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Appendix A

Generic Architecture of an Access Point

Figure A.1 illustrates the generic architecture of a common access point. A common access point is mainly consisting of components like Network Address Translation (NAT) Modular Router and Backhaul Interfaces.

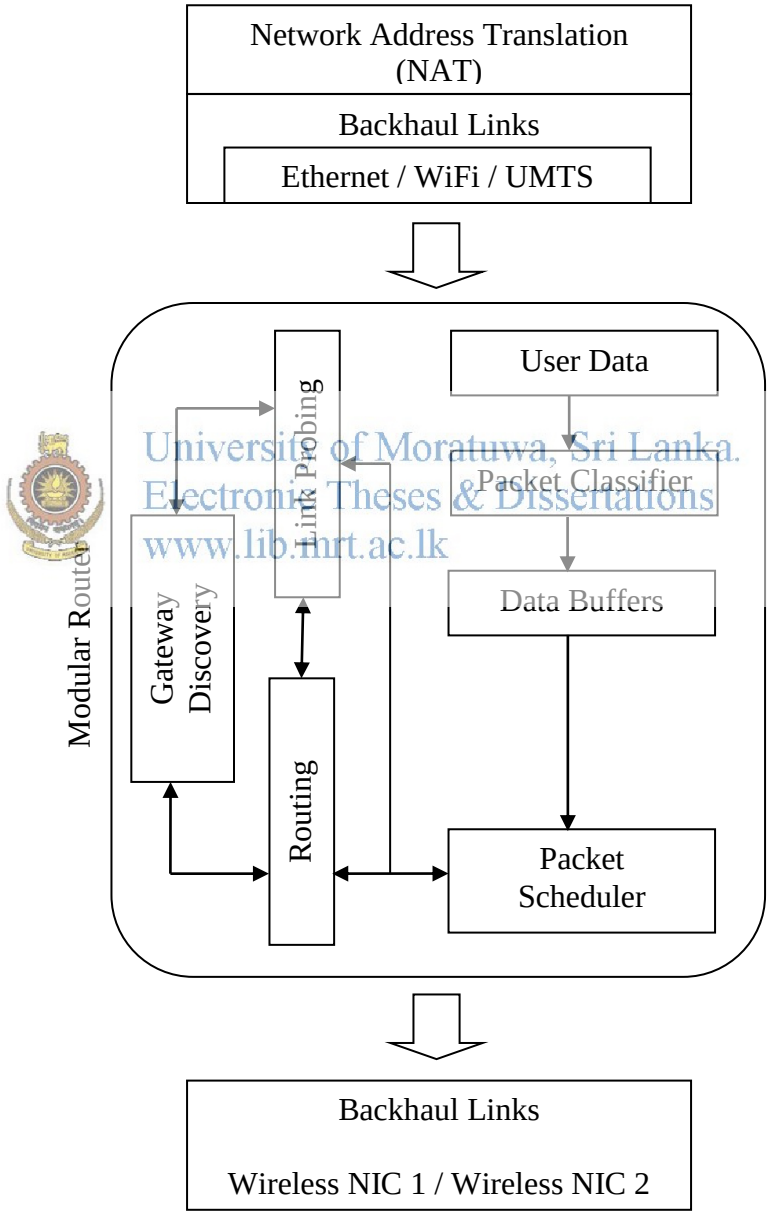

Figure A.1: Common Architecture of Access Point

Appendix B

Activity Diagrams

This appendix includes activity diagrams of various modules of the MAS based wireless resource management system. Figure B.2 illustrates activities of the connector module of the host agent and section 6.2.1 discusses more about the module.

