CSE 4840: Internetworking Protocols Lab
Lab - 1

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1 Introduction

For this lab, there are seven scripts provided in the *examples/tutorial* folder. We run the scripts using the following command:

```
./ns3 run examples/tutorial/first
```

Here, *examples/tutorial/first* is the relative path to the *.cc* file.
If we wish to include animation in our scripts then we can use the *netanim* module. To do so, we need to add the following lines in our *.cc* file.

```
#include "ns-3/netanim-module.h"
AnimationInterface anim("180041120.xml"); //Before running the simulation add this line
```

After we run the script using ns-3 again, we will get a *.xml* file which can be loaded in NetAnim to see the animation.

2 Task 1: First

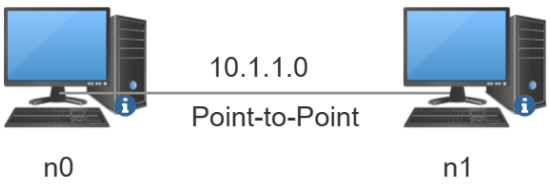


Figure 1: Network Topology of Task-1

The network topology is simple - two nodes n0 and n1 are connected using a point-to-point connection as seen in the figure. Point-to-point communication is a direct connection between two end devices which allows faster and more efficient file transfer due to the dedicated path between the nodes. The network has the address 10.1.1.0. The topology is written in the script as:

$$10.1.1.0$$

$$n0 - - - - - - - - - - - - - - - - n1$$

$$point - to - point$$

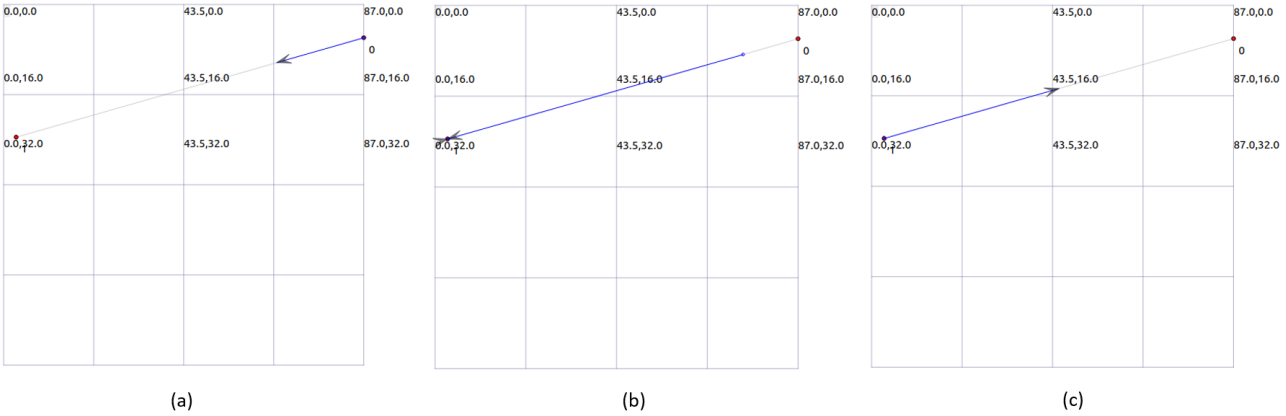


Figure 2: Screenshots of the animation of Task-1 in NetAnim: (a) The packet in the transmission medium after being sent by node-0, (b) The packet received by node-1 and preparing the send the next packet to node-0, (c) The packet sent by node-1 in the transmission medium on its way to node-0

