Offline-capable Mobile Application using Multi-hop MANET and Wi-Fi Direct

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INTRODUCTION

Wi-Fi Direct

WHAT

What is Wi-Fi Direct?

Wi-Fi Direct is a peer-to-peer standard that allows devices to connect wirelessly without an intermediary, allowing fast data exchange

WHY

Why use Wi-FI Direct?

Wi-Fi Direct operates at a range of up to 200 meters and ~250 Mbps data rate vs. Bluetooth, whose range averages at 10 meters and ~1 Mbps data rate

HOW

How will Wi-Fi Direct be used?

The Wi-Fi Direct NSD library in the Android API will be used for the route discovery process and single-hop data transfers will be done using Wi-Fi Direct connections

Objectives of the Study

» Collect weather forecast data and disseminate information from the server to end-users.

» Develop a weather monitoring mobile application that allows end-users to send feedback regarding the accuracy of the weather forecast, as well as be able to provide proof of their feedback through captured images or videos.

» Allow mobile application to send or receive data without network access

Previous Works

Multi-hop MANET using Wi-Fi Direct

Casetti et al., 2015

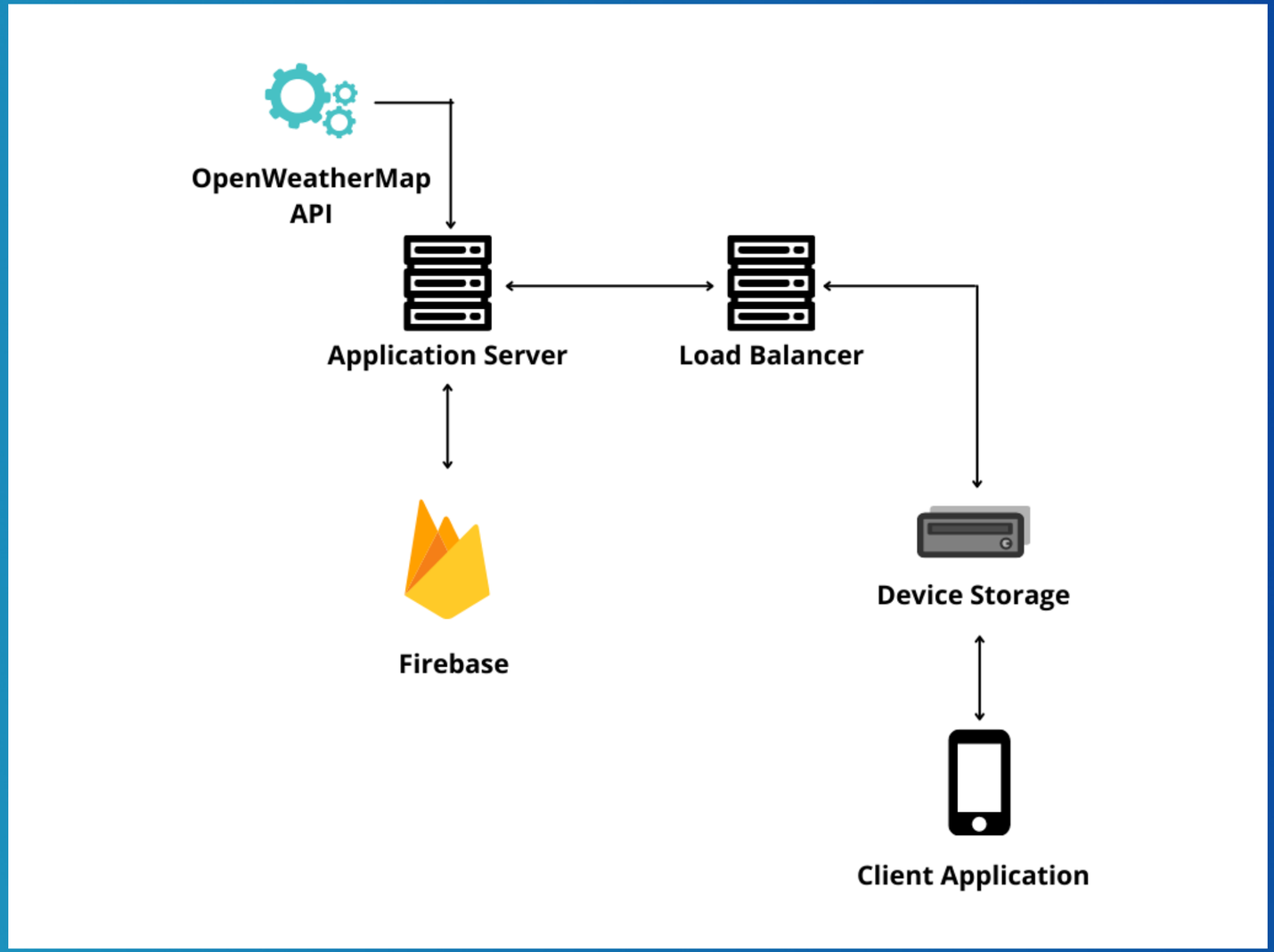
Bypassed the Peer-To-Peer nature of the Wi-Fi Direct by connecting a GO as a legacy Wi-Fi client in another GO