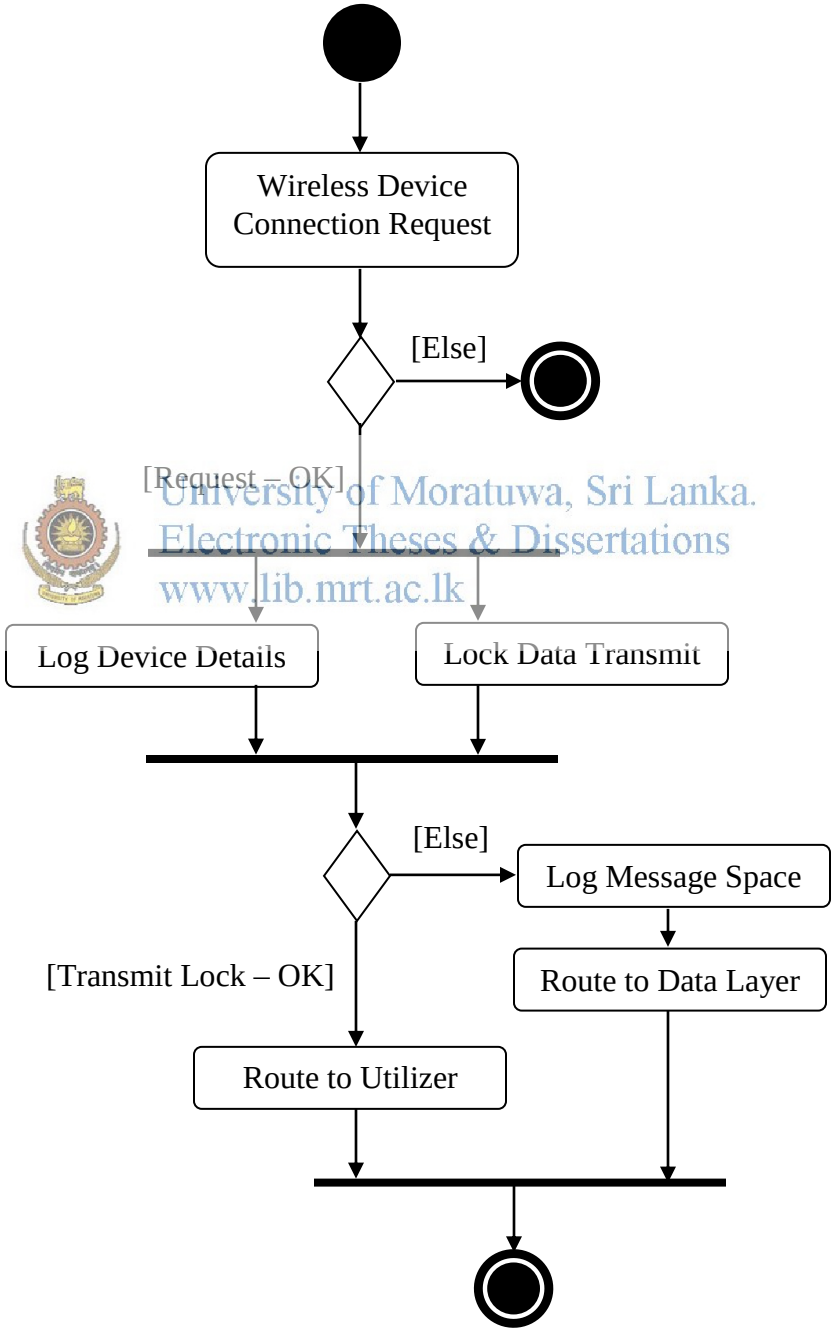

Figure B.1: Activity Diagram of the Connector Module

Figure B.3 describe the activities of utilizer module of the host agent. Utilizer is doing the main processing of the host agent and section 6.2.2 explains all the activities in details.

