Communication System Report

Team Rudra (SRM):

- Products of Ubiquity networks used as primary communication systems, operating at 2.4 GHz coupled with high gain antennas to provide a range of 1.2 km for control.
    - Omni directional antenna at the access point and direction sector antenna at the base station.
- The range is optimised using antenna tracking algorithms to obtain maximum strength in communication.
- 1.2 and 5.8 GHz transmitters for analog feed of the cameras.
- Internal communication of rover subsystems is handled by ROS serial. Communication between robotic arm and motherboard is done by checksum based serial communication.
- Ethernet modules with UDP for inter communication within the rover over synchronous serial communication protocols to put the system on a single unified network.
- Live stream feature gives uninterrupted feed from camera mounted on the rover via UDP connection.
- Uses GPS module and inbuilt compass to navigate during autonomous tasks.

MRDT:

- A dual linear base station yagi maintains a wireless backhaul link in 900 MHz band allowing large object RF penetration.
- 2 circular polarised omni directional antenna onboard rover, alleviate multi-path interference and provide robust connection over full range of field.
- Onboard GPS and magnetometer tracks rover location for point to point navigation.
- Controlled by custom GUI designed to provide all relevant to the operators, such as embedded digital camera feeds, dynamic network ping map etc. provides the driver a quick reference of the state of the rover.
- Commands, telemetry and video feeds are sent through one of the 2 signal stacks: 900 MHz signal stack is used for long range, low bandwidth operations whereas 5.8 GHz stack is used for short range tasks and provides a lower latency.

Cornell Mars Rover (CMR):

- 900 MHz and 2.4 GHz omni directional antenna on the rover and a 2.4 GHz sector antenna at the base station.
- Rocket M2 is a rugged, high-power, linear 2x2 MIMO radio with enhanced receiver performance.

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

Cornell's team has been working on this system for the 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.

Omnidirectional antennas receive signals equally from all directions. Directional antennas pull in signals better from one direction. In this direction, they can detect a weaker or more distant signal than an equivalent omnidirectional antenna. The trade-off is that they do this by decreasing their ability to pull in signals from other directions.

Although a directional antenna can increase the signal power in one direction, the total radiated signal power of any antenna cannot exceed that of an ideal isotropic antenna. Therefore, a directional antenna with positive gain in certain directions will naturally have negative gain in other directions to reduce the total emitted power below that of an ideal isotropic antenna.

Team Continuum:

- 2.4 GHz and 900 MHz for transmission between rover and the base.
- Full communication ranges upto 1 Km.
- WiFi connection allows streaming of high quality video footage without any noticeable lag.
- Better latency leaves a lot of bandwidth left for control commands.
- Directional antenna to follow the rover to ensure connection is optimised .
- Uses selected different channels for different data transfer.

Ryerson Rams Robotics (R3):

- 900MHz and 2.4GHz radios connected in parallel. This allows elements of the control system to be hotspot between the links providing fallback in case of catastrophic communication loss.
- Rocket M900 is used which is a powerful 2x2 MIMO 500g radio.
- Cameras utilize a low bitrate WebRTC transport system which transports 6 camera feeds simultaneously over the communication system.
- WebRTC based connections provide them with low latency feeds in addition to high levels of encoding. This gives the driver a complete picture of what is going on.

Team Anveshak:

- Directional antenna at the base station and an omnidirectional antenna mounted on the rover operating at 2.4GHz.
- 2.4 GHz band with a 13 dbi omni directional antenna at the rover and a 15 dbi sector antenna at the base station .
- The setup can communicate over 1km even in the absence of Line of Sight.
- Near zero lag in video transfer using high compression video encoding algorithm and multiple camera feeds.
- The Jetson Nano forms the core of all computation on the rover. It interfaces with 2 networks of STMs that communicate over an I2C over CAN bus. The shift to CAN bus reduced noise in communication.