

# Green Communication- An Introduction

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# Outlines

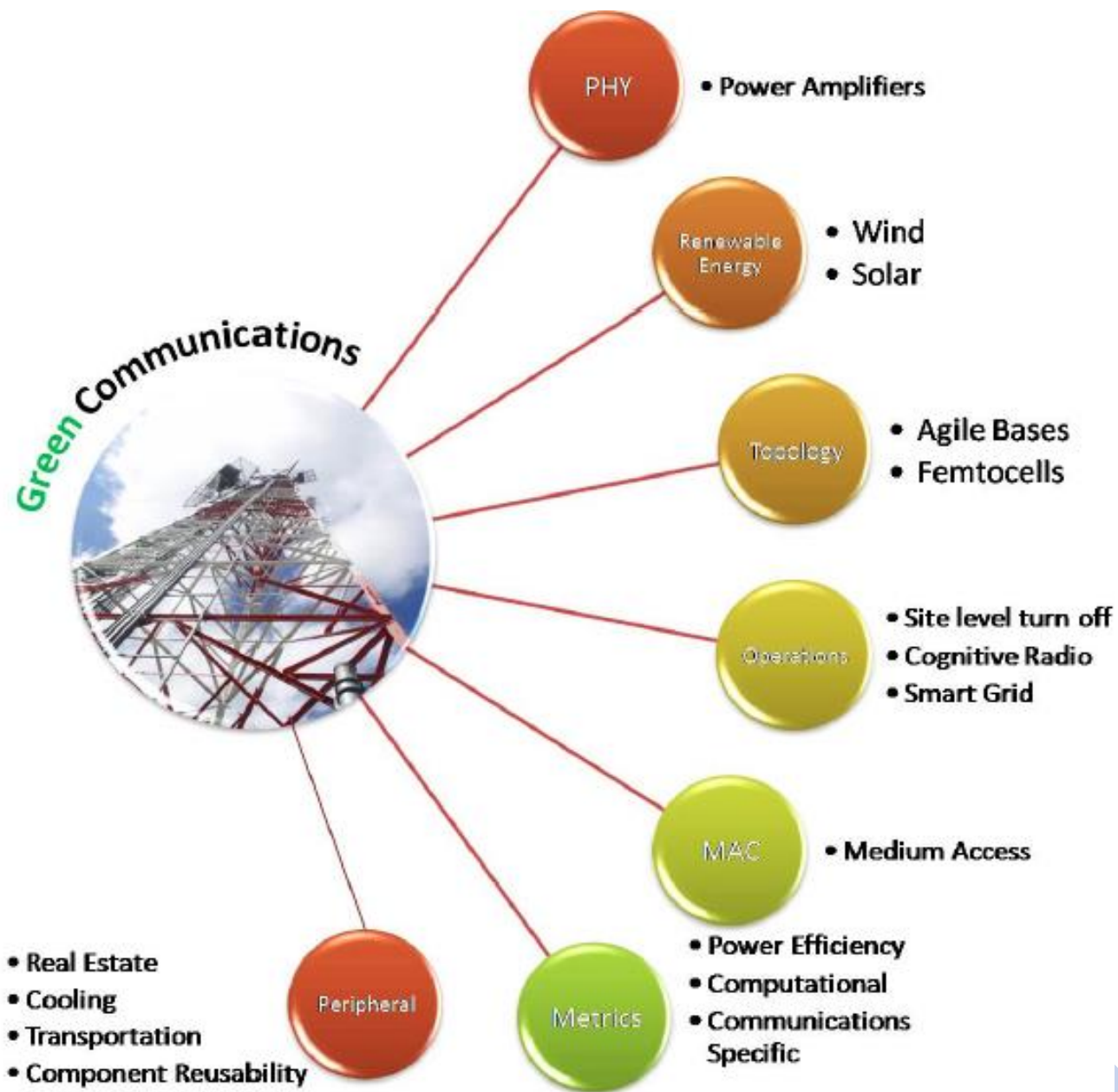
- ❖ Introduction
- ❖ Objective
- ❖ Green Communication Research Vision
- ❖ Power Consumption Parameter in wireless domain
- ❖ Some Existing Solution for Energy Saving in Wireless Domain
- ❖ Massive MIMO Architecture