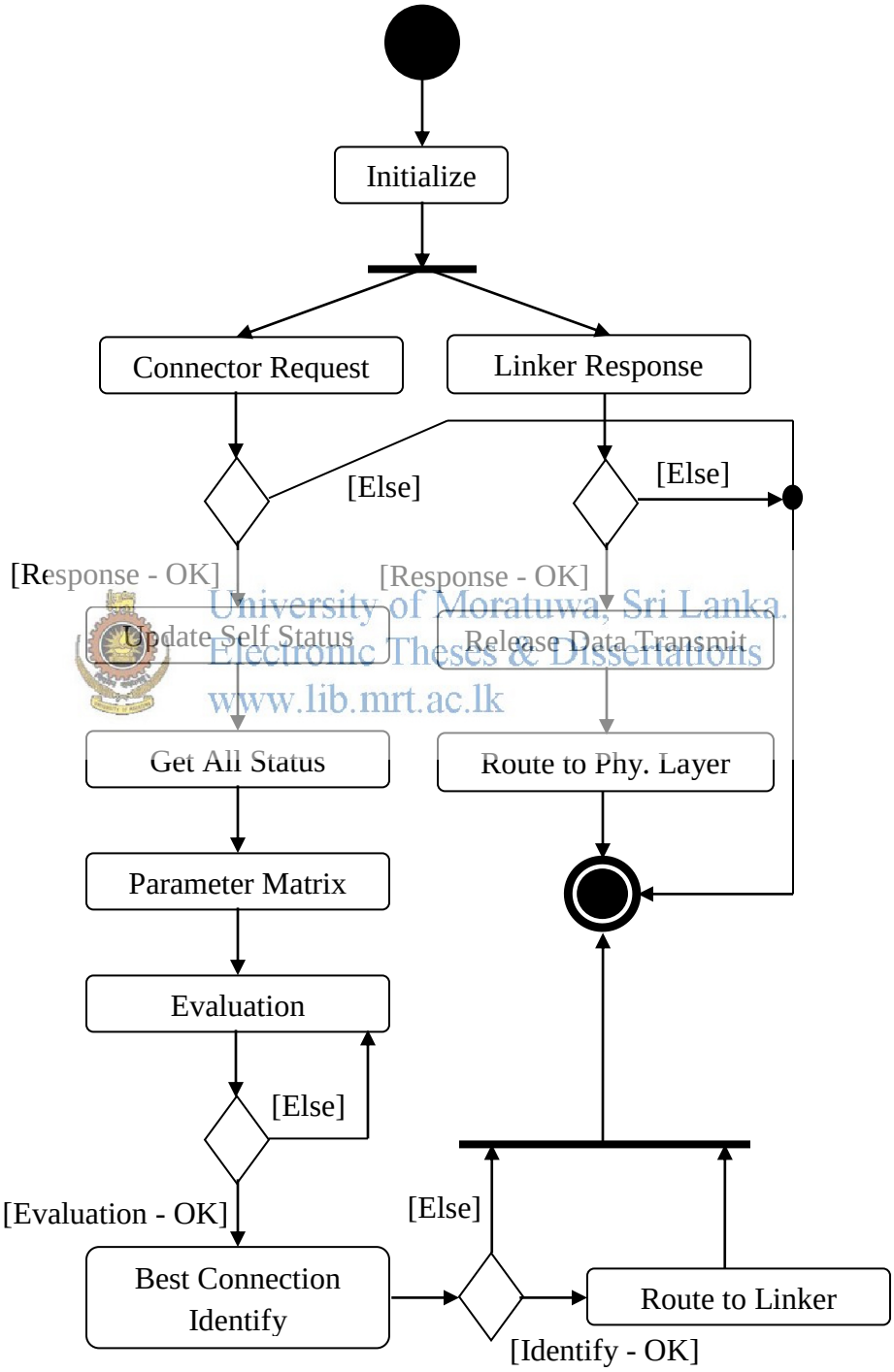

Figure B.2: Activity Diagram of the Utilizer Module

Figure B.4 describe the activities of the linker module of the host agent. Linker act as a simple router of the communication channels and section 6.2.3 discuss about it more in details.

