

REPORT TITLE

COMMUNICATION SYSTEM INSIGHTS



Introduction

Communication system's importance in any robot, rover or any machine in general is of great importance as an unmanned vehicle is too much dependent of the base station for what to do what not to do. Also, this system will give all the data that has been collected by the vehicle not only this but the current condition of parts, system reviews and much more. So in short, everything will fall apart without the communication systems.

In the University Rover Challenge from last year to improve our own system, it's really helpful to see how the best teams have organized their system so that we can excel our own designs too or more we can learn about many more methods to do so.

These teams have been very successful in their campaigns. What we want you to do is to search and find insights about their communication systems that they have used.

FOR EACH TEAM I HAVE MENTIONED MOST ABOUT COMPONENTS AND WHAT THEIR IMPLEMENTATION HAVE ACHIEVED

BASIC COMPONENTS AND SOME DISCUSSION ON THEM:-

ANYONE CAN READ THEM HERE:

- [BASE STATION](#)
- [ACCESS POINT](#)
- [ANTENNA](#)

DIRECTIONAL ANTENNA OVERVIEW :-

https://www.researchgate.net/publication/258837351_An_overview_of_using_directional_antennas_in_wireless_networks

D.R. Kaufman, in [Instrumentation Reference Book \(Fourth Edition\)](#), 2010.

Read more about these types of antennas --

https://en.wikipedia.org/wiki/Directional_antenna

<https://www.sciencedirect.com/topics/physics-and-astronomy/directional-antennas>

- ACTIVE ANTENNA TRACKING WITH DIRECTIONAL ANTENNAS

https://www.researchgate.net/publication/276074422_Active_Antenna_Tracking_System_with_Directional_Antennas_for_Enhancing_Wireless_Communication_Capabilities_of_a_Networked_Robotic_System

- SIGNAL SOURCE LOCATION WITH DIRECTIONAL ANTENNAS

<https://arxiv.org/pdf/1905.08869.pdf>

- OMNI DIRECTIONAL ANTENNA :-

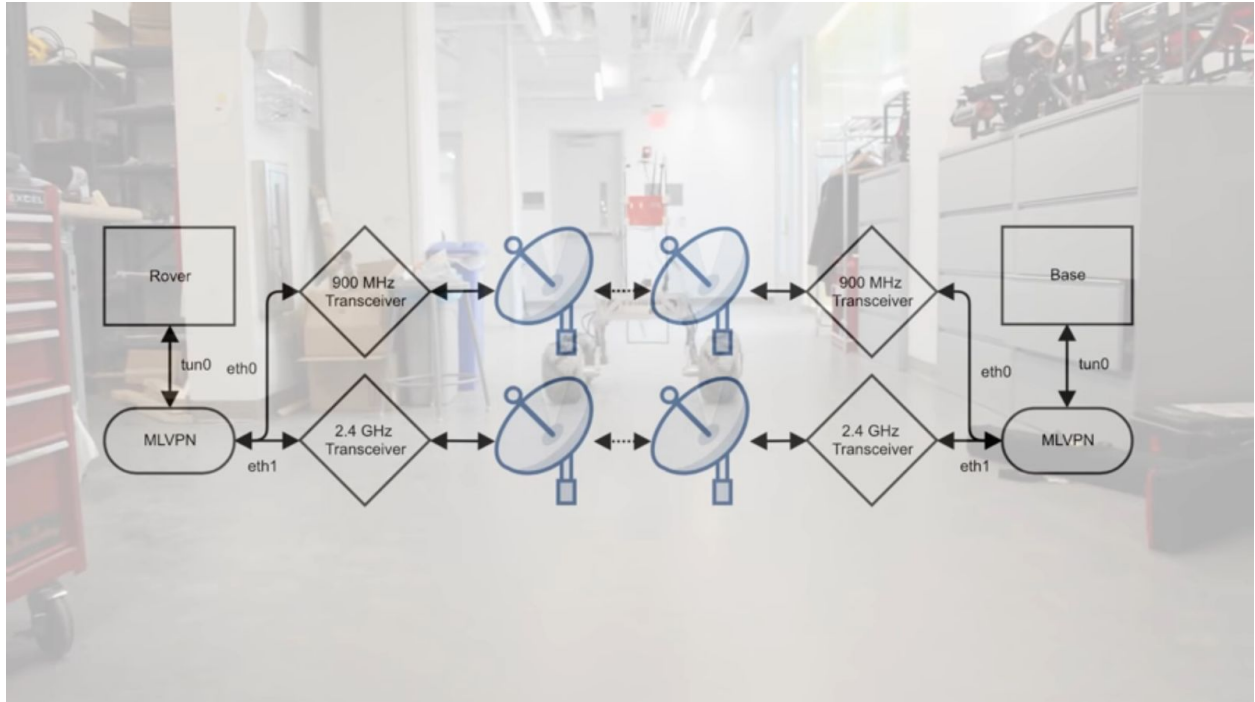
<https://www.sciencedirect.com/topics/computer-science/omnidirectional-antenna>

1.CORNELL MARS ROVER -- CMR BY CORNELL UNIVERSITY

COMMUNICATION SYSTEMS

BASIC COMPONENTS AND SOFTWARES USED --

GIT-- <https://github.com/CornellMarsRover>



1.**ANTENNA** -- 900 Mhz AND 2.4 Ghz OMNI DIRECTIONAL ANTENNA AT ROVER AND A 2.4 GHZ SECTOR ANTENNA AT BASE STATION .

