ITU Kaleidoscope 2016

ICTs for a Sustainable World

WiFi Networks on Drones

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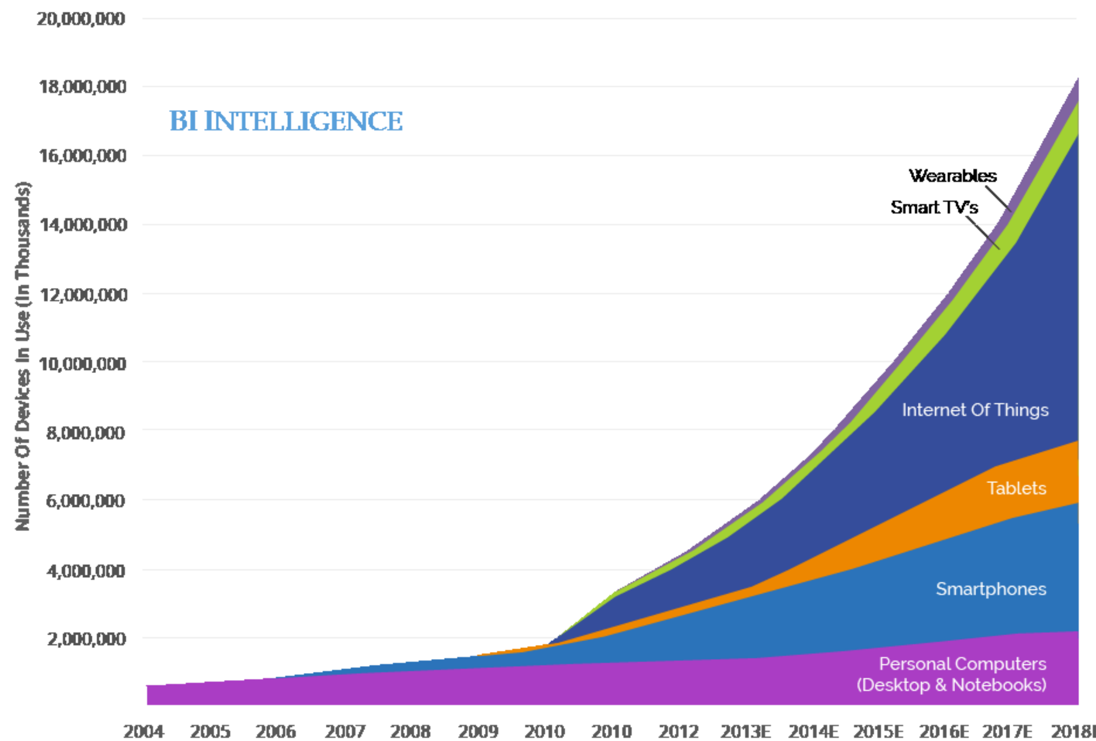
1 Introduction

Introduction

1.1. Motivation

- Internet of Things development
- Huge number of connected devices
- Support or back-up infrastructures to provide constant connectivity



Introduction

1.2. Aims and development stages

Aims:

- Main objective: aerial WiFi network deployment (802.11n)
- Sustainable and cheap components:

  Intel Galileo development board + UAV (drone)

Development stages:

- Theoretical coverage study
- Communication capabilities evaluation
- Energy efficiency
- Real deployment

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2 Aerial Networks

Aerial Networks

2.1. UAV - FANETS

UAV (Unmanned Aerial Vehicle):

- Multiple purposes during last times: surveillance tasks, traffic control, catastrophic event monitoring, etc.
- Telecommunication field: deployment of aerial networks to increase/improve the connectivity capabilities of current networks or deployment of temporary ones (highly-crowded events, tactical networks…)

FANETs (Flying Ad-hoc NETworks):