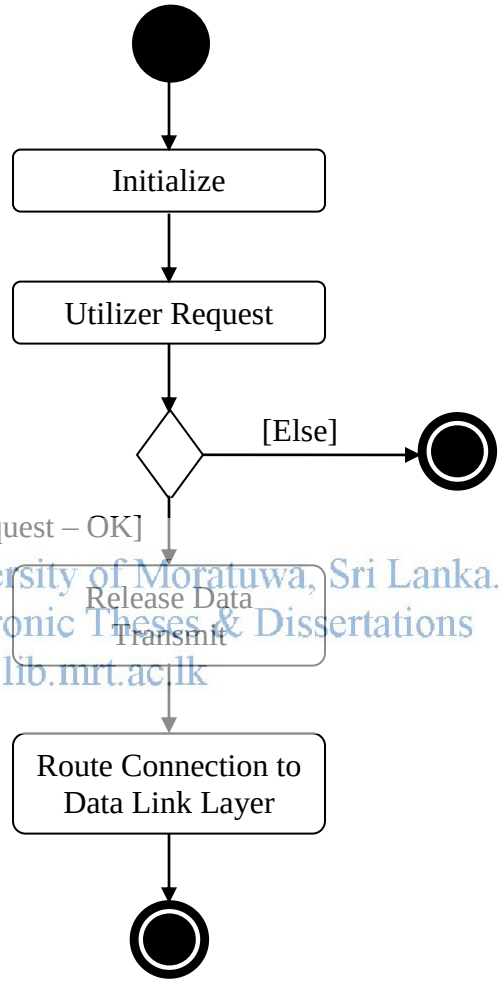

Figure B.3: Activity Diagram of the Linker Module

Appendix C

Sample Ontology of a Host Agent

This section includes a sample local ontology associated with the host agent. This ontology is used to identify the performance parameters and there condition levels that going to consider with the specific access point in the wireless system. Based on the different environment condition it is possible to set the parameter levels accordingly in this ontology.

```
<?xml version="1.0" encoding="utf-8"?>
<HostOntology>
    <ActivityStatus>
        <Value>True</Value>
        <Desc>True if enabled, False otherwise</Desc>
    </ActivityStatus>
    <Conditions>
        <ConditionsList>
            <Item ID="1" Active="1" Desc="bandwidth" />
            <Item ID="2" Active="0" Desc="p-level" />
            <Item ID="3" Active="1" Desc="eval algo" />
        </ConditionsList>
        <ConditionsParam>
            <Param ID="1">
                <Mode Val="TCP">
                    <load count="2" val="40" />
                    <load count="3" val="50" />
                </Mode>
                <Mode Val="UDP">
                    <load count="" val="100" />
                </Mode>
            </Param>
```

```
                    <Param ID="1">
                        <sysinfo status="PowerLineStatus" val="online" />
                        <sysinfo status="BatteryLifeRemaining" val="100" />
                    </Param>
                    <Param ID="1">
                        <!-- Possible derivation of Information Theory -->
                        <algo status="1" val="BF" />
                        <algo status="1" val="DSR" />
                        <algo status="1" val="AODV" />
                    </Param>
                </ConditionsParam>
            </Conditions>
</HostOntology>
```

The sample ontology is pre-constructed XML file. With the Java environment it is quite easy to manipulate than a database or a flat file.

Appendix D

Screenshots

This section includes screenshots of the proposed MAS based resource management systems for wireless instrumentation.

IPERF Performance Evaluation Tool

Figure D.1 is a screenshot of how IPERF is running as a server and Figure D.2 shows that how it is running as a client.

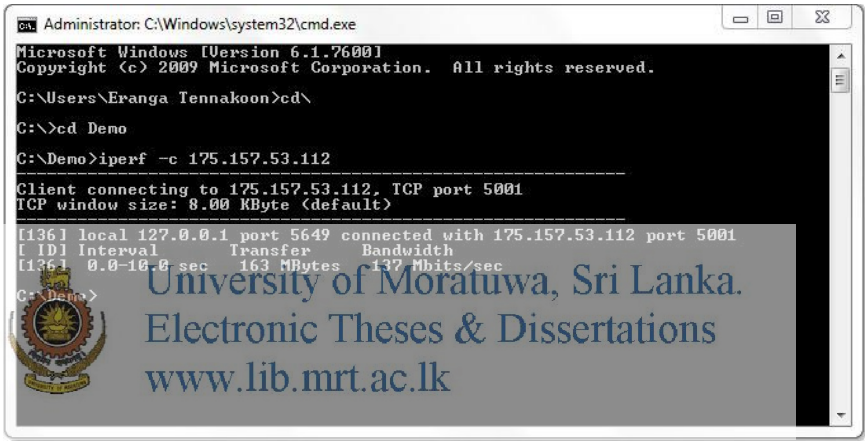

Figure D.1: IPERF Running as a Server

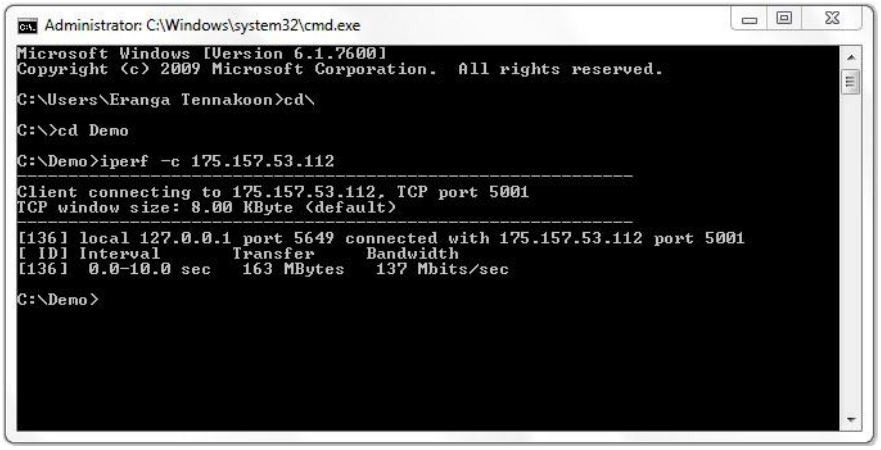

Figure D.2: IPERF Running as a Client

Figure D.3 is a screenshot of the results console. Appendix E and Appendix F shows the experimental results obtain from the control.

