WiFi-Direct Simulation for INET in OMNeT++

Syphax Iskounen, **Thi Mai Trang NGUYEN** and **Sébastien Monnet**

University Pierre and Marie Curie (UPMC), France
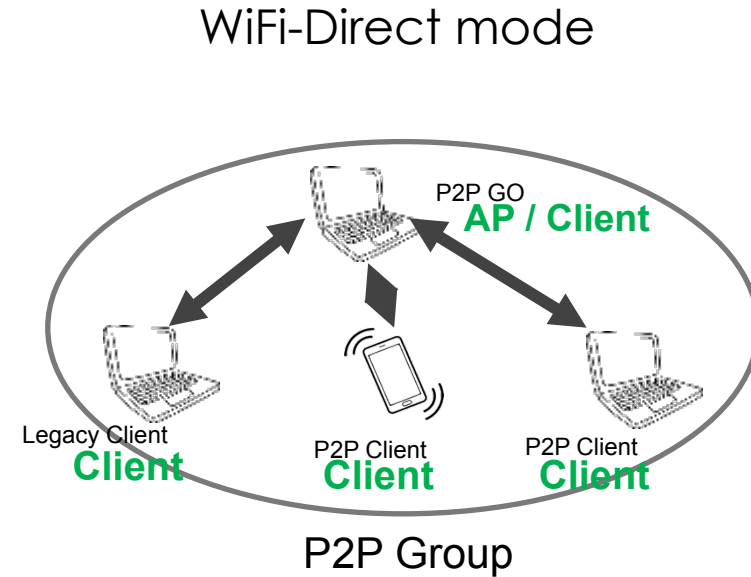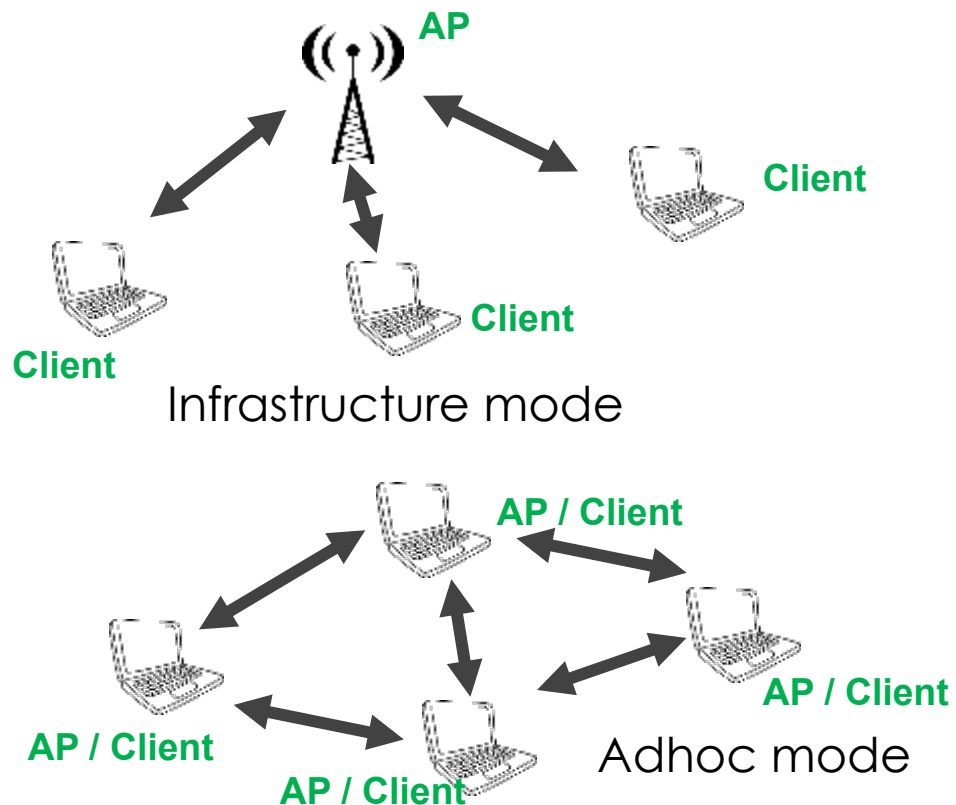Laboratoire d'Informatique de Paris 6 (LIP6)
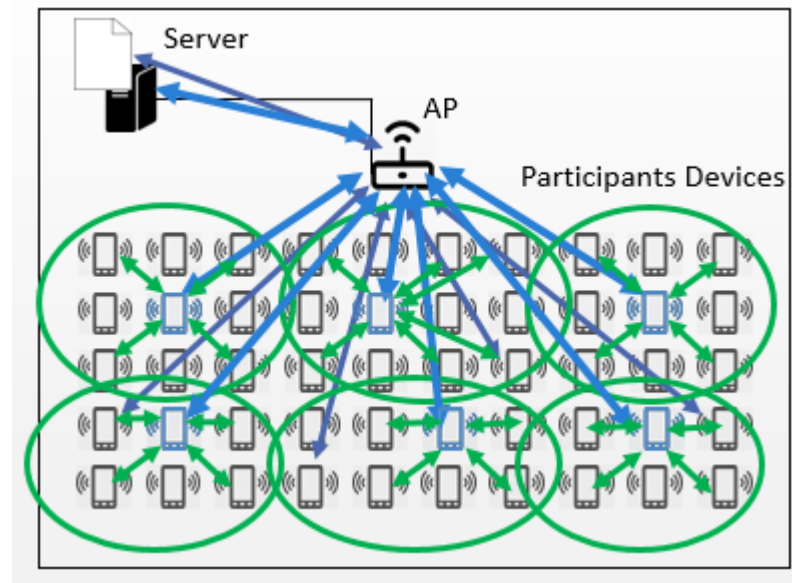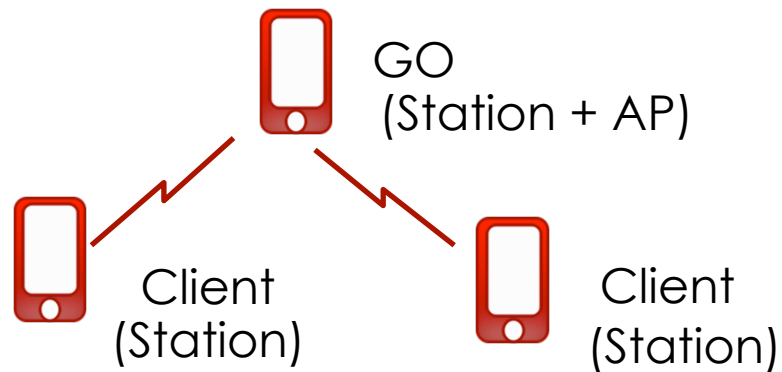
OMNeT++ COMMUNITY SUMMIT 2016

