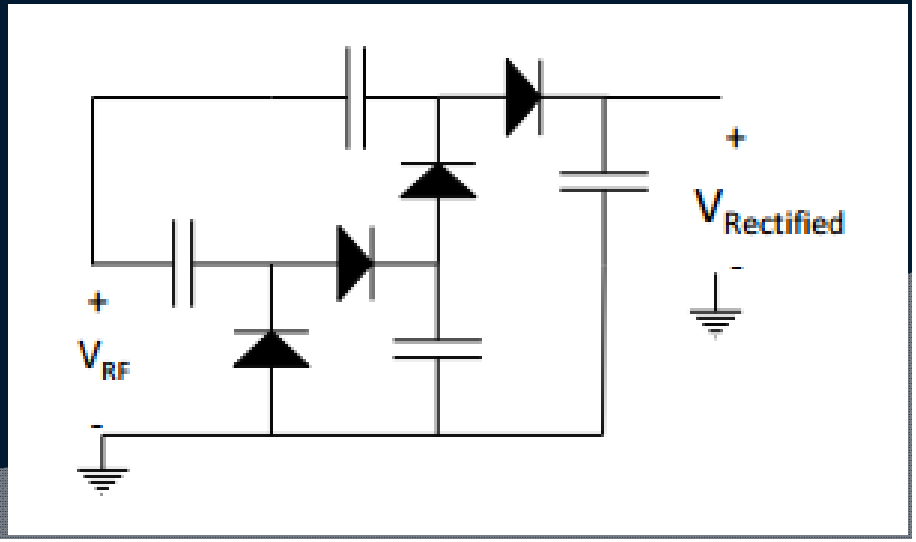
Matching Circuit

- Reduce the transmission loss from an antenna to a rectifier circuit
- Increase the input voltage of a rectifier circuit
- Reflection Equation

$$\Gamma_L = \frac{Z_L - Z_0}{Z_L + Z_0}$$

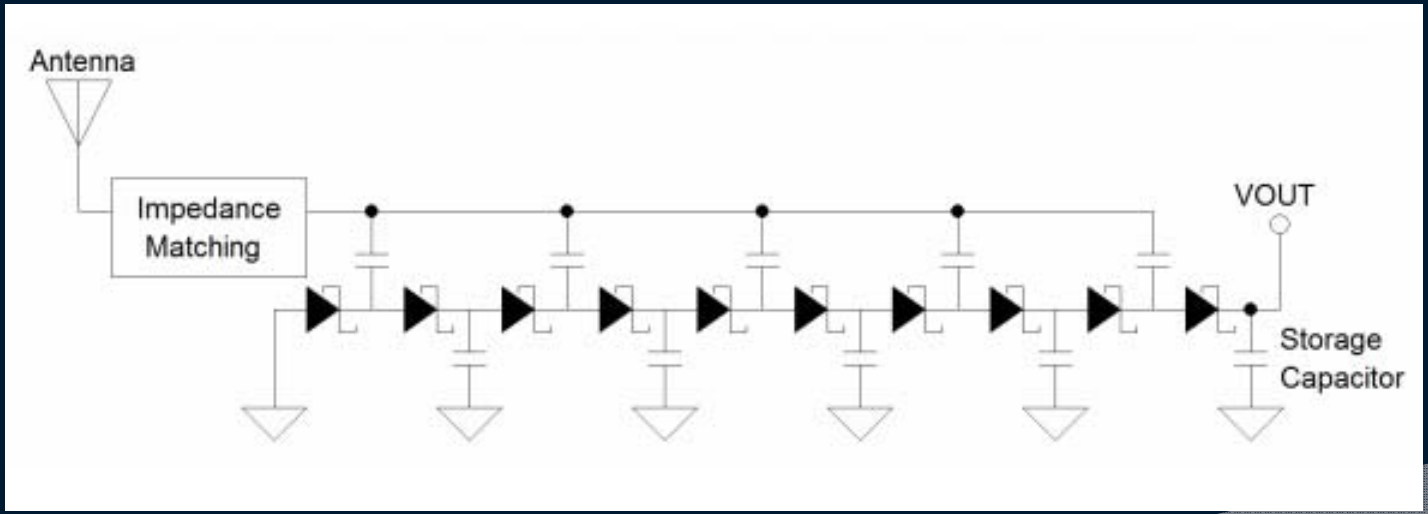
Multiplier/Rectifier

- Dickinson Rectifier Design
- Schottky barrier diodes
  - Low built in voltage
  - Fast switching time
  - High saturation current



