# Introduction

Intermittently connected mobile networks (ICMN) are sparse wireless networks where the nodes are scattered with different mobility and may have different paths, where there connections are rarely exist or it is highly unstable, this situation happens due to nodes mobility. The main purpose of ICMN is to utilize this behavior of ICMN to transmit and rout packets of data at certain conditions, for example (when some countries has natural disaster that cause the communications system to breakdown), ICMN can handle in this situation, and also it can be used in many other situations.

There are many current implementation of ICMN like monitoring wildlife for tracking and studying the behavior and movement of animals to understand how the animals lives, From that studies scientists can predict and save some animals species from extinction. Also it used in military for exchange the information between allies forces in secure and reliable way to protect extremely classified information and hide it from enemies.

ICMN faces many challenges and difficulties to be implemented in real life for daily uses, due to the existence of better communication technologies its hard to make technology companies to certify ICMN in every device, and it’s hard to make them realize the importance the ICMN technology, that make the number of ICMN users very low compared to other communication technologies. When the number of user is very low the transmission speed affected and become very slow, on the other hand if ICMN has very large number of users that make congestion in the transmission media. Also ICMN has problems in transmission media as we know WiFi has different range compared with Bluetooth and ZigBee range.

ICMN consists of multiple nodes, transmission media, and a routing scheme and each node act like a router itself to be able to transmit data to other base on routing scheme. There are three type of nodes, sender node (source), receiver nodes (destination) and relays.

# Power consumption

The power consumption considered the most major problem in the technology industries.

# Wireless Transmission Technologies

There are famous Types of Wireless Transmission Technologies such as INFRARED (IR) that use infrared light waves to send signals. Infrared (IR) communication requires line of sight transmission, so is unable to pass or penetrate obstructs and has a short transmission range. These major limitations cause INFRARED (IR) Transmission Media to be a good solution for short range communication.

Further, there is a [wireless](https://en.wikipedia.org/wiki/Wireless) technology called Bluetooth that a allows different electronic devices to connect with each other using short-wavelength Ultra high frequency [radio waves](https://en.wikipedia.org/wiki/Radio_waves) by building [personal area networks](https://en.wikipedia.org/wiki/Personal_area_network) (PANs).

Also, we have another a wireless communication called ZigBee that use with [IEEE 802.15.4](https://en.wikipedia.org/wiki/IEEE_802.15.4)-based [specification](https://en.wikipedia.org/wiki/Specification_%28technical_standard%29) Suits for low-power, low-cost wireless sensors. ZigBee requires little power to operate and it is easy to implement. Since ZigBee devices needs low-power to function, so it can have extremely long battery life.

Further, there is satellite communication Technology that uses [electromagnetic waves](https://en.wikipedia.org/wiki/Electromagnetic_wave) to carry signals. These [electromagnetic waves](https://en.wikipedia.org/wiki/Electromagnetic_wave) cannot pass obstructs, so a line of sight is required. The main purpose of satellite communication is to broadcast and connect between a [transmitter](https://en.wikipedia.org/wiki/Transmitter) and a [receiver](https://en.wikipedia.org/wiki/Radio_receiver) at different locations on Earth. Satellite communication used for internet, telephone, television, radio, and military applications.

Moreover, a Wireless Transmission Technology names WiMAX. It is stand for Worldwide Interoperability for Microwave Access and it is a wireless communication with [IEEE 802.16](https://en.wikipedia.org/wiki/IEEE_802.16)-based [specification](https://en.wikipedia.org/wiki/Specification_%28technical_standard%29). It is faster than Wi-Fi, it can cover a wider area than Wi-Fi. WiMAX can provide indoor and out across whole cities or countries connecting different electronic devices together.

And last, the most famous Wireless Transmission Technology Wi-Fi, it is a wireless communication with [IEEE 802.](https://en.wikipedia.org/wiki/IEEE_802.15.4)11-based [specification](https://en.wikipedia.org/wiki/Specification_%28technical_standard%29). This wireless technology can be found almost everywhere. Wi-Fi uses radio waves to cover an area and by covering the area, each node within the covered area will have the ability to communicate with the world.

# Security

Intermittently connected mobile networks use nodes as relays to transmit data, because of that it require a security to prevent snooping or manipulating the data. Due to absent of network connectivity at the time we can’t use the traditional encryption methods. The packet should contain sender and receiver ID to authorize the packet, if the packet isn’t authorized it shouldn’t be accessed by the application, and the receiver should have an information about sender to encrypt the packet.