Output

```
------------------------------------------------------------
Server listening on TCP port 5001
TCP window size: 8.00 KByte (default)
------------------------------------------------------------
[244] local 157.235.202.9 port 5001 connected with 157.235.202.9 port 56921
[280] local 157.235.202.9 port 5001 connected with 157.235.202.9 port 56923
[296] local 157.235.202.9 port 5001 connected with 157.235.202.9 port 56925
[272] local 157.235.202.9 port 5001 connected with 157.235.202.9 port 56922
[288] local 157.235.202.9 port 5001 connected with 157.235.202.9 port 56924
[ ID] Interval       Transfer     Bandwidth
[244]  0.0- 1.0 sec  35840 KBytes  293601 Kbits/sec
[296]  0.0- 1.0 sec  43296 KBytes  354681 Kbits/sec
[280]  0.0- 1.0 sec  37968 KBytes  311034 Kbits/sec
[272]  0.0- 1.0 sec  35176 KBytes  288162 Kbits/sec
[288]  0.0- 1.0 sec  36824 KBytes  301662 Kbits/sec
[SUM]  0.0- 1.0 sec  189104 KBytes  1549141 Kbits/sec
[244]  1.0- 2.0 sec  56871 KBytes  465885 Kbits/sec
[296]  1.0- 2.0 sec  32752 KBytes  268304 Kbits/sec
[280]  1.0- 2.0 sec  32968 KBytes  270074 Kbits/sec
[288]  1.0- 2.0 sec  33024 KBytes  270532 Kbits/sec
[272]  1.0- 2.0 sec  33360 KBytes  273285 Kbits/sec
[SUM]  1.0- 2.0 sec  188975 KBytes  1548081 Kbits/sec
[244]  2.0- 3.0 sec  91537 KBytes  749873 Kbits/sec
[296]  2.0- 3.0 sec  23392 KBytes  191627 Kbits/sec
[280]  2.0- 3.0 sec  23648 KBytes  193724 Kbits/sec
[272]  2.0- 3.0 sec  23552 KBytes  192938 Kbits/sec
[288]  2.0- 3.0 sec  23571 KBytes  193097 Kbits/sec
[SUM]  2.0- 3.0 sec  185701 KBytes  1521259 Kbits/sec
[244]  3.0- 4.0 sec  66504 KBytes  544801 Kbits/sec
[296]  3.0- 4.0 sec  33808 KBytes  276955 Kbits/sec
[ ID] Interval       Transfer     Bandwidth
[280]  3.0- 4.0 sec  33504 KBytes  274465 Kbits/sec
[288]  3.0- 4.0 sec  33637 KBytes  275551 Kbits/sec
[272]  3.0- 4.0 sec  33480 KBytes  274268 Kbits/sec
[SUM]  3.0- 4.0 sec  200933 KBytes  1646040 Kbits/sec
[244]  4.0- 5.0 sec  75640 KBytes  619643 Kbits/sec
[296]  4.0- 5.0 sec  27200 KBytes  222822 Kbits/sec
[280]  4.0- 5.0 sec  27032 KBytes  221446 Kbits/sec
[288]  4.0- 5.0 sec  29512 KBytes  241762 Kbits/sec
```


Figure D.3: System Results Console

Appendix E

Test Results for Wireless Device Connectivity

This section includes the test results for wireless device connectivity to the evaluation setup, with six access points. Section 7.4.1 of Chapter 7 discusses about the test carried out. Table E.1 list the test results gathered during this test phase on conventional wireless system.

ID column shows the unique ID assign by the physical layer when the connection request is identified. This ID is only valid through the life cycle of the connection as well as with the access point availability. If the connection is lost during the connection between the wireless devices or the wireless router is restarted a new ID is generated. Transfer Data column shows the amount of data transfer during the time interval specified in the Interval column of the table. Bandwidth column shows the allocated bandwidth at that time period to transfer the data. Last row of each table shows the cumulative results.