3 Task 2: Second

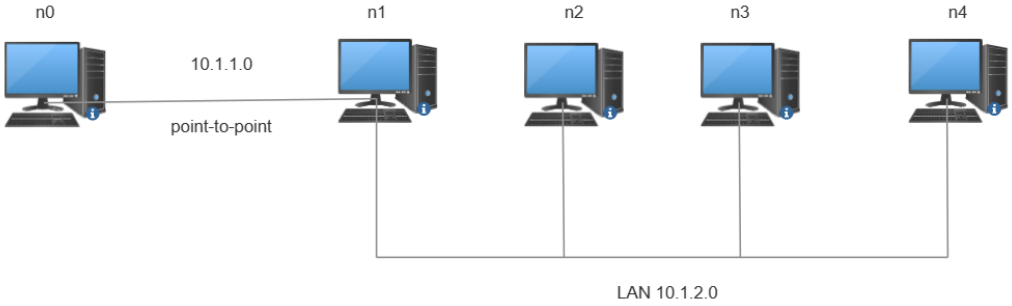


Figure 3: Network Topology of Task-2

In this topology, there are 5 nodes - from n0 to n5. n0 has a point-to-point connection with n1. The network has the address 10.1.1.0. The nodes n1, n2, n3, and n4 are connected in a Local Area Network (LAN) with the address 10.1.2.0. LAN connected multiple nodes to a common medium where the bandwidth of the medium will be shared among the nodes. The topology is written in the script as:

$$
\begin{array}{ccccccc}
 & & & 10.1.1.0 & & & \\
n0 & - - - - - - - - - - - - - - - - & n1 & & n2 & n3 & n4 \\
 & point-to-point & | & & | & | & | \\
 & & ========== & & & & \\
 & & LAN\ 10.1.2.0 & & & &
\end{array}
$$