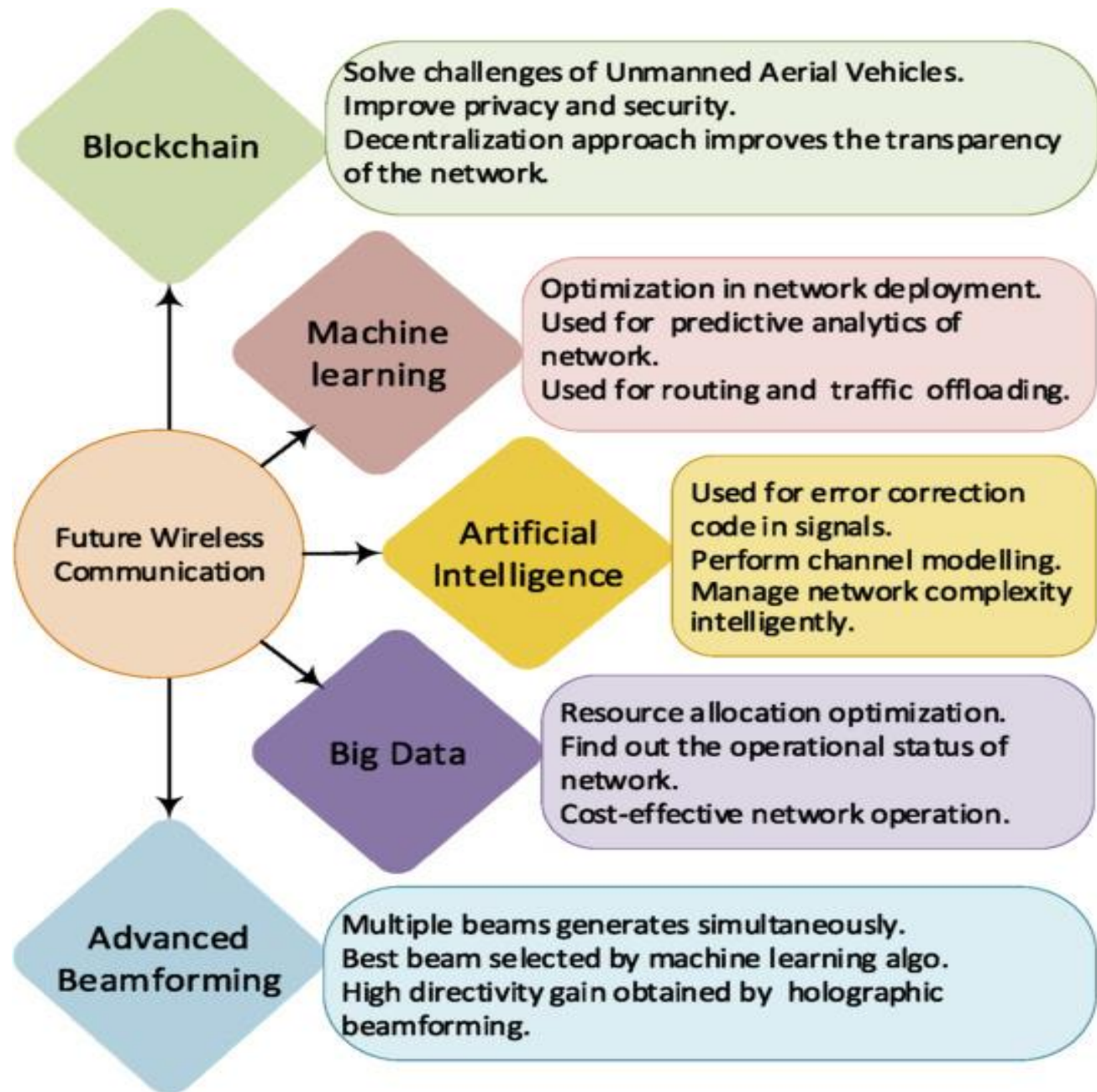
# Introduction

*Green Communication* is a growing research area in *wireless communication*. To make an energy efficient wireless communication without disturbing the other performance matrices (Capacity, BER etc).

## Objective

- ❖ To protect environment from harmful EM radiation
- ❖ Reducing green house gas
- ❖ Reducing operational cost for wireless network.