Outline

- Introduction to WiFi-Direct

- 802.11 in INET Framework

- WiFi-Direct Implementation

- Validation Tests

- Conclusion and perspectives

Introduction

- WiFi-Direct is a new operation mode in Wi-Fi networks


AP

Client

Client

Client

Infrastructure mode

AP / Client

AP / Client

AP / Client

AP / Client

Adhoc mode

WiFi-Direct mode

P2P GO
AP / Client

Legacy Client
Client

P2P Client
Client

P2P Client
Client

P2P Group

Wi-Fi Direct applications

GO
(Station + AP)

Client
(Station)

Client
(Station)
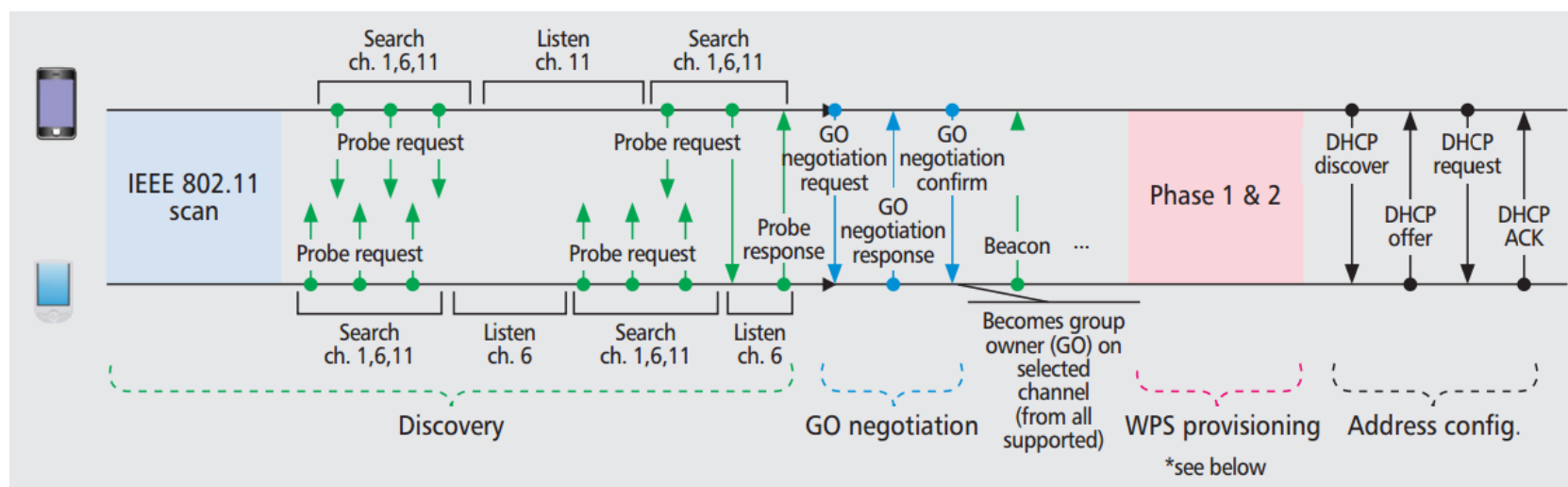

Server

AP

Participants Devices

- File exchange between smartphones
- WiFi-Direct based Device-to-device transmission in dense wireless networks
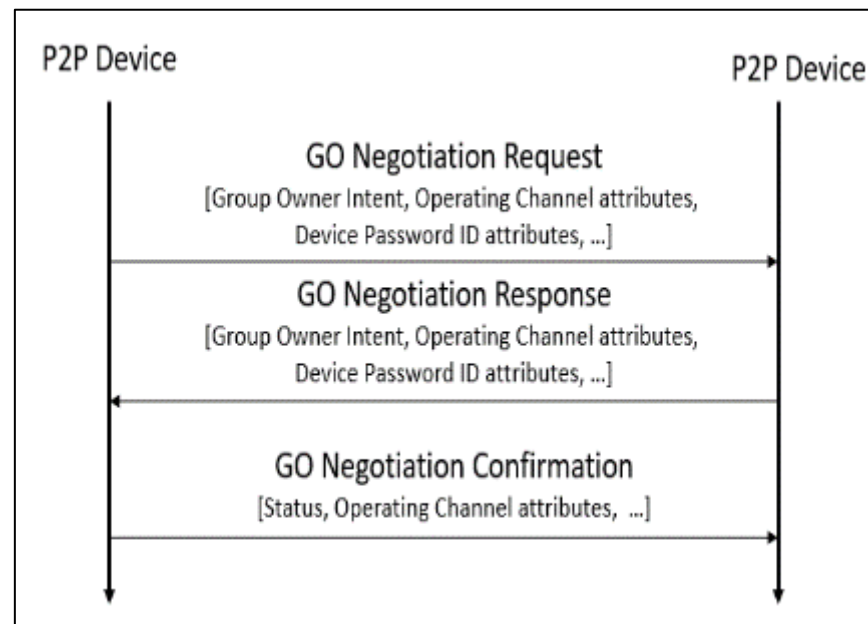
Group formation
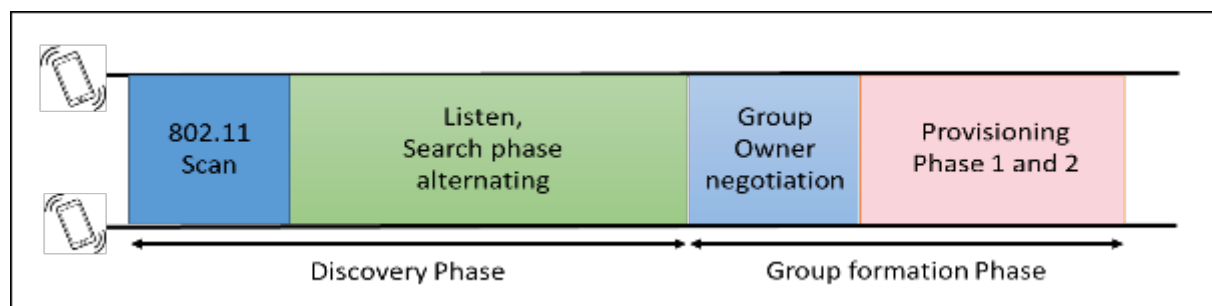
- 3 cases
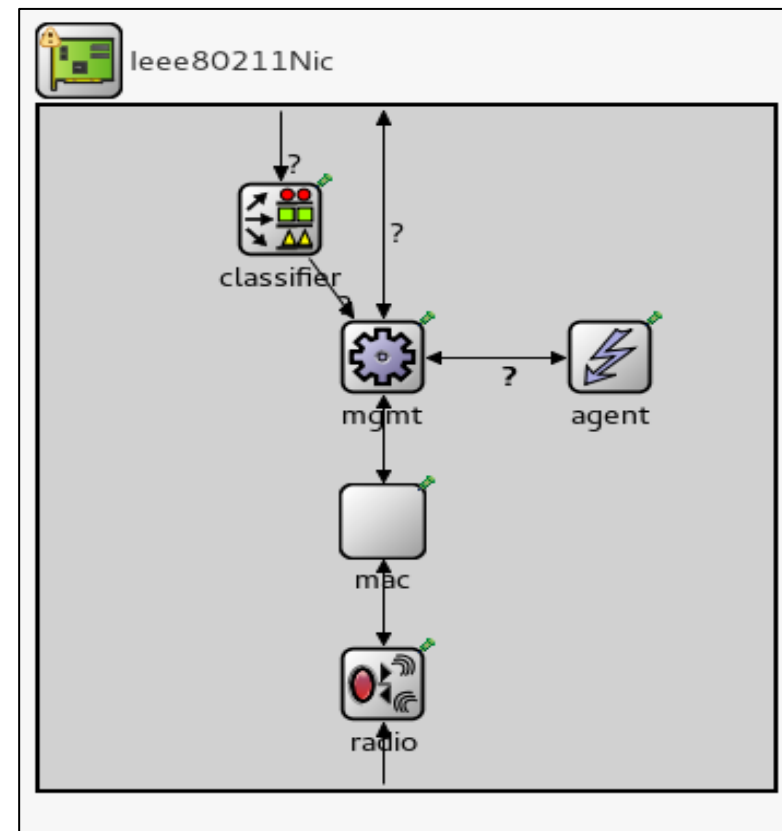 - Standard
  - Autonomous
  - Persistent