2.**Rocket M2** is a rugged, high-power, linear 2x2 MIMO radio with enhanced receiver performance.

DATASHEET LINK :- https://dl.ubnt.com/datasheets/rocketm/RocketM_DS.pdf

3.**MLVPN** - Multi-Link Virtual Public Network is open source software.

GITHUB REPO :- <https://github.com/zehome/MLVPN>

ACHIEVEMENT BY THIS SYSTEM --

Comfortably able to provide access in 1km even without direct line of sight and partially obstructed line of site.

Controlling the low level control of the rover in a manual state is possible by this communication system with a good speed.

Explanation :--

Cornell's team has been working on this system for last 7 years. In start they were using 2 2.4 ghz omni antennas and a single antenna at base station but they moved on to the 12 dbi antenna and note they are using a combination of 900 mhz and 2.4 ghz with rocket m2 radio which provides a really good transmission speeds in about a km of range ,even in a obstructed line of sight which is good.

[Antenna gain](#) is the same during receive and transmit modes. For example, if antenna gain is +3 dBi in the direction that the signal is received, the [received signal power](#) is 3 dB stronger compared to an omnidirectional antenna.[1]

THIS IS THE REASON FOR THEIR RANGE IS IN 1 KM ONLY.

These powerful antennas are then integrated with a Rocket M2 wireless radio base station which further completes the system with a MLVPN. This **Rocket M2** 2.4GHz MiMO PtP/PtMP Bridge, Base Station ROCKETM2. The Ubiquiti **Rocket M2** is a 2.4GHz rugged, hi-power, very linear, 2x2 MIMO radio with enhanced receiver performance. The Ubiquiti **Rocket M2 features** incredible range performance (50+km) and breakthrough speed (150+Mbps real TCP/IP)[2].

MLVPN will do its best to achieve the following tasks:[3]

- Bond your internet links to increase bandwidth (unlimited)
- Secure your internet connection by actively monitoring your links and removing the faulty ones, without losing your TCP connections.
- Secure your internet connection to the aggregation server using strong cryptography.

-
- Scriptable automation and monitoring.

2.TEAM RUDRA BY SRM UNIVERSITY

RUDRAX

COMMUNICATION SYSTEM

SAR 2019

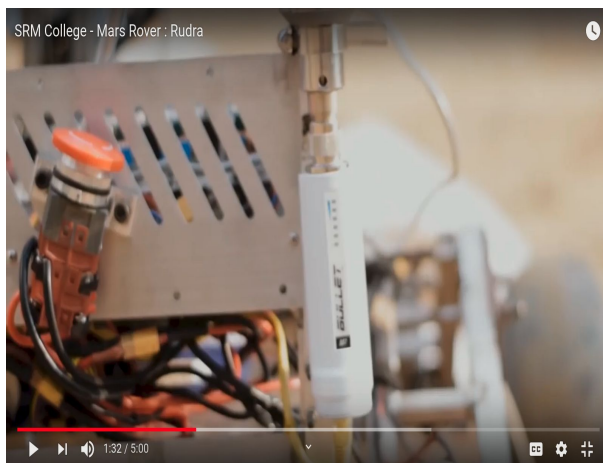
A DETAILED POINT WISE EXPLANATION WITH THEIR COMPONENTS:-

1.As mentioned in their sar videos they have mentioned using the products of ubiquiti networks with powerful antennas.they may be using any variant from ubiquiti catalogue .

2. As seen in their video their base station antenna is directional and is 2.4ghz .

Also as seen in video their rover antenna is also directional.

3.As said they try to use directional algorithms to match the antenna directions and can achieve maximum strength and communication in a range of 2 km which is good.