Ahmed, I.M., & Ali, H.M., 2020

Used 1-to-1 connections with nearby peers to get routing information then sent data to destination using DSDV routing protocol

METHODOLOGY

Overall System Architecture



Application when online :

Use caching and long polling with conditional HTTP requests to reduce data consumption

Application when offline :

Use a modified Ad Hoc On-demand Distance Vector (AODV) routing protocol with Wi-Fi Direct to create a multi-hop MANET

Modified AODV

» Discovers a route by broadcasting Route Request (RREQ) packets, with the neighbors rebroadcasting the RREQ until the destination is reached

» Destination rebroadcasts a Route Reply (RREP) packet until original sender is reached, then data hopping through intermediary nodes can begin using Wi-Fi Direct

» Nodes that receive non-duplicate packets store the routing information of the source nodes to populate their routing table

Modified AODV

» RREQ packets consist of <source MAC address, next hop MAC address, destination MAC address, source sequence no. , destination sequence no. , hop count >

» RREP packets consist of < destination MAC address, next hop MAC address, source MAC address, destination sequence no. , hop count >

» Nodes assign a lifetime fo routes that are stored to prevent old routes from being utilized without being checked

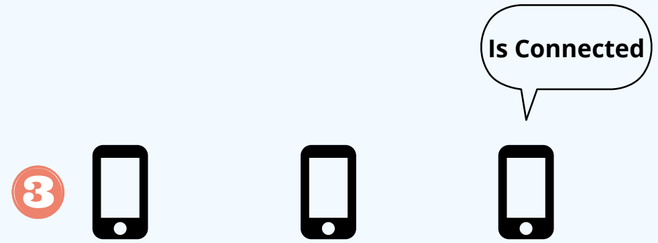
Route Discovery : RREQ

Device A broadcasts an RREQ packet containing its own MAC address and sequence number

Current RREQ: {A, A, null, 1, null, 1}

Device B saves the information of A on the routing table, inserts its MAC address as the next hop MAC address, increments the hop count, and rebroadcasts the RREQ

Current RREQ: {A, B, null, 1, null, 2}



Device A acknowledges that B has received the RREQ and stores its routing information.
Device C receives the RREQ, stores B's information, and prepares to send an RREP

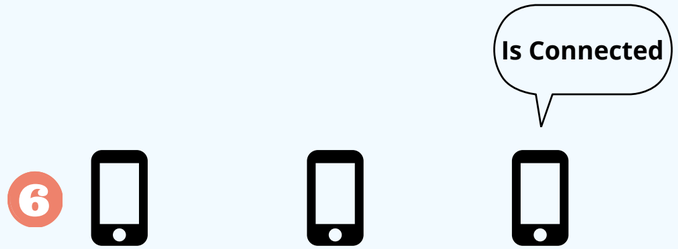
Route Discovery : RREP

Device C broadcasts an RREP packet with its MAC address, sequence number, A's MAC address, and a new hop count