ID	Interval (sec)	Transfer Data (KB)	Bandwidth (Kb/S)
172	0.0- 1.0	166,848	1,366,819
172	1.0- 2.0	121,552	995,754
172	2.0- 3.0	161,840	1,325,793
172	3.0- 4.0	146,576	1,200,751
172	4.0- 5.0	165,944	1,359,413
172	5.0- 6.0	172,504	1,413,153
172	6.0- 7.0	158,984	1,302,397
172	7.0- 8.0	168,240	1,378,222
172	8.0- 9.0	156,328	1,280,639
172	9.0- 10.0	165,234	1,289,203
172	**0.0- 10.0**	**1,587,264**	**1,300,807**

Table E.1: Wireless Device Connectivity (Conventional Wireless System)

Table E.2 list the test results gathered on proposed MAS based system.

ID	Interval (sec)	Transfer Data (KB)	Bandwidth (Kb/S)
236	0.0- 1.0	165,712	1,357,513
236	1.0- 2.0	159,512	1,306,722
236	2.0- 3.0	159,656	1,307,902
236	3.0- 4.0	161,304	1,321,402
236	4.0- 5.0	151,328	1,239,679
236	5.0- 6.0	158,912	1,301,807
236	6.0- 7.0	72,390	593,016
236	7.0- 8.0	0	0
236	8.0- 9.0	0	0
236	9.0- 10.0	0	0
236	10.0- 11.0	0	0
236	**0.0- 11.5**	**1,028,824**	**733,700**

Table E.2: Wireless Device Connectivity (Proposed Wireless System)

Appendix F

Test Results for Data Management of the System

This section includes the test results for the data management of the evaluation. Test is carried out in two steps, file download from the server and file upload to the server. Section 7.4.2 of Chapter 7 discusses about the test carried out.

Interval (sec)	Communication Channels						Transfer Data (KB)
	1	2	3	4	5	6	
0.0- 1.0	16384	20480	28672	14336	20480	22528	122880
1.0- 2.0	20480	18432	22528	28672	16384	20480	126976
2.0- 3.0	20480	24576	22528	22528	18432	22528	131072
3.0- 4.0	20480	24576	20480	36864	18432	16384	137216
4.0- 5.0	12288	14336	53248	12288	22528	20480	135168
5.0- 6.0	12288	45056	22528	16384	20480	18432	135168
6.0- 7.0	20480	20480	18432	30720	22528	22528	135168
7.0- 8.0	18432	30720	18432	20480	24576	24576	137216
8.0- 9.0	24576	24576	26624	30720	20480	22528	149504
9.0- 10.0	20480	20480	20480	22528	20480	30720	135168
10.0- 11.0	20480	20480	20480	36864	20480	22528	141312
11.0- 12.0	20480	20480	20480	22528	24576	26624	135168
12.0- 13.0	18432	18432	30720	22528	18432	18432	126976
13.0- 14.0	18432	30720	22528	26624	20480	26624	145408
14.0- 15.0	20480	20480	26624	22528	26624	24576	141312
15.0- 16.0	24576	22528	26624	22528	18432	24576	139264
16.0- 17.0	22528	16384	22528	47104	22528	22528	153600
17.0- 18.0	30720	18432	24576	22528	24576	20480	141312
18.0- 19.0	20480	22528	26624	18432	22528	22528	133120
19.0- 20.0	20480	24576	26624	28672	20480	20480	141312
20.0- 21.0	20480	24576	24576	22528	20480	24576	137216

21.0- 22.0	24576	22528	24576	22528	28672	24576	147456
22.0- 23.0	24576	22528	20480	30720	22528	22528	143360
23.0- 24.0	20480	22528	24576	24576	24576	26624	143360
24.0- 25.0	18432	20480	18432	26624	24576	24576	133120
25.0- 26.0	38912	26624	16384	20480	16384	22528	141312
26.0- 27.0	22528	32768	18432	22528	24576	28672	149504
27.0- 28.0	22528	32768	22528	20480	22528	18432	139264
28.0- 29.0	20480	24576	24576	28672	26624	26624	151552
29.0- 30.0	18432	18432	24576	30720	24576	26624	143360
0.0- 30.1	**634880**	**655360**	**643072**	**948224**	**647168**	**657408**	**4186112**

Table F.1: Transfer Data on File Upload (Conventional Wireless System)