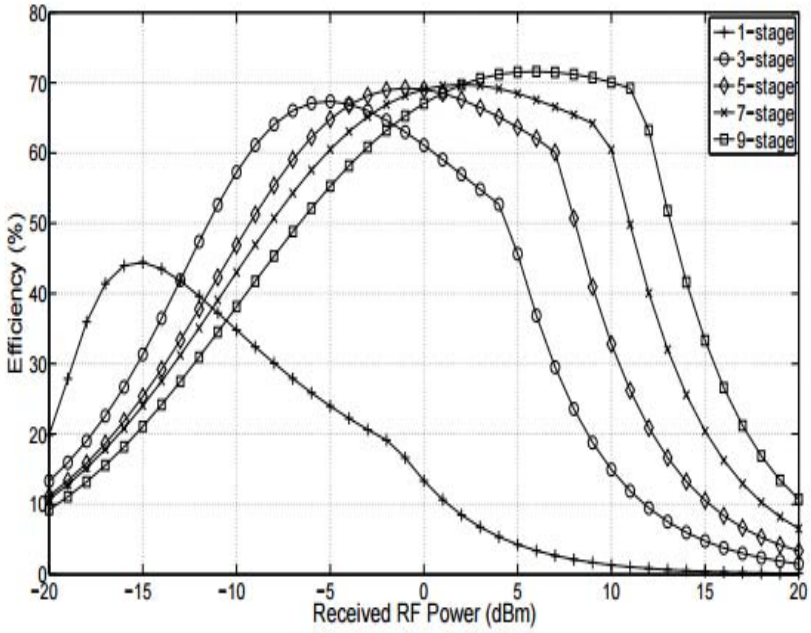
Rectifier Stages

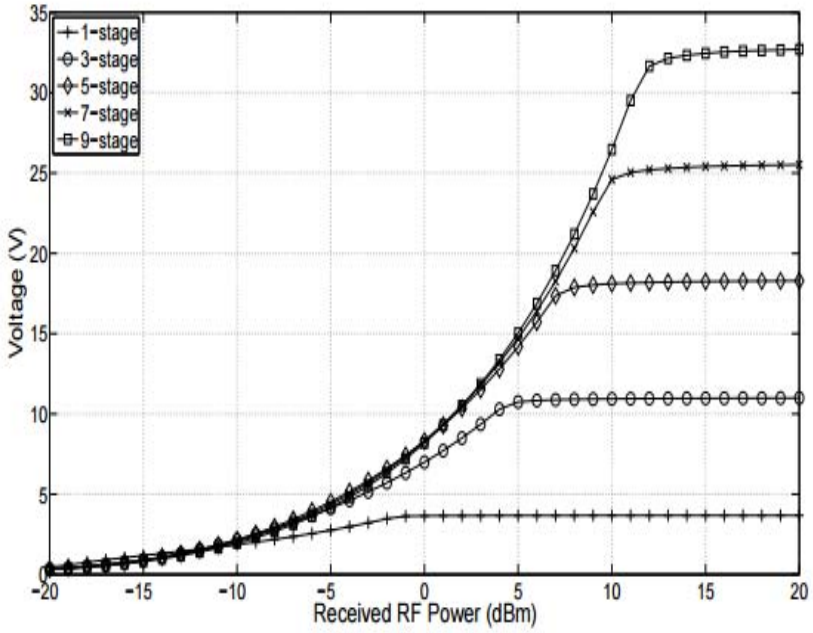
- Proportional to output voltage
- Capacitor parasitic effects