# Power Consumption Parameter in wireless domain:

- Distance
- Surrounding environment
- Total number of user in a cell
- Capacity
- Delay in signal reception
- Inter-cell Interference
- BER or  $P_e$
- Number of Antenna
- Modulation Technique

Free space path loss equation:

$$P_r(d, f_c, P_t) = \frac{P_t G_t G_r \lambda^2}{4\pi d^2} \text{ where } \lambda = \frac{1}{f_c}$$

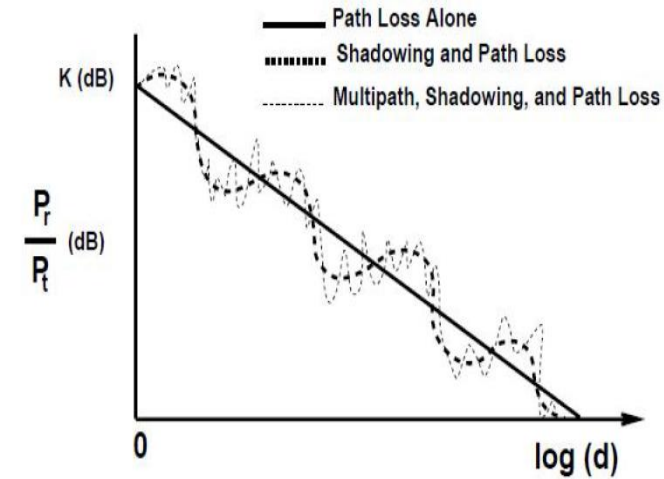


Fig.1.1 Path loss, shadowing and multipath versus distance

$G_t$ ,  $G_r$  are the directivity of  $R_t$ ,  $R_x$  receiving antennas.  $\lambda$  is signal wavelength,  $d$  is the distance between antennas

## Some Existing Solution for Energy Saving in Wireless Domain:

There are technique like:

- ❖ MIMO HARQ (3G/4G)
- ❖ Beamforming
- ❖ wireless mess networks
- ❖ Distributed equipment
- ❖ Proper Channel Estimation for Energy Saving
- ❖ Detection and Estimation: using ZF, MMSE, ML, MAP,..etc

## Emerging Area or Open Research Area for Green Communication:

- ❖ MIMO (3G/4G) or Massive MIMO(5G)
- ❖ Co-Operative Communication (D2D Communication)
- ❖ Space Time Wireless Communication (O-STBC, STTC)
- ❖ Using Multiple Antenna System

All the above topics are used:

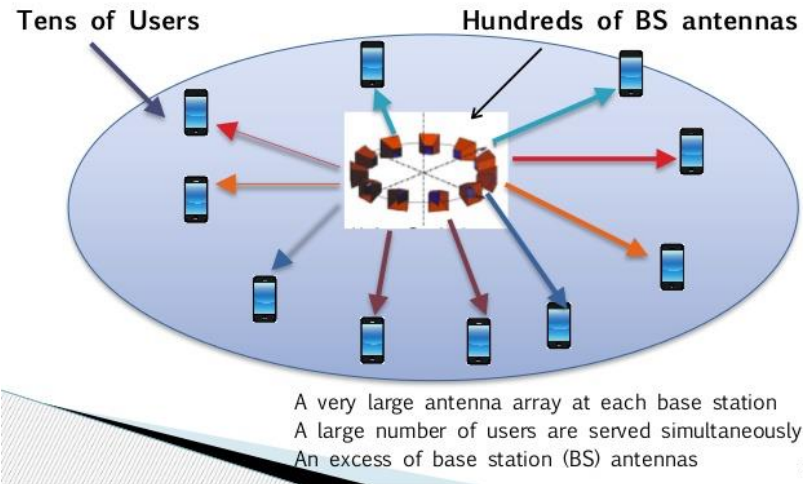
- To increase diversity
- To increase multiplexing gain
- SNR improvement through beamforming



# Massive MIMO

## What is Massive MIMO

Essentially multiuser MIMO with lots of base station antennas



- Maximum capacity depends on inter-cell interference and total no of interfering cell.
- MMSE/RZF gives better performance in UL/DL scenario.
- Large number of antenna is utilized in adaptive manner .
- A detector/precoder performance has been observed in non cooperative multicellular UL/DL scenario.

Thank You