GO Negotiation

■ Device declaring the highest *GO Intent* value becomes P2P GO

802.11 in INET Framework

- 802.11 network interface card
  - Radio
    - Physical layer
  - MAC
    - CSMA/CA
  - Management
    - Encapsulation/decapsulation
    - 802.11 mode configuration
      - Station (STA) or Access Point (AP)
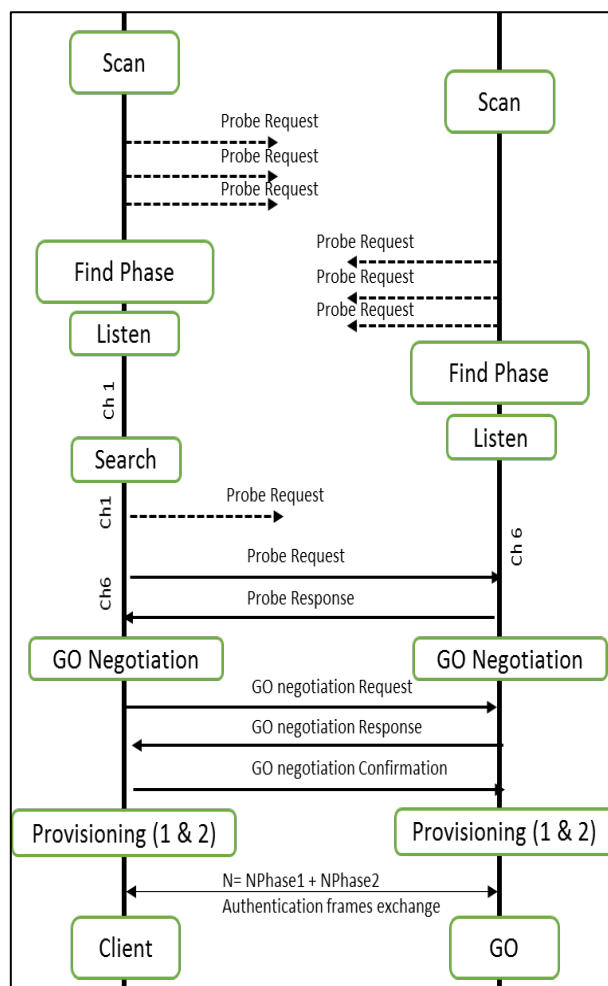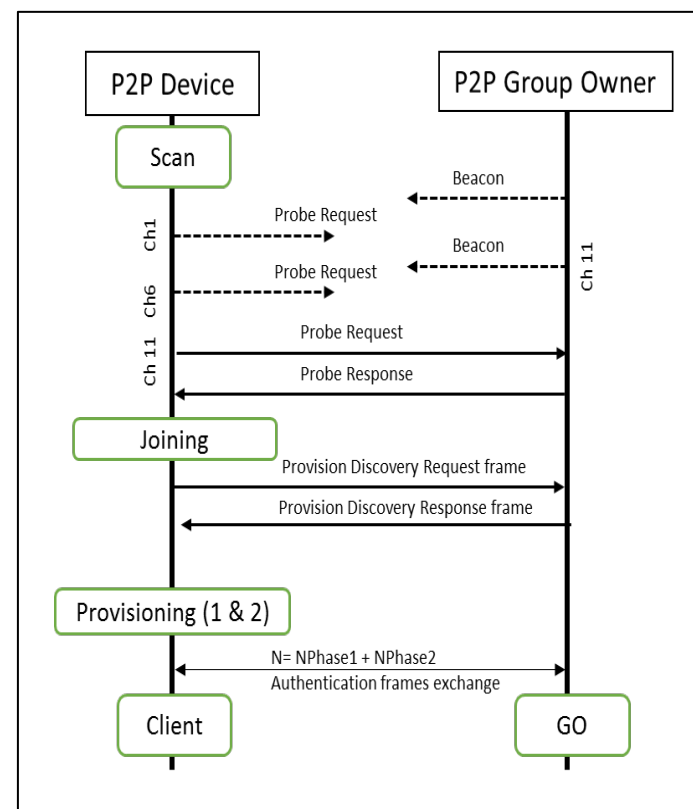   - Adhoc mode