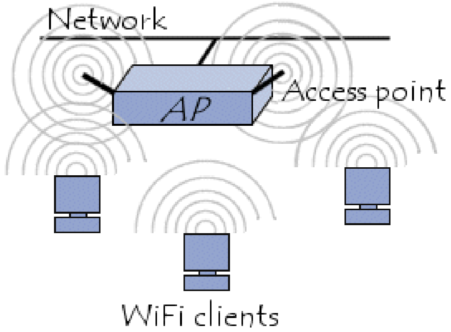
- WiFi, most extended network-access technology
- Different 802.11 functioning modes: infrastructure (Access Point) vs. ad-hoc

Aerial Networks

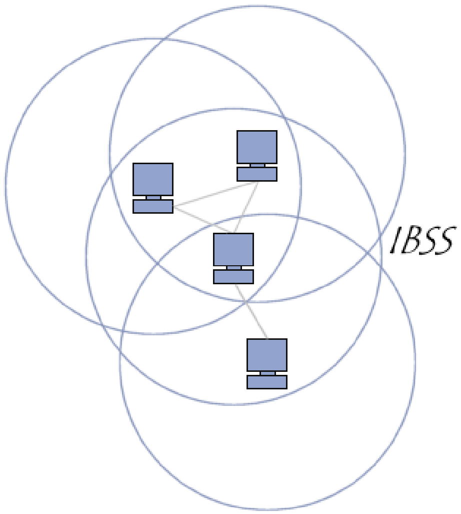
2.1. UAV - FANETS

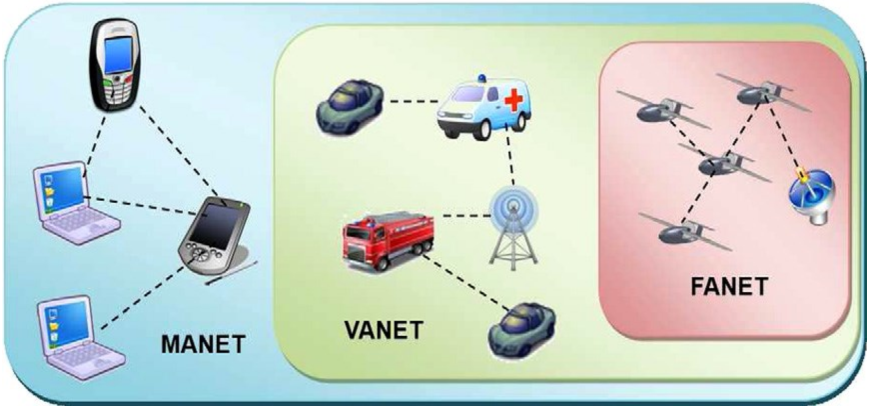
FANETS:

- Infrastructure mode: conventional WiFi routers



- Ad-hoc mode: mesh-networks, sensors, Mobile Ad-hoc NETworks





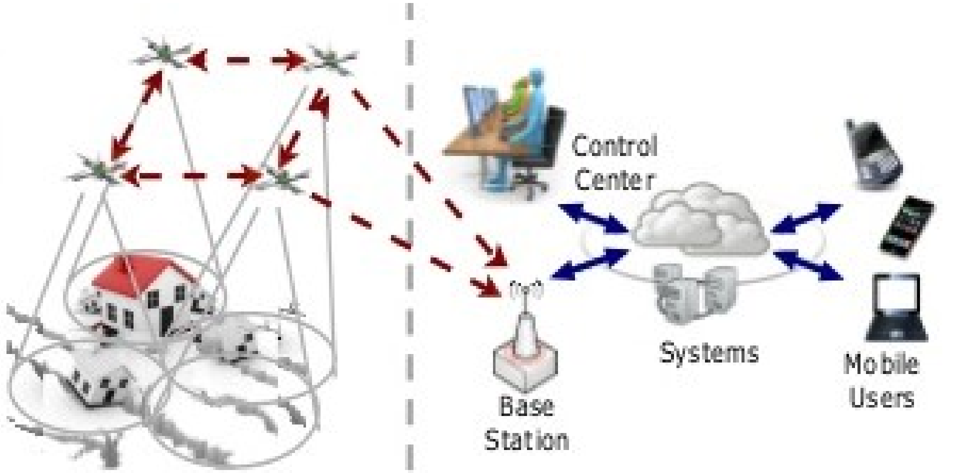
Aerial Networks

2.1. UAV - FANETS

FANETS:

Features:

- Great mobility among network nodes (2D and 3D)
- Extremely changing topology
- Highly effective routing protocols
- Efficient algorithms for saving energy



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3 Test-benches

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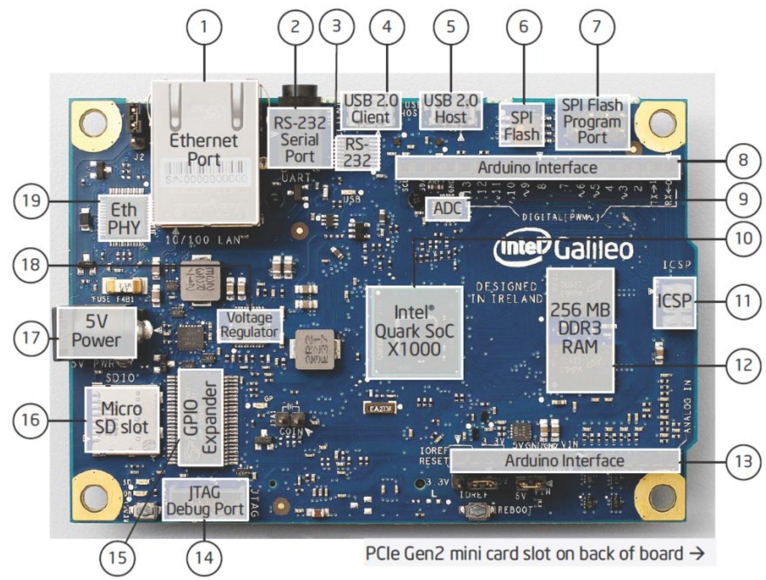
Test-benches

3.1. Equipment

Intel Galileo:



- Focused on IoT application development
- Different connectivity possibilities and low power consumption

Idea-Fly IFLY-4S:

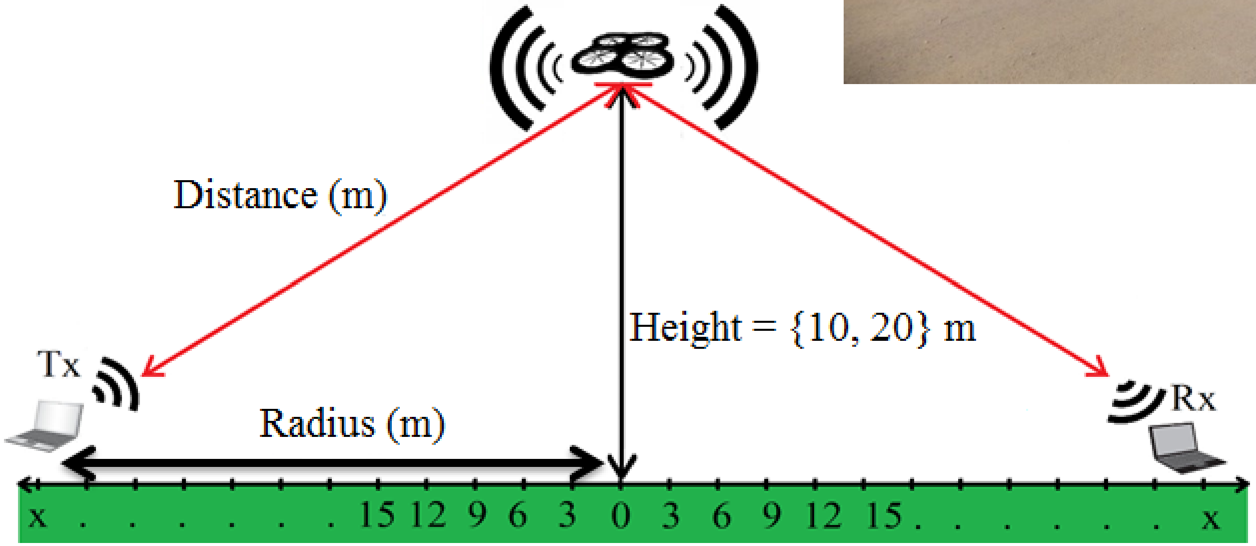
- Great performance and efficiency
- Up to 15 min. flying