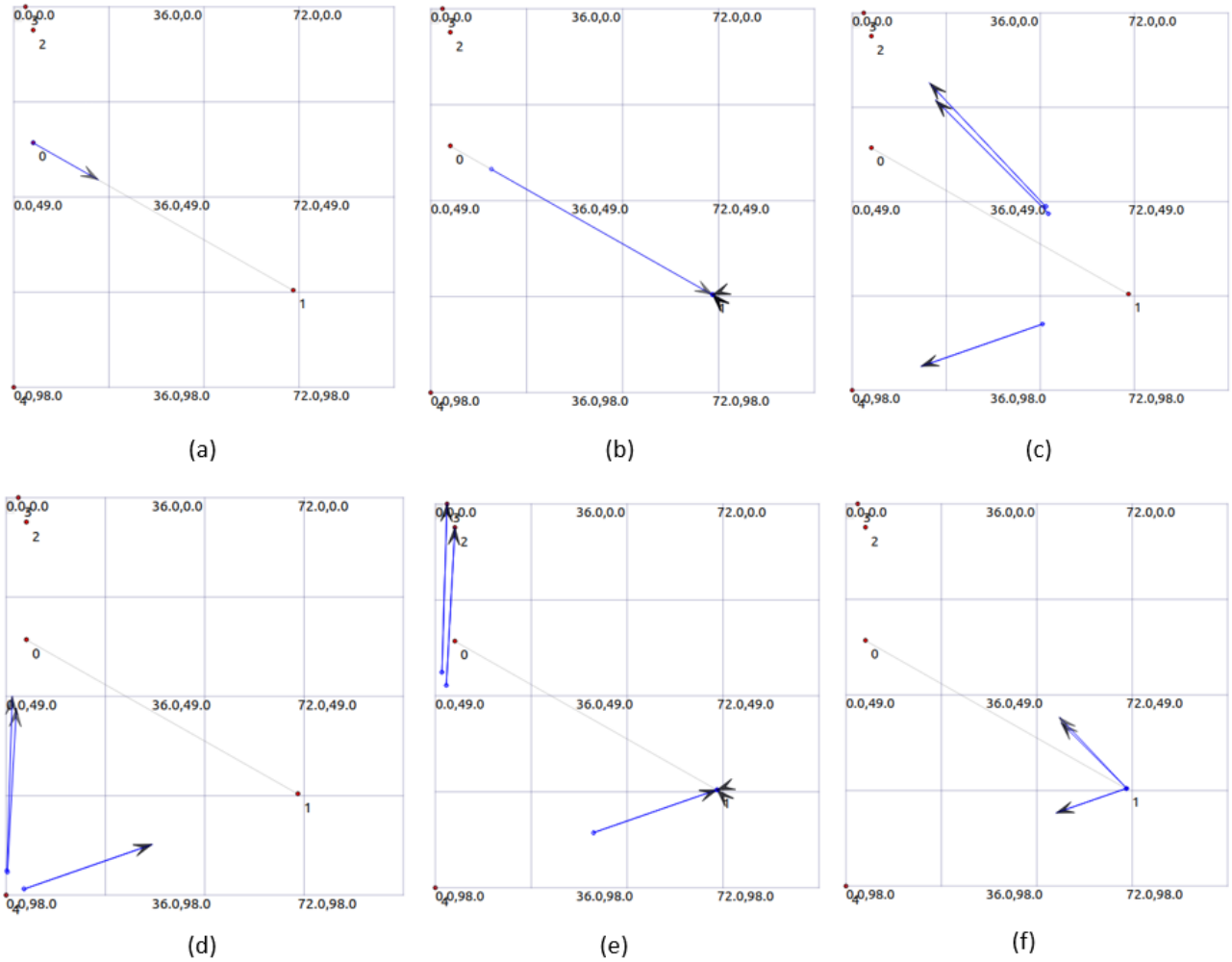


Figure 4: Screenshots of the animation of Task-2 in NetAnim: (a) Packet being sent from node-0 to node-1, (b) Packet reached node-1 and three packets are being processed to be transmitted, (c) Three packets out of delivery to node-2,3,4, (d) After receiving the packet, node-4 sends three packets to node-1,2,3, (e) Packets are received at their respective nodes, (f) Node-1 is sending packets again to node-2,3,4 like (c)

4 Task 3: Third

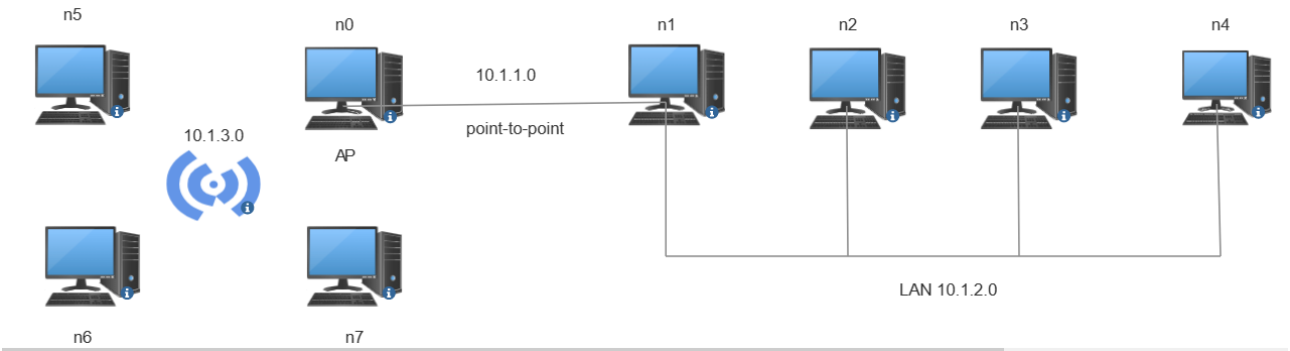
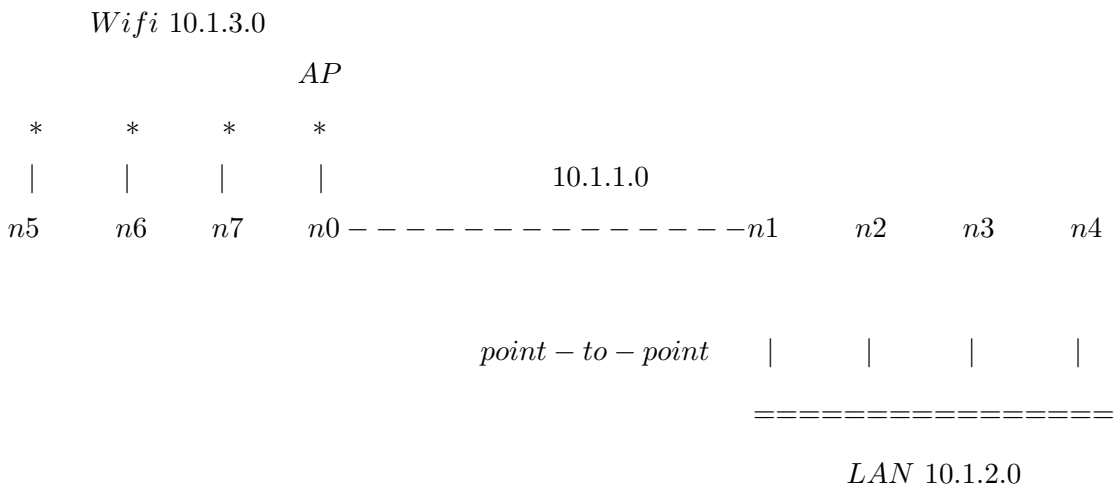