Current RREP: {C, null, A, 1, 1}

Device B saves the information of C on the routing table, inserts its MAC address as the next hop MAC address, increments the hop count, and rebroadcasts the RREP

Current RREP: {C, B, A, 1, 2}



Device C acknowledges that Device B has received the RREP.
Device A receives the RREP, stores C's information, and prepares to send the data through Wi-Fi Direct

TESTING AND RESULTS

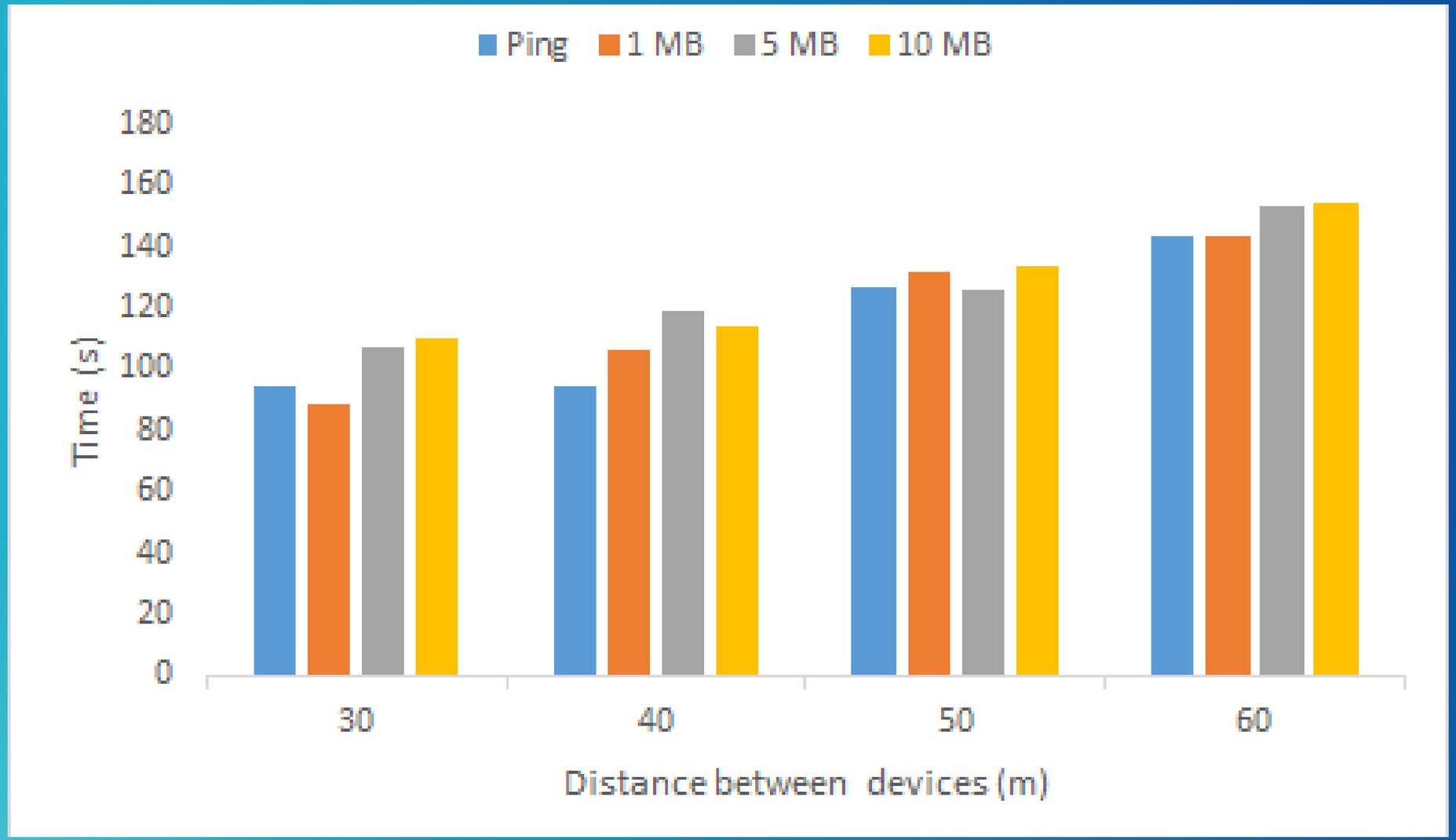
Testing Environment

Device A
Samsung J7
API 23

Device B
Samsung A20
API 29

Device B
Samsung A01
API 29

2-hop Data Transfer by distance and payload



	RREQ Travel	RREP Travel	Data Transfer	Total
Ping	52.77s	40.13s	1.50s	94.40s
1 MB	46.64s	39.88s	2.24s	88.76s
5 MB	61.36s	41.89s	3.89s	107.14s
10 MB	62.47s	41.24s	5.98s	109.70s

TABLE I: 30 meters distance between each device

	RREQ Travel	RREP Travel	Data Transfer	Total
Ping	48.51s	44.26s	1.73s	94.51s
1 MB	61.05s	41.63s	3.59s	106.28s
5 MB	67.95s	45.75s	5.47s	119.17s
10 MB	60.81s	45.85s	7.42s	114.09s

TABLE II: 40 meters distance between each device

	RREQ Travel	RREP Travel	Data Transfer	Total
Ping	67.27s	57.68s	2.27s	127.22s
1 MB	71.38s	55.76s	4.10s	131.23s
5 MB	68.38s	51.09s	6.21s	125.67s
10 MB	65.48s	60.18s	7.98s	133.64s

TABLE III: 50 meters distance between each device

	RREQ Travel	RREP Travel	Data Transfer	Total
Ping	77.21s	63.63s	2.84s	143.67s
1 MB	70.81s	67.58s	5.17s	143.57s
5 MB	79.85s	65.84s	7.75s	153.45s
10 MB	81.77s	63.40s	9.09s	154.26s

TABLE IV: 60 meters distance between each device

Device A Log file

```
[Monday 7 Jun 05:15:13.179] Initialize application