WiFi-Direct implementation (1)

- …/inet/linklayer/ieee80211/mgmt
  - Modified
    - Ieee80211MgmtFrame.msg
    - Ieee80211MgmtBase.cc
    - Ieee80211MgmtBase.h
  - New
    - Ieee80211MgmtSTAWifiDirect.cc
    - Ieee80211MgmtSTAWifiDirect.h
    - Ieee80211MgmtSTAWifiDirect.ned

- …/inet/linklayer/ieee80211
  - Ieee80211Nic.ned
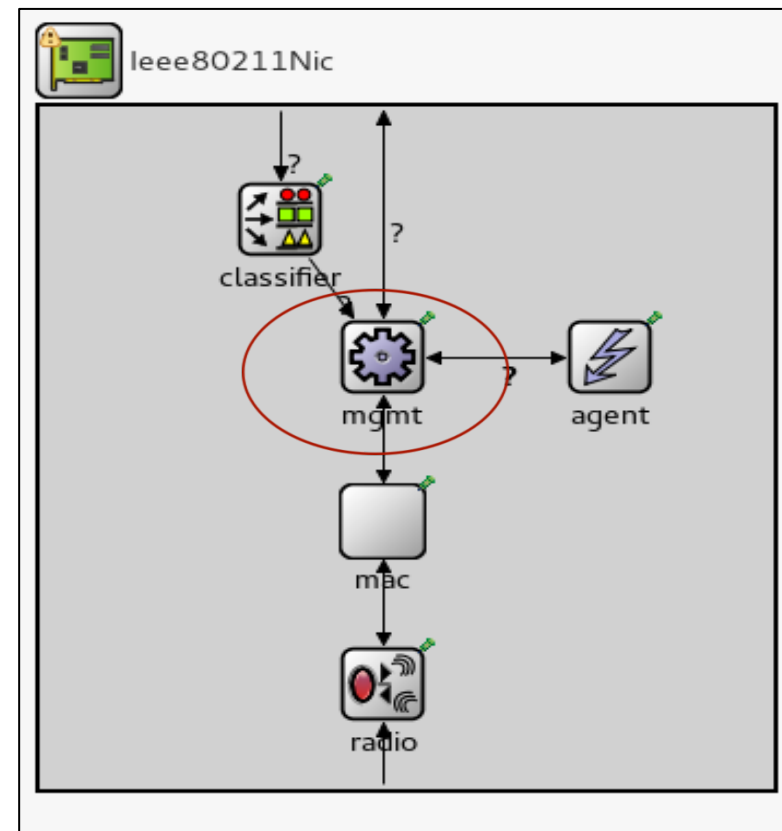
# WiFi-Direct implementation (2)
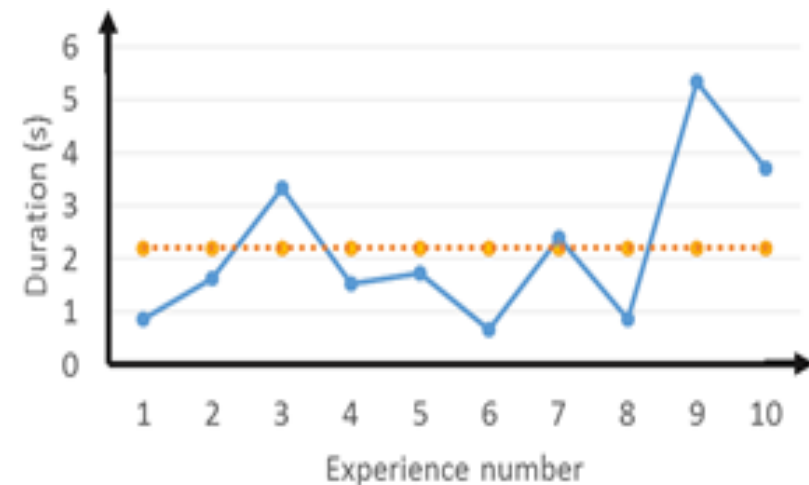