Figure 5: Network Topology of Task-3

Task-3 is an extension of task-2 where n0 is used as an access point for a WiFi network where three new nodes - n5, n6, n7 are connected. The address of the WiFi network is 10.1.3.0. The access point connects the wireless network (WiFi) to the wired network (LAN). The nodes connected to the WiFi pick the signal from the access point which is n0 to communicate with the rest of the network. The topology is written in the script as:



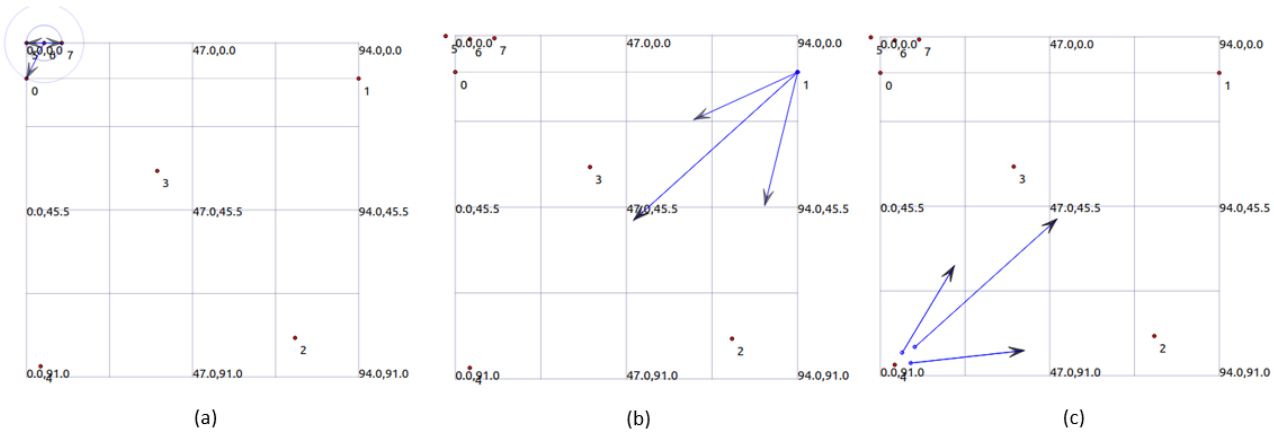


Figure 6: Screenshots of the animation of Task-3 in NetAnim: (a) n0, n5,n6, n7 exchanging packets, (b) n1 sending 3 packets to n2,n3,n4, (c) n4 sending 3 packets to n1,n2,n3

5 Task 4: Fourth

The fourth task shows us how to create an object to hook a trace. The file contains **no network topology**. As there is nothing to simulate, the generated XML file can not be animated using NetAnim.

6 Task 5: Fifth, Sixth, Seventh

The fifth, sixth and seventh tasks share the same network topology. The topology consists of two nodes in a point-to-point connection. The connection has a 5Mbps bandwidth or data rate and a 2ms delay. Both nodes use the Transmission Control Protocol (TCP) as defined in NS-3. It is a layer-4 protocol i.e. it works on the Transport Layer and is reliable. The IP address assigned to the first node is 10.1.1.1 and the second node is 10.1.1.2.