[Monday 7 Jun 05:15:41.117] Broadcasting packet : rreq,6a:5a:cf:19:02:6a,6a:5a:cf:19:02:6a,,0,,0,1
[Monday 7 Jun 05:16:00.921] Establishing Wi-Fi Direct Connection with 4a:79:4d:0c:cc:9b
[Monday 7 Jun 05:16:12.752] Wi-Fi Direct connection to 192.168.49.1
[Monday 7 Jun 05:16:13.771] Received payload : Hello World
[Monday 7 Jun 05:18:44.223] Stopped Service
```

Device B Log file

```
[Monday 7 Jun 05:15:15.331] Initialize application
[Monday 7 Jun 05:15:10.109] Started listening for broadcasts
[Monday 7 Jun 05:15:37.231] Sending RREP : rrep,4a:79:4d:0c:cc:9b,4a:79:4d:0c:cc:9b,6a:5a:cf:19:02:6a,1,1
[Monday 7 Jun 05:15:57.228] Wi-Fi Direct connection to 192.168.49.1
[Monday 7 Jun 05:21:52.772] Stopped Service
```

Conclusion

» Using Wi-Fi Direct for ad hoc networks can be effective if a reliable route discovery process is found

» The Network Service Discovery (NSD) is not reliable enough to reliably discover valid routes quickly

» Forced user input during the Wi-Fi Direct connection phase is also a factor to consider as most implicit operations cannot be performed for ad hoc networking

References

[1] https://www.wi-fi.org/discover-wi-fi/wi-fi-direct

[2] https://www.pna.gov.ph/articles/1123445

[3] Casetti, C., Chiasserini, C. F., Pelle, L. C., Del Valle, C., Duan, Y., & Giaccone, P. (2015, June). Content-centric routing in Wi-Fi direct multi-group networks. In 2015 IEEE 16th international symposium on a world of wireless, mobile and multimedia networks (WoWMoM) (pp. 1-9). IEEE.

[4] Ahmed, I. M., & Ali, H. M. (2020). Building a Dynamic Multi-hop WiFi Direct Network For Android Smartphones. Solid State Technology, 63(2s).