Group formation

Group joining

Validation tests

- Topology
  - 3 WiFi-Direct hosts

- Scenario 1 : Standard group formation
  - Stations start scanning
  - Finding a peer
  - GO negotiation between 2 peers
    - One becomes GO
    - The other becomes client
    - GO starts sending Beacon messages
  - The 3rd station joins the group
  - Ping for connectivity test

- Scenario 2: Autonomous group formation
  - GO is assigned by configuration in the .ini file
  - After scanning to detect the presence of GO, other hosts join the group
  - Ping for connectivity test
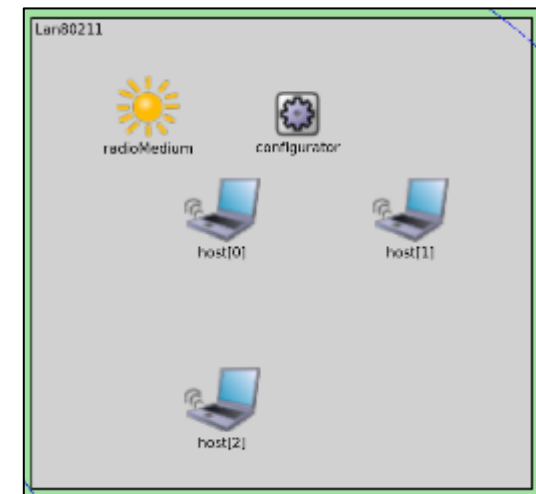
Scenario 1 : Standard group formation (1)

- Discovery Phase
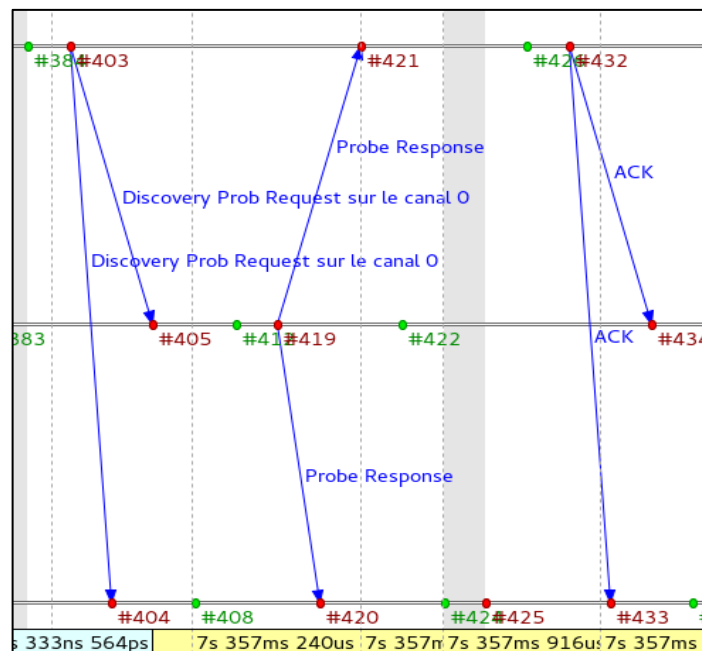
host[0] and host[1] discovers each other   Discovery time measurement

Scenario 1 : Standard group formation (2)
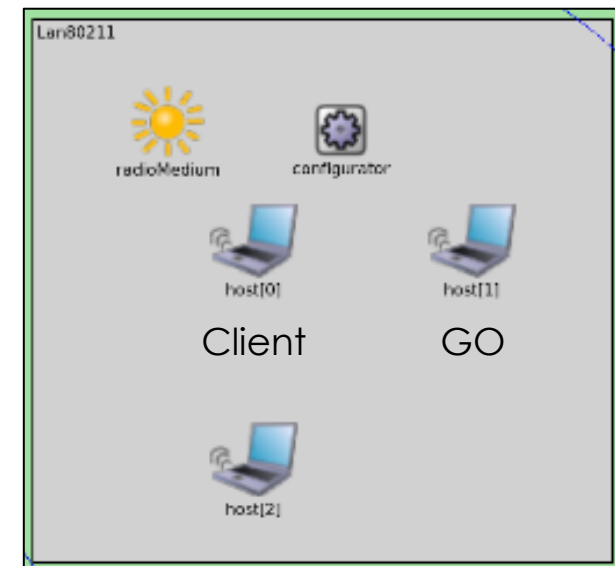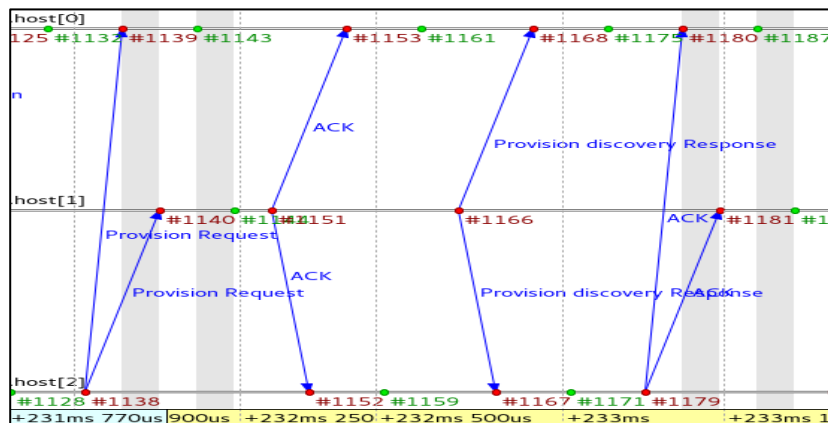
- GO Negotiation