# The ONE simulator

## Introduction

The ONE simulator is a simulation environment that is capable of generating a behavior of delay tolerant network system using various DTN routing algorithms and generating number of nodes with different movement models and different transmission range. The ONE simulator provide a graphical user interface to visualize sending or receiving messages or been relayed and mobility of each node in real time. The ONE simulator can generate empty areas with different sizes, so the nodes can move freely or import real world maps with different roads. It can also produce report for every simulation contains number of nodes to general calculation like number of delivered messages, average latency, median latency, and overhead ratio etc.

Simulation scenarios

These scenarios was been simulated using four delay tolerant network algorithms: epidemic, maxprop, spray and wait, and Direct Transmission while the results will be on:

1. Number of delivered messages which counts of the number of messages delivered to the destination node.
2. Average latency: it is average delay time between messages is generated at the senders until it is received by the receivers. Average latency calculation is based on sum of delay times divided on number of Delivered messages.
3. Overhead ratio : it is metric that been measured by calculating the extra numbers of messages needed to generate so the message can reach the destination

First scenario: the performance will be measured based number of nodes while the other parameters are constant

Simulation parameters table

|  |  |
| --- | --- |
| Parameter | Value |
| Number of nodes | From 10 to 100 |
| number of messages | 169 |
| range | 10 m |
| buffer size | 50 M |
| node speed | 0.5 - 1.5 k |
| message size | 500KB - 1MB |
| message TTL | 300 minutes |
| transmission speed | 250 K |
| simulation time | 5000 second |
| area | 650\*340 m2 |

After observing this chart if we increase the number of nodes, the number of Delivered messages increase with it. We can see that spray and wait is better while epidemic and maxprop are similar and the number of Delivered messages in Direct Transmission are very low since it is single copy mode

In average latency we can see it is unstable for every routing schemes from 10 to 100

Some cases epidemic is better and some cases is not. The same thing happen to spray and wait while direct Transmission an average latency is low because average latency calculation based on sum of delay times and number of Delivered messages if we get low number of Delivered messages we get low sum of delay times, so we get low average latency

|  |
| --- |
|  |

In this chart, we realize that Epidemic and maxprop are getting worse if we increase number of nodes because the nodes will send a copy of the messages every time they meet other nodes, while Spray and Wait is better because the nodes have a limited number of copies while the nodes cannot copy in the Direct Transmission scheme because it’s single copy scheme, so the overhead ratio is zero

Second scenario: the performance will be measured based on the area while the other parameters are constant

Simulation parameters table

|  |  |
| --- | --- |
| Parameter | Value |
| number of messages | 169 |
| range | 10 m |
| buffer size | 50 M |
| node speed | 0.5 - 1.5 k |
| message size | 500KB - 1MB |
| message TTL | 300 minutes |
| transmission speed | 250 K |
| simulation time | 5000 second |
| area | from 100\*100 m2 to 1000\*1000 m2 |

Delivered messages was getting worse in all routing schemes from area 100 to area 1000. At 100 we can clearly see maxprop and spray and Wait are kind of similar while at 1000 maxprop is better because of the wide area and limitation of number of copies can the nodes generate when using spray and wait

From area 100 to 300 Direct Transmission is better

From area 400 to 1000 Spray and Wait is better

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In this chart, we realize that Epidemic and maxprop are getting better form area 100 to 1000 because if we increase the area the probability of nodes meetings decreased due to the increasing the distances between nodes, while Spray and Wait is better than Epidemic and maxprop because the nodes have a limited number of copies. In the Direct Transmission the nodes cannot copy scheme because it’s single copy scheme, so the overhead ratio is zero

Third scenario: the performance will be measured based on transmission range while the other parameters are constant

Simulation parameters table

|  |  |
| --- | --- |
| Parameter | Value |
| number of nodes | 100 |
| number of messages | 169 |
| range | From 10 m to 100 m |
| buffer size | 50 M |
| node speed | 0.5 - 1.5 k |
| message size | 500KB - 1MB |
| message TTL | 300 minutes |
| transmission speed | 250 K |
| simulation time | 5000 second |
| area | 650\*340 m2 |

After observing this chart if we increase the range, the number probability of nodes meetings increase with it. we can clearly see maxprop and spray and Wait are kind of similar, while epidemic didn’t get better regardless of the long transmission range because the nodes was sending useless messages. In Direct Transmission the number of Delivered messages is increased if we increase the transmission range.

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In this chart, we realize that Epidemic and maxprop are getting worse if we increase transmission range probability of nodes meetings increase because the nodes will send a copy of the messages every time they meet other nodes, while Spray and Wait is better because the nodes have a limited number of copies while the nodes cannot copy in the Direct Transmission scheme because it’s single copy scheme, so the overhead ratio is zero