Test-benches

3.2. Test-bench

Throughput and signal level:

- *'Iperf3'* tool
- Linux *'iw'* command and spectrum analyzer

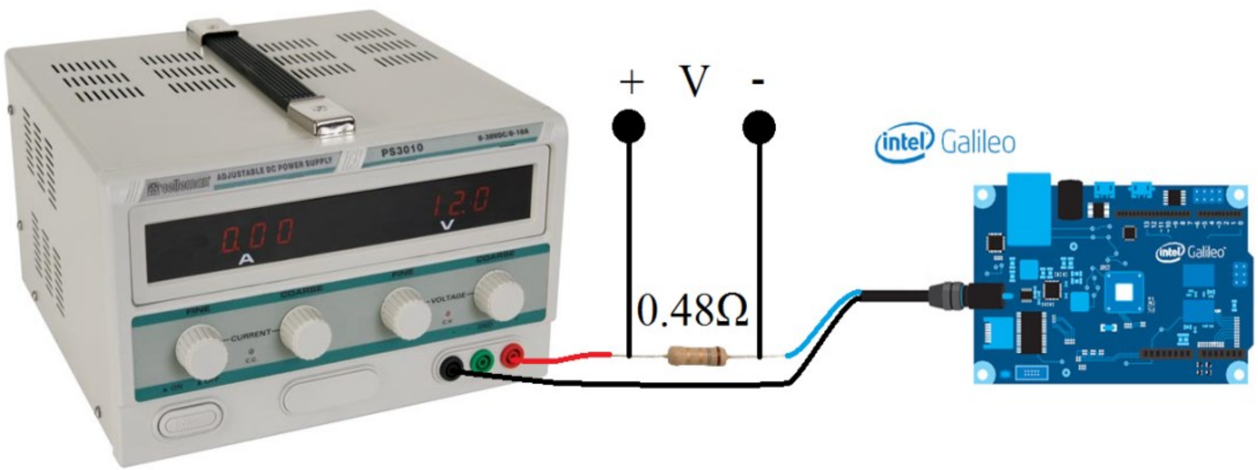


Test-benches

3.2. Test-bench

Power consumption:

- Demanded current by the board
- 30 s CBR transmissions at different rates
- Intel Galileo performing as: router (infrastructure mode) and intermediate hop (ad-hoc mode)



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4 Results

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Results

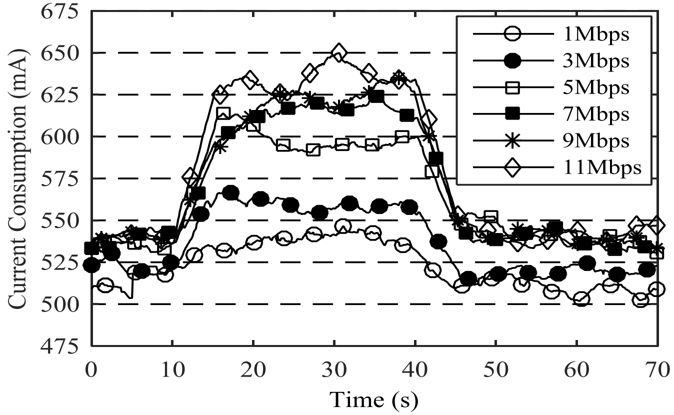
4.1. Throughput (lab conditions)