Interval (sec)	Communication Channels						Bandwidth (Kb/S)
	1	2	3	4	5	6	
0.0- 1.0	134218	167772	234881	117441	167772	184549	1006633
1.0- 2.0	167772	150995	184549	234881	134218	167772	1040187
2.0- 3.0	167772	201327	184549	184549	150995	184549	1073742
3.0- 4.0	167772	201327	167772	301990	150995	134218	1124073
4.0- 5.0	100663	117441	436208	100663	184549	167772	1107296
5.0- 6.0	100663	369099	184549	134218	167772	150995	1107296
6.0- 7.0	167772	167772	150995	251658	184549	184549	1107296
7.0- 8.0	150995	251658	150995	167772	201327	201327	1124073
8.0- 9.0	201327	201327	218104	251658	167772	184549	1224737
9.0- 10.0	167772	167772	167772	184549	167772	251658	1107296
10.0- 11.0	167772	167772	167772	301990	167772	184549	1157628
11.0- 12.0	167772	167772	167772	184549	201327	218104	1107296
12.0- 13.0	150995	150995	251658	184549	150995	150995	1040187
13.0- 14.0	150995	251658	184549	218104	167772	218104	1191182
14.0- 15.0	167772	167772	218104	184549	218104	201327	1157628
15.0- 16.0	201327	184549	218104	184549	150995	201327	1140851
16.0- 17.0	184549	134218	184549	385876	184549	184549	1258291
17.0- 18.0	251658	150995	201327	184549	201327	167772	1157628
18.0- 19.0	167772	184549	218104	150995	184549	184549	1090519
19.0- 20.0	167772	201327	218104	234881	167772	167772	1157628
20.0- 21.0	167772	201327	201327	184549	167772	201327	1124073
21.0- 22.0	201327	184549	201327	184549	234881	201327	1207960
22.0- 23.0	201327	184549	167772	251658	184549	184549	1174405
23.0- 24.0	167772	184549	201327	201327	201327	218104	1174405
24.0- 25.0	150995	167772	150995	218104	201327	201327	1090519
25.0- 26.0	318767	218104	134218	167772	134218	184549	1157628
26.0- 27.0	184549	268435	150995	184549	201327	234881	1224737
27.0- 28.0	184549	268435	184549	167772	184549	150995	1140851

28.0- 29.0	167772	201327	201327	234881	218104	218104	1241514
29.0- 30.0	150995	150995	201327	251658	201327	218104	1174405
0.0- 30.1	**172928**	**178774**	**175142**	**258105**	**176076**	**179195**	**1138431**

Table F.2: Bandwidth Allocation on File Upload (Conventional Wireless System)

Interval (sec)	Communication Channels						Transfer Data (KB)
	1	2	3	4	5	6	
0.0- 1.0	26624	18432	10240	18432	14336	18432	106496
1.0- 2.0	24576	12288	24576	16384	16384	18432	112640
2.0- 3.0	28672	32768	12288	12288	16384	12288	114688
3.0- 4.0	40960	12288	28672	16384	16384	12288	126976
4.0- 5.0	24576	20480	24576	16384	16384	20480	122880
5.0- 6.0	20480	24576	12288	12288	12288	16384	98304
6.0- 7.0	36864	40960	12288	12288	16384	12288	131072
7.0- 8.0	36864	8192	28672	12288	12288	12288	110592
8.0- 9.0	16384	28672	28672	12288	12288	12288	110592
9.0- 10.0	28672	32768	12288	12288	12288	12288	110592
10.0- 11.0	36864	36864	12288	12288	12288	16384	126976
11.0- 12.0	8192	36864	36864	4096	8192	8192	102400
12.0- 13.0	36864	36864	12288	12288	8192	12288	118784
13.0- 14.0	36864	36864	12288	8192	8192	12288	114688
14.0- 15.0	12288	32768	36864	12288	12288	12288	118784
15.0- 16.0	28672	32768	16384	12288	12288	16384	118784
16.0- 17.0	24576	24576	16384	16384	20480	20480	122880
17.0- 18.0	36864	8192	36864	8192	12288	12288	114688
18.0- 19.0	32768	16384	32768	12288	12288	16384	122880
19.0- 20.0	32768	40960	4096	10240	8192	12288	108544
20.0- 21.0	45056	40960	4096	8192	8192	8192	114688
21.0- 22.0	24576	24576	24576	24576	4096	28672	131072
22.0- 23.0	24576	36864	8192	12288	12288	12288	106496
23.0- 24.0	28672	32768	12288	8192	12288	16384	110592
24.0- 25.0	40960	40960	8192	8192	8192	8192	114688
25.0- 26.0	45056	45056	8192	8192	8192	8192	122880
26.0- 27.0	43008	45056	4096	6144	8192	8192	114688
27.0- 28.0	38912	40960	10240	8192	8192	12288	118784