- Provisioning phase

- After the Negotiation phase, host[1] becomes GO.


Client   GO

Scenario 1 : Standard group formation (3)

■ Group joining & connectivity test

```
#2342   9.531719516371    host[1] --> host[2]   Beacon
#2362   9.548813502304    host[0] --> host[1]   ping9
#2362   9.548813502304    host[0] --> host[2]   ping9
#2375   9.549495974034    host[1] --> host[0]   ACK
#2375   9.549495974034    host[1] --> host[2]   ACK
#2390   9.549949974034    host[1] --> host[0]   ping9
#2390   9.549949974034    host[1] --> host[2]   ping9
#2407   9.550632307598    host[2] --> host[0]   ACK
#2407   9.550632307598    host[2] --> host[1]   ACK
#2422   9.551066307598    host[2] --> host[0]   ping9-reply
#2422   9.551066307598    host[2] --> host[1]   ping9-reply
#2435   9.551748641162    host[1] --> host[0]   ACK
#2435   9.551748641162    host[1] --> host[2]   ACK
#2450   9.552122641162    host[1] --> host[0]   ping9-reply
#2450   9.552122641162    host[1] --> host[2]   ping9-reply
#2465   9.552805112892    host[0] --> host[1]   ACK
#2465   9.552805112892    host[0] --> host[2]   ACK
#2493   9.592844616388    host[1] --> host[0]   ping9
#2493   9.592844616388    host[1] --> host[2]   ping9
#2510   9.593527088118    host[0] --> host[1]   ACK
#2510   9.593527088118    host[0] --> host[2]   ACK
#2525   9.593961088118    host[0] --> host[1]   ping9-reply
#2525   9.593961088118    host[0] --> host[2]   ping9-reply
#2540   9.594643559848    host[1] --> host[0]   ACK
#2540   9.594643559848    host[1] --> host[2]   ACK
#2561   9.631719516371    host[1] --> host[0]   Beacon
```

- host[2] joins the group
- When host[0] sends a Ping to host[2], host[1] plays the role of Access Point and relays the message.
- When host[1] sends a Ping to host[0], the communication is direct.

Lan80211

radioMedium   configurator

host[0]   host[1]
Client   GO

host[2] Client
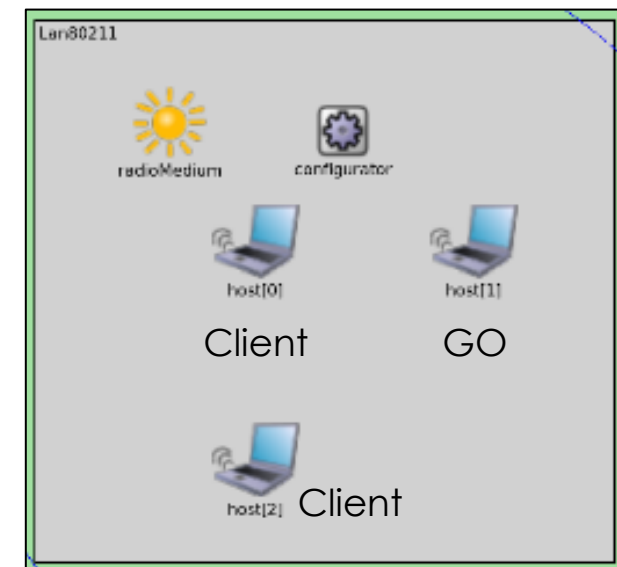
Scenario 2 : Autonomous group formation (1)

