

WiFi-Direct Simulation for INET in OMNeT++

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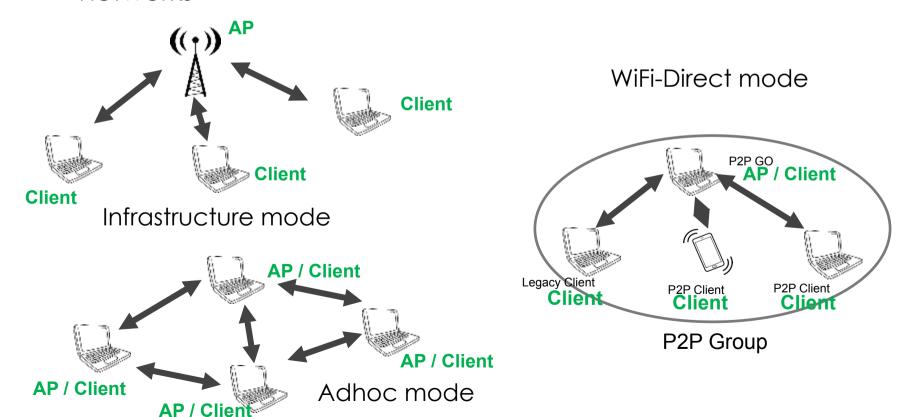
OMNET++ COMMUNITY SUMMIT 2016

Outline

- Introduction to WiFi-Direct
- 802.11 in INET Framework
- WiFi-Direct Implementation
- Validation Tests
- Conclusion and perspectives

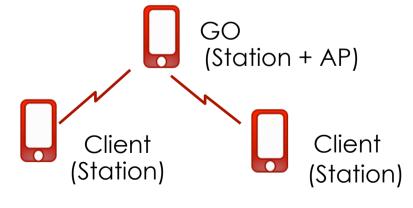
Introduction

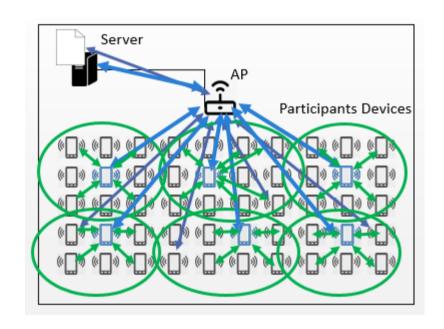
WiFi-Direct is a new operation mode in Wi-Fi networks



Wi-Fi Direct applications

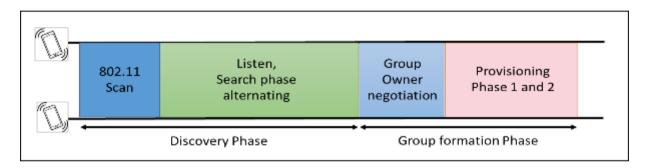