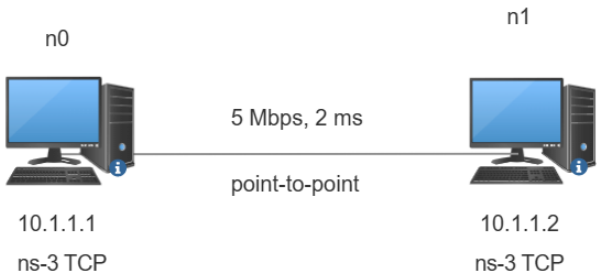


Figure 7: Network Topology of Task-5, 6, 7

The topology is written in the script as:

$$
\begin{array}{ccc}
 & node0 & node1 \\
+----------+ & + & +----------+ \\
| \quad ns-3\ TCP \quad | & | & | \quad ns-3\ TCP \quad | \\
+----------+ & + & +----------+ \\
| \quad 10.1.1.1 \quad | & | & | \quad 10.1.1.2 \quad | \\
+----------+ & + & +----------+ \\
| \quad point-to-point \quad | & | & | \quad point-to-point \quad | \\
+----------+ & + & +----------+ \\
| & & | \\
+----------+ & & +----------+ \\
 & 5Mbps, 2ms &
\end{array}
$$

The animation in NetAnim for these three tasks differs. The screenshots of the animation are described in figure- 8, 9, and 10. Although they share the same topology, the underlying mechanism of exchanging the packets is different and it can be properly visualized in the animation. For clarity the node size has been increased in figure-10.