- Galileo board acting as an intermediate node

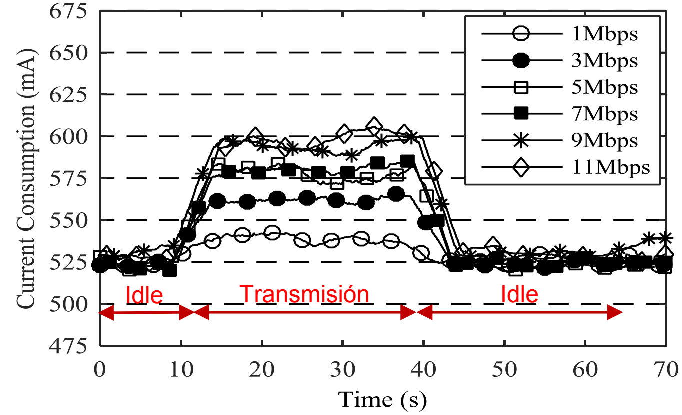
Operational mode	Packet size (Bytes)	Max. Throughput (Mbps)
AP	512	10.5
	1024	11
Ad-hoc	512	4.5
	1024	7.5

Results

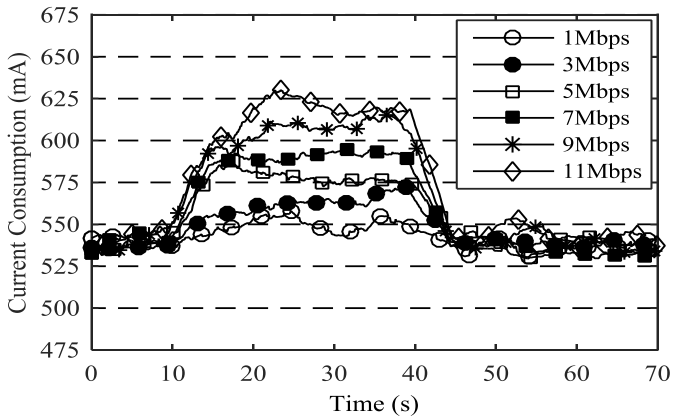
4.2. Energy consumption (lab conditions)



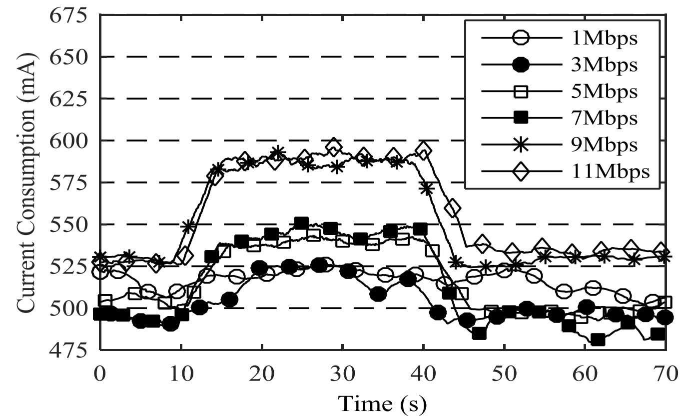
(a) Infrastructure mode. Packet size: 512 B.



(b) Ad-hoc mode. Packet size: 512 B.



(c) Infrastructure mode. Packet size: 1024 B.