- host[0] is configured to be GO of the group in the .ini file

```
# ping app host[0] pinged by Host[1]
**.numPingApps = 1
*.host[1].pingApp[0].destAddr = "host[0]"
*.host[1].pingApp[0].sendInterval = 1s
# ping app host[1] pinged by host[2]
*.host[2].pingApp[0].destAddr = "host[1]"
*.host[2].pingApp[0].sendInterval = 1s
#Configure the P2P Group
**.host[0].wlan[0].mgmt.WiFiDirectUsed=true
**.host[0].wlan[0].mgmt.WiFiDirectGO=true
**.host[0].wlan[0].mgmt.strGroup="Groupe Wifi Direct"

**.host[1].wlan[0].mgmt.WiFiDirectUsed=true
**.host[1].wlan[0].mgmt.WiFiDirectGO=false
**.host[1].wlan[0].mgmt.strGroup="Groupe Wifi Direct"

**.host[2].wlan[0].mgmt.WiFiDirectUsed=true
**.host[2].wlan[0].mgmt.WiFiDirectGO=false
**.host[2].wlan[0].mgmt.strGroup="Groupe Wifi Direct"
```

Scenario 2 : Autonomous group formation (2)

- When host[2] pings host[1], the GO (host[0]) plays the role of AP and relays the message
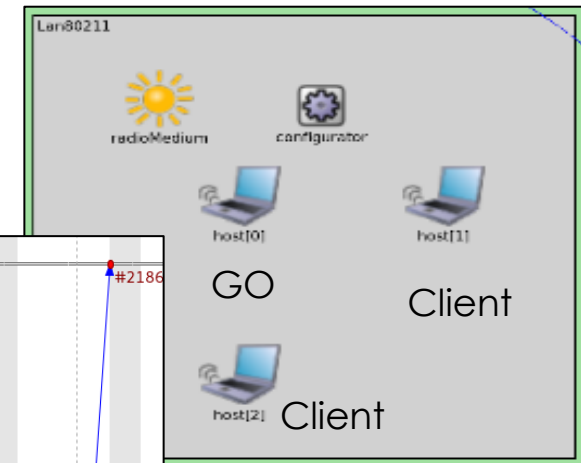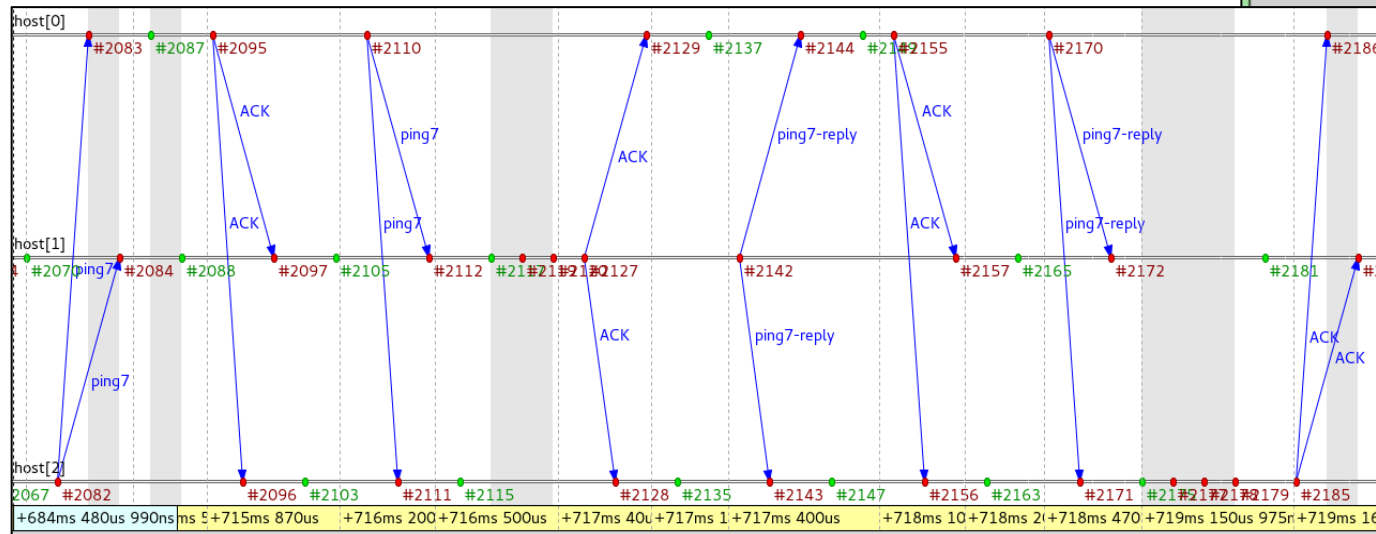
Conclusion

- WiFi-Direct is a new communication mode for 802.11 networks and widely used by smartphones or tablets

- We have implemented the WiFi-Direct protocol in the INET framework of OMNeT++ following the Technical Standard Specification defined by Wi-Fi Alliance

- This implementation can be used for research on protocol design and performance evaluation of WiFi-Direct based networks (e.g. Device-to-Device dense wireless networks)

Thank you !

Questions ?