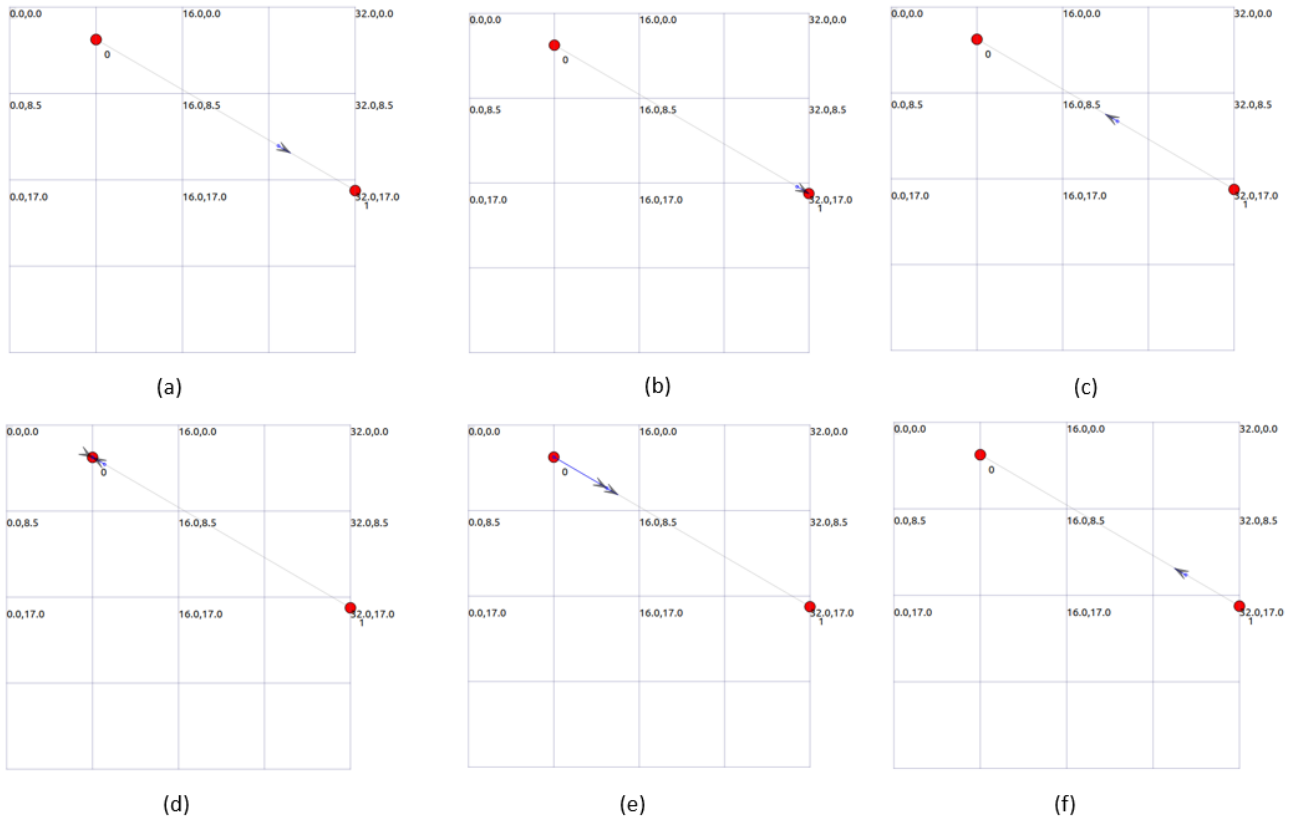


Figure 8: Screenshots of the animation of Fifth in NetAnim: (a) A packet being sent from n0 to n1, (b) n1 receiving the packet, (c) A response being sent to n0, (d) Packet received by n0 preparing to send two packets back to n1, (e) The two packets in transmission medium about to be received by n1, (f) n1 responses with another packet similar to (c)