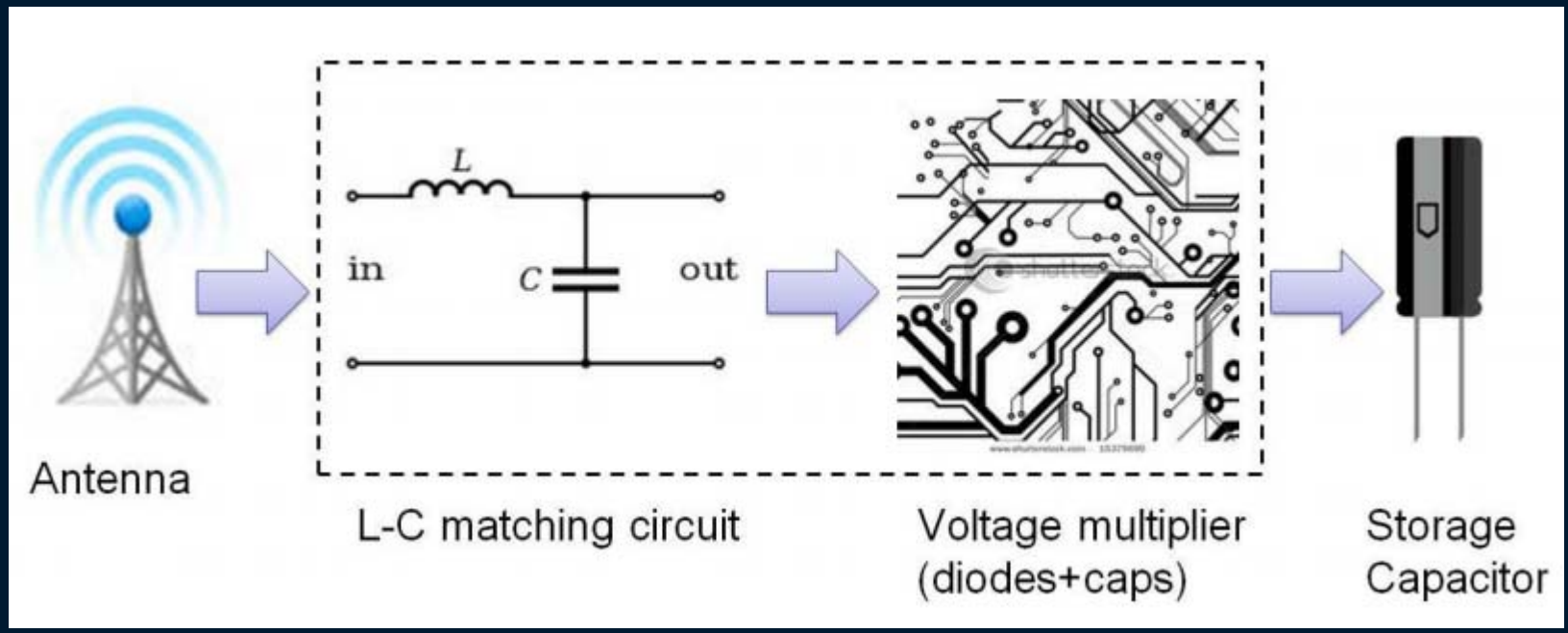


Rectifier Stages

$$V_{out} = \frac{nV_0}{nR_0 + R_L} R_L = V_0 \frac{1}{\frac{R_0}{R_L} + \frac{1}{n}}$$






L
in
C
out
Antenna
L-C matching circuit
Voltage multiplier
(diodes+caps)
Storage
Capacitor

Georgia Tech

Summary

- Concept
- Advantages and Disadvantages
- Anatomy
  - Antenna
  - Matching Circuit
  - Rectifier
  - Charging

Georgia Tech

Questions?