28.0- 29.0	47104	4096	45056	4096	6144	8192	114688
29.0- 30.0	30720	32768	12288	12288	8192	12288	108544
30.0- 31.0	28672	32768	8192	16384	16384	16384	118784
31.0- 32.0	40960	40960	4096	8192	8192	8192	110592
32.0- 33.0	28672	12288	32768	16384	12288	16384	118784
33.0- 34.0	36864	36864	4096	4096	8192	8192	98304
34.0- 35.0	40960	45056	8192	8192	12288	8192	122880
0.0- 35.3	**475136**	**466944**	**446464**	**1404928**	**1384448**	**473088**	**4076167**

Table F.3: Transfer Data on File Upload (Proposed Wireless System)

Interval (sec)	Communication Channels						Bandwidth (Kb/S)
	1	2	3	4	5	6	
0.0- 1.0	218104	150995	83886	150995	117441	150995	872415
1.0- 2.0	201327	100663	201327	134218	134218	150995	922747
2.0- 3.0	234881	268435	100663	100663	134218	100663	939524
3.0- 4.0	335544	100663	234881	134218	134218	100663	1040187
4.0- 5.0	201327	167772	201327	134218	134218	167772	1006633
5.0- 6.0	167772	201327	100663	100663	100663	134218	805306
6.0- 7.0	301990	335544	100663	100663	134218	100663	1073742
7.0- 8.0	301990	67109	234881	100663	100663	100663	905970
8.0- 9.0	134218	234881	234881	100663	100663	100663	905970
9.0- 10.0	234881	268435	100663	100663	100663	100663	905970
10.0- 11.0	301990	301990	100663	100663	100663	134218	1040187
11.0- 12.0	67109	301990	301990	33554	67109	67109	838861
12.0- 13.0	301990	301990	100663	100663	67109	100663	973079
13.0- 14.0	301990	301990	100663	67109	67109	100663	939524
14.0- 15.0	100663	268435	301990	100663	100663	100663	973079
15.0- 16.0	234881	268435	134218	100663	100663	134218	973079
16.0- 17.0	201327	201327	134218	134218	167772	167772	1006633
17.0- 18.0	301990	67109	301990	67109	100663	100663	939524
18.0- 19.0	268435	134218	268435	100663	100663	134218	1006633
19.0- 20.0	268435	335544	33554	83886	67109	100663	889192
20.0- 21.0	369099	335544	33554	67109	67109	67109	939524
21.0- 22.0	201327	201327	201327	201327	33554	234881	1073742
22.0- 23.0	201327	301990	67109	100663	100663	100663	872415
23.0- 24.0	234881	268435	100663	67109	100663	134218	905970
24.0- 25.0	335544	335544	67109	67109	67109	67109	939524
25.0- 26.0	369099	369099	67109	67109	67109	67109	1006633
26.0- 27.0	352322	369099	33554	50332	67109	67109	939524
27.0- 28.0	318767	335544	83886	67109	67109	100663	973079

28.0- 29.0	385876	241990	369099	33554	50332	67109	939524
29.0- 30.0	0	98435	100663	100663	67109	100663	889192
30.0- 31.0	0	0	67109	134218	134218	134218	973079
31.0- 32.0	0	0	33554	67109	67109	67109	905970
32.0- 33.0	0	0	268435	134218	100663	134218	973079
33.0- 34.0	0	0	33554	33554	67109	67109	805306
34.0- 35.0	0	0	67109	67109	100663	67109	1006633
0.0- 35.3	**97195**	**95536**	**91294**	**287325**	**283059**	**96699**	**946885**

Table F.4: Bandwidth Allocation on File Upload (Proposed Wireless System)

Appendix G

Abbreviations

This appendix listed out all the abbreviations discussed and listed in this dissertation.

ACL – Agent Communication Language
ADOV – Ad hoc On Demand Distance Vector
AS – Autonomous Systems
BF – Bellman-Ford
CAIDA – Cooperative Association for Internet Data Analysis
DSR – Dynamic Source Routing
FIPA – Foundation for Intelligent Physical Agents
JADE – Java Agent DEvelopment Framework
JNI – Java Native Interface
JRE – Java Runtime Environment
JVM – Java Virtual Machine
LAN – Local Area Network
MAS – Multiagent Systems
NAT – Network Address Translation
PCI – Peripheral Component Interconnect
SPOF – Single Point Of Failure
TCP – Transmission Control Protocol
UDP – User Datagram Protocol
XML – Extensible Markup Language