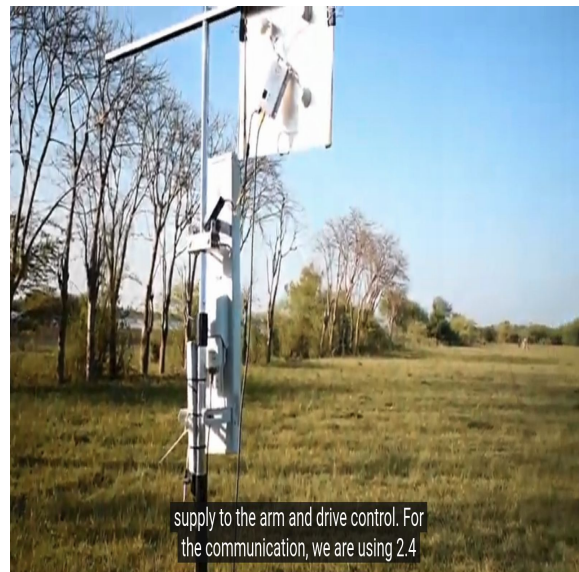
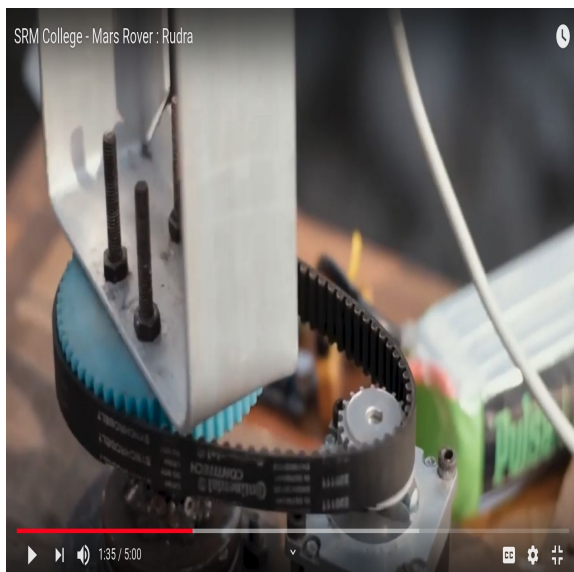


5.The direction tracking algorithm they may be using is to move the antenna using 2 motors in rotation till they achieve maximum strength in signal in manet which is great application but this consumes power for the motor and puts more pressure on the power supply with the other power inputs too.

6. Furthermore they can be using many different algorithms to do so. this paper by byung-cheol min will get a good idea about how active tracking is done.

7. now with their latest video sar 2020 they have mentioned more - that they are using 2.4 ghz spectrum coupled with an omni directional antenna at the access point point and a directional antenna at the base station which gives a range of 1.2 km with low latency.

8. this decrease in range is due to the removing of the active antenna tracking algorithm i guess.



3.Team Anweshak BY IIT MADRAS

DARK KNIGHT

COMMUNICATION SYSTEMS

A DETAILED POINT WISE EXPLANATION WITH THEIR COMPONENTS:-

1.This team is also using an omni directional lantern at the rover and a directional antenna at base station with direction tracking for signal optimization to get a range of 1 km even in absence of line of sight,which is the similar kind if communication architecture we are talking about from the start with 2.4 ghz bandwidth spectrum.



2.In 2019 sar review they mentioned how they decreased their video lag using high compression video encoding algorithm to reduce bandwidth consumption by 4 times.

3. They used a 2.4 ghz band with a 13 dbi omni directional antenna at the rover and a 15 dbi sector antenna at the base station . what the lag problem was reduced in a better way by team continuum.

4. Team Continuum BY UNIVERSITY OF WROCLAW

Aleph 1

COMMUNICATION SYSTEMS

A DETAILED POINT WISE EXPLANATION WITH THEIR COMPONENTS:-

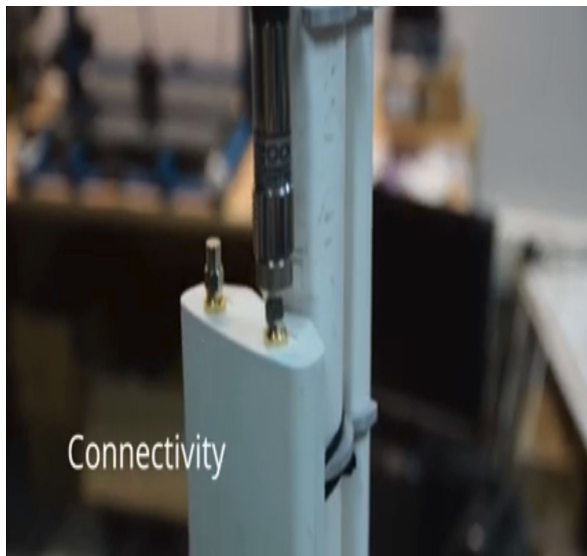
1.This team used a 900mhz and 2.4 ghz with wifi for video transmission like cornell mars rover .

2.They achieved better latency and a lot of bandwidth left for control commands their network became more smooth.

3.They used a directional antenna to follow the rover to ensure connection is optimised .

4.They combined both the directional and high bandwidth which gave better results also using the directional antenna at the base stations saved them from using extra power.