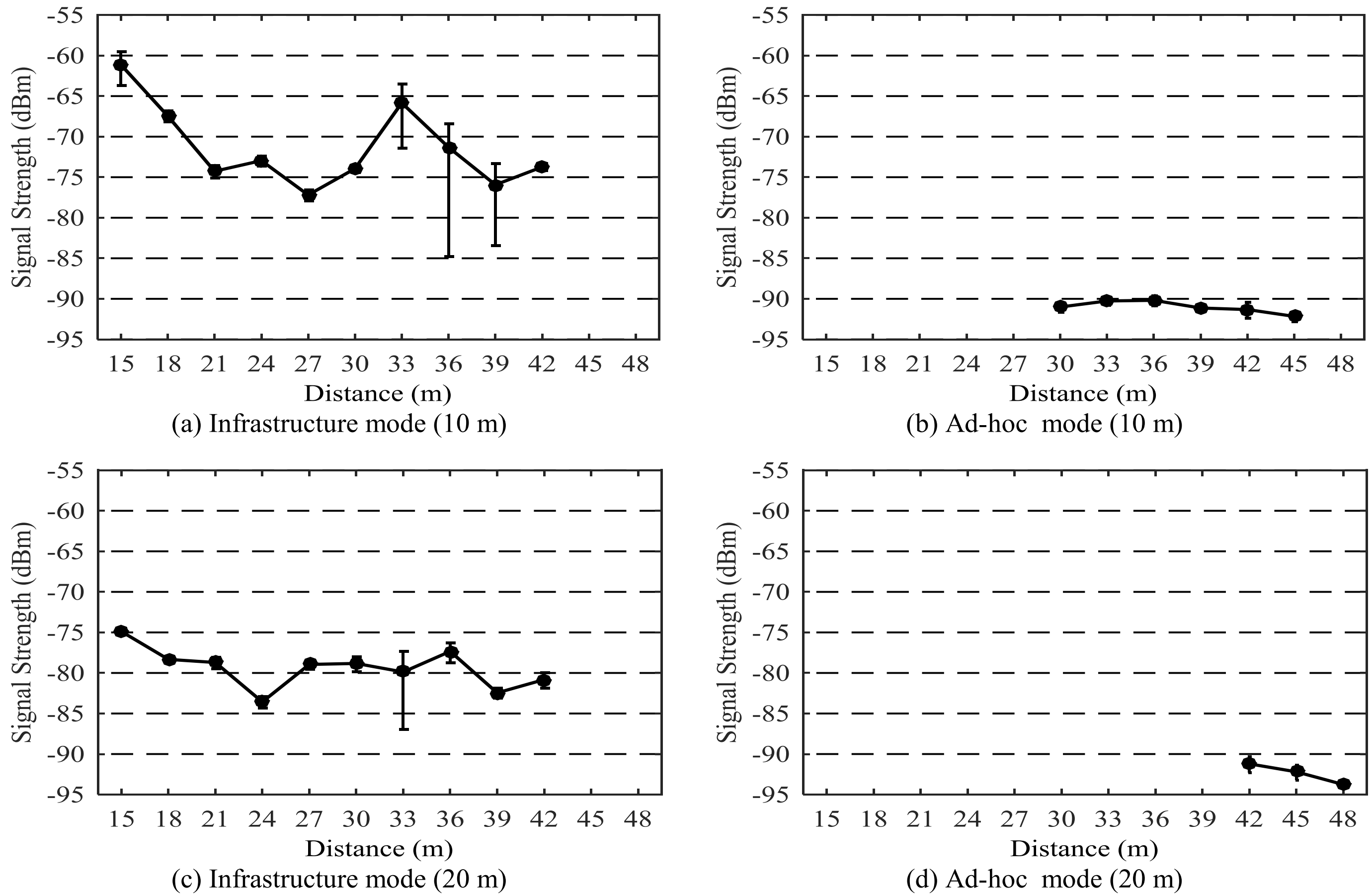


(d) Ad-hoc mode. Packet size: 1024 B.

Current consumption (mA) for both modes of operation and different CBR rates

Results

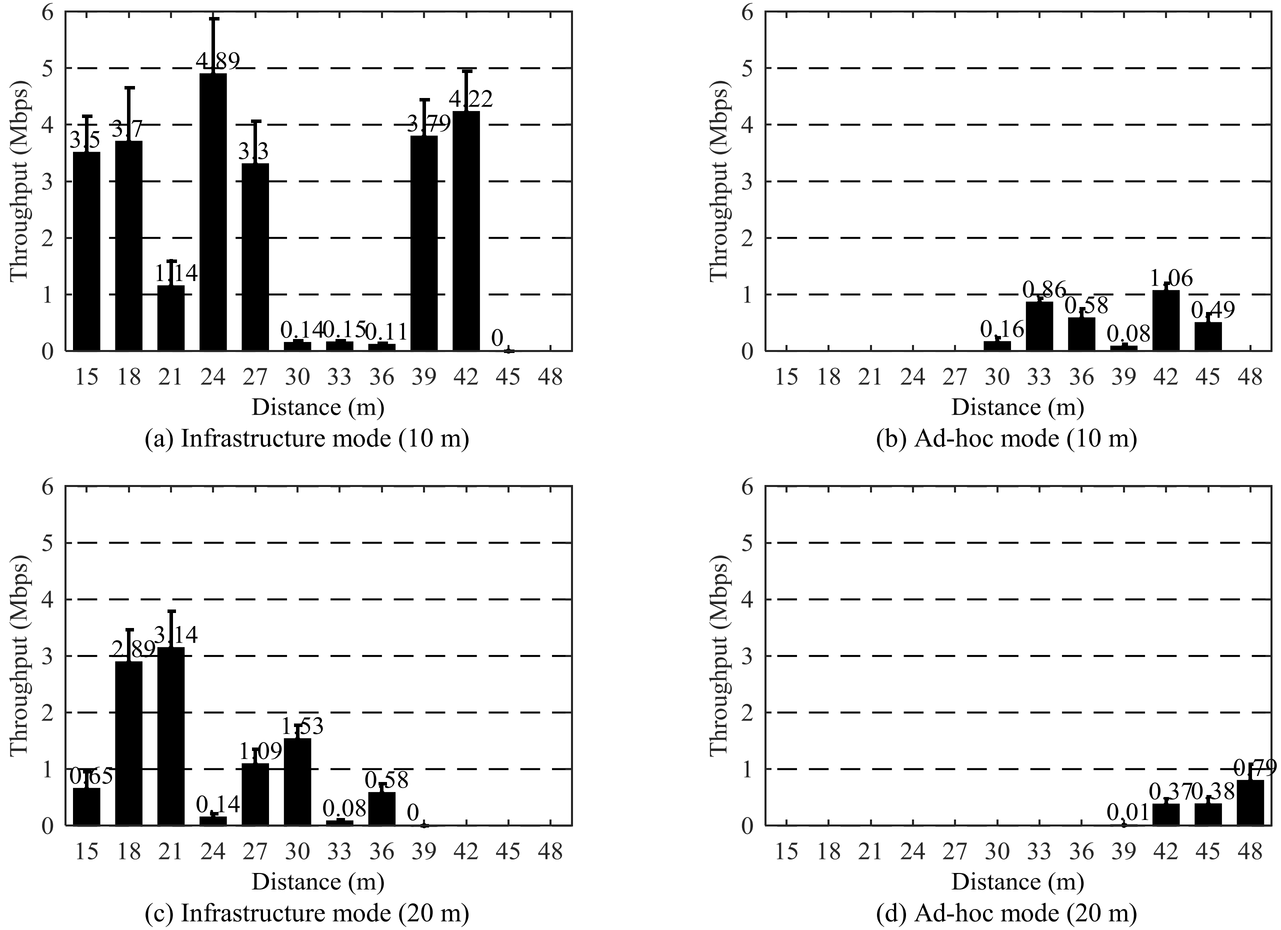
4.3. Coverage range (real experiment)



Signal level (dBm) for both modes of operation at a drone height of 10 m (a and b) and 20 m (c and d)

Results

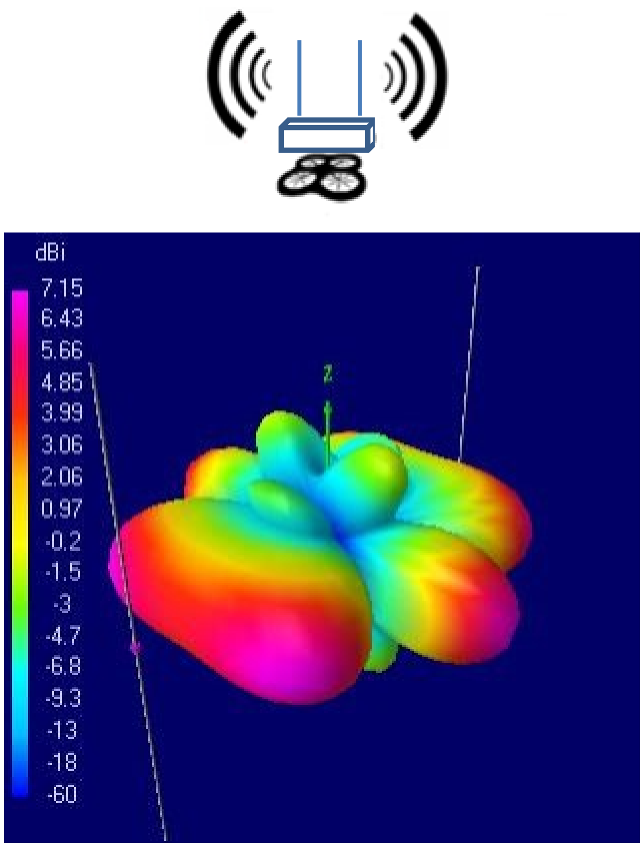
4.4. Throughput (real experiment)

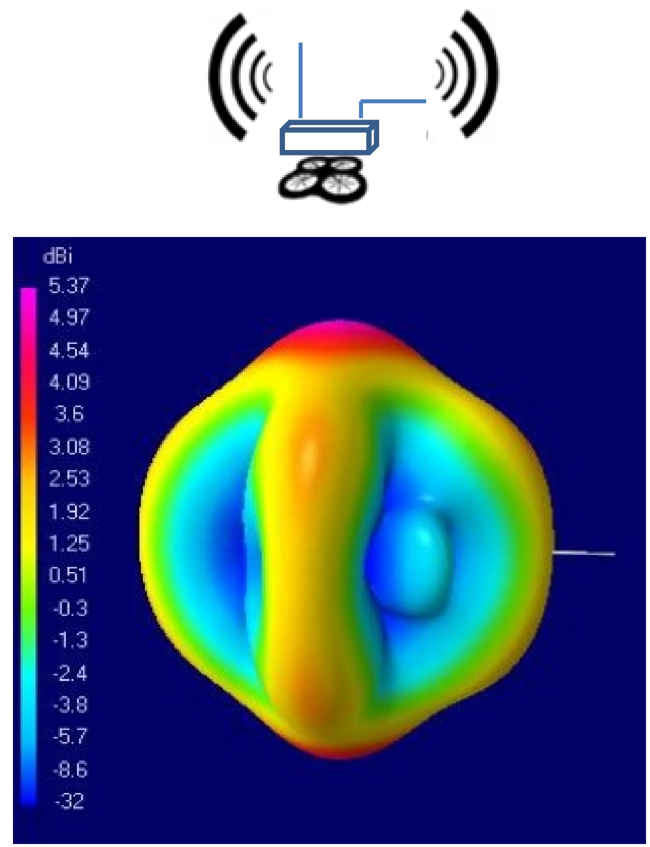


Average throughput (MBps) for both modes of operation at a drone height of 10 m (a and b) and 20 m (c and d)

Results

4.5. Impact of antenna configuration





Radiation patterns for different antenna configuration

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5 Conclusion

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Conclusion

5.1. Conclusion and future work

- Trade-off between infrastructure (AP) and ad-hoc modes:

  - AP provides greater signal level and throughput

  - Ad-hoc provides better energy efficiency

- Real experiments are severely impacted by enviromental conditions, drone unstability and antenna configuration: additional tests are required

- **Future work:** multiple nodes (FANETS). Mixed configurations: AP mode for users' connectivity and ad-hoc for routing traffic, considering the newest versions of the WiFi standard (e.g., 802.11ac)

THANKS FOR YOUR ATTENTION

WiFi Networks on Drones

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