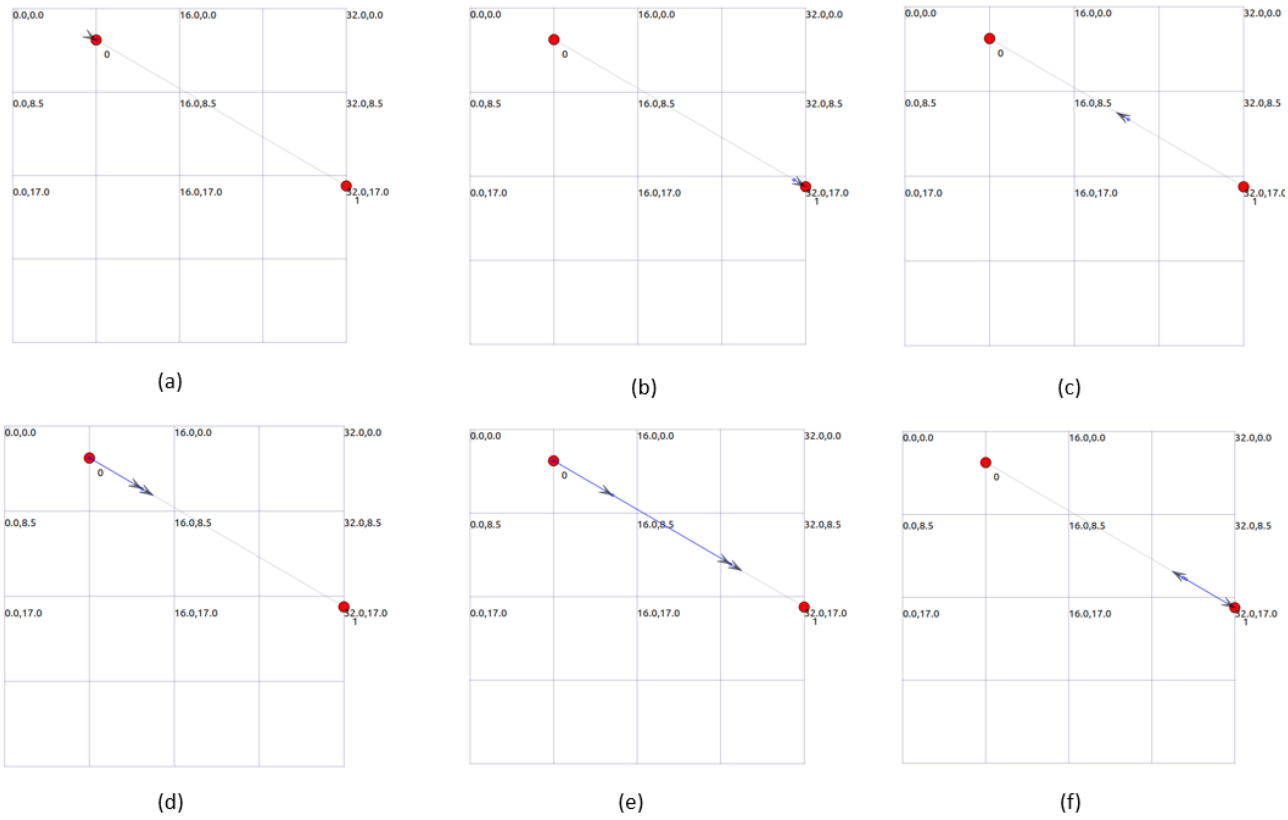


Figure 9: Screenshots of the animation of Sixth in NetAnim: (a)-(d) same as Fifth, (e) an additional packet sent to n1, (f) a response from n1 after receiving the packet

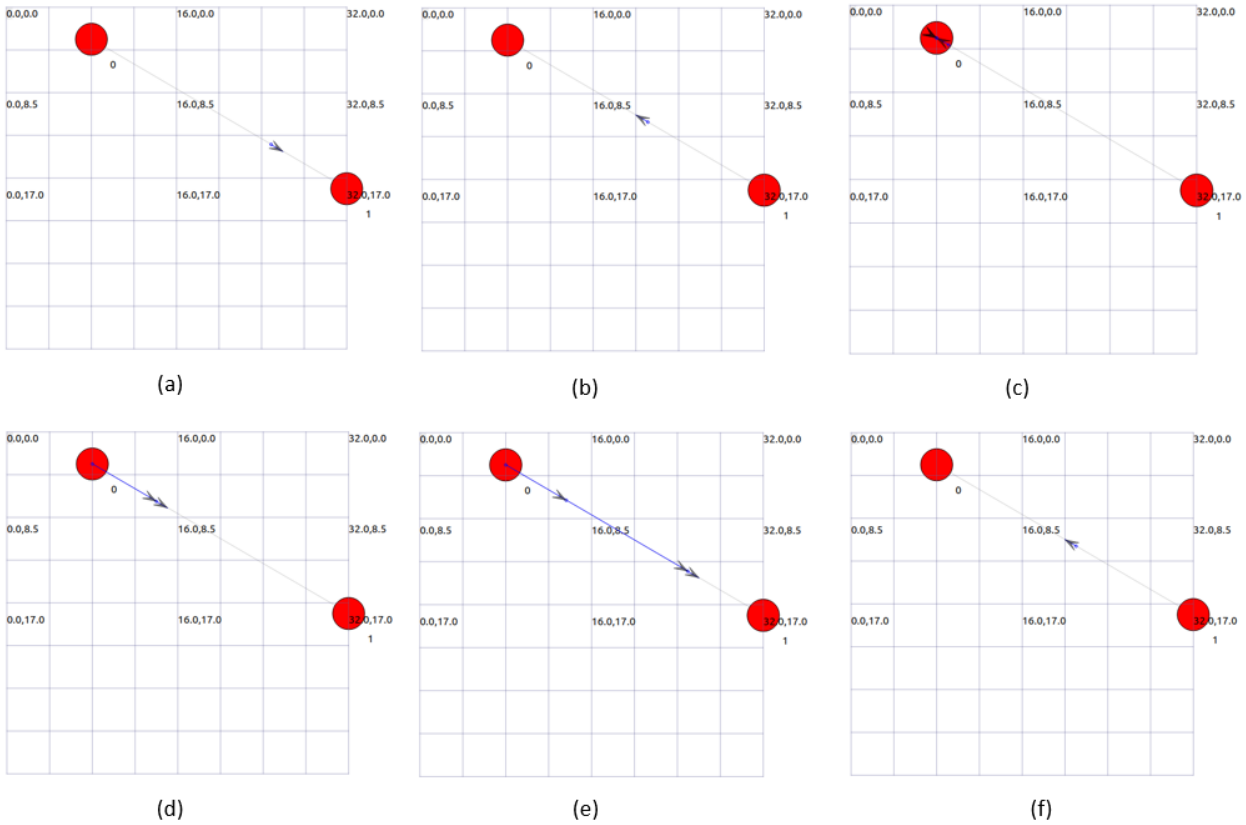


Figure 10: Screenshots of the animation of Seventh (a)-(f) same as Sixth