Furthermore they used selected different channels for different data transfer that helped them more.



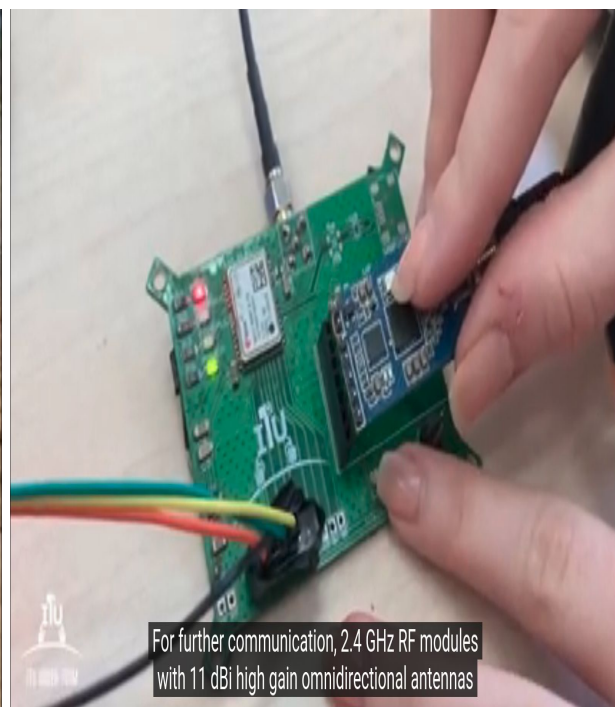
5.ITU ROVER TEAM BY ISTANBUL TECHNICAL UNIVERSITY

COMMUNICATION SYSTEMS

A DETAILED POINT WISE EXPLANATION WITH THEIR COMPONENTS:-

- 1.Using serial communication between rover electronics and the ground station for controlling the drive system.
2. For further communication they have used 2.4 ghz rf modules with 11 dbi high gain omni directional antennas .
- 3.Further for backup links 900mhz rf modules were used.

This gave ITU a very different type of architecture of the network then other rovers.



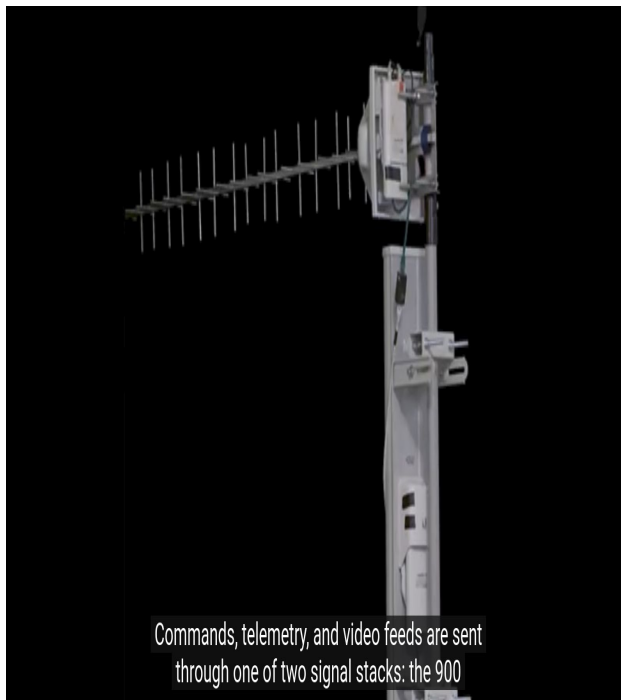
6.MRDT MISSOURI S&T

ICRAUS

COMMUNICATION SYSTEMS

A DETAILED POINT WISE EXPLANATION WITH THEIR COMPONENTS:

1. These people have given a custom gui to maintain stabilization in network and provide all telemetry to operators.
2. Operators can quickly switch between cameras and adjust the resolutions and framerate to optimize the bandwidth
3. With a little difference icarus is given 2 signal stacks with a big an directional antenna commands telemetry and videos are sent by one of two signal sets.
4. The 900 mhz set is used for long range low bandwidth applications.
5. Whereas 5.8 ghz is used for short range gives low latency.



Reference links :

1. OMNI DIRECTIONAL ANTENNA :-

<https://www.sciencedirect.com/topics/computer-science/omnidirectional-antenna>

2. ROCKET M2 :- https://dl.ubnt.com/datasheets/rocketm/RocketM_DS.pdf

3. MLVPN:- <https://github.com/zehome/MLVPN>

4. DIRECTIONAL ANTENNA :-

<https://www.sciencedirect.com/topics/physics-and-astronomy/directional-antennas>

5. DIRECTION TRACKING ALGORITHMS:-

https://www.researchgate.net/publication/224620463_Location_tracking_with_directional_antennas_in_wireless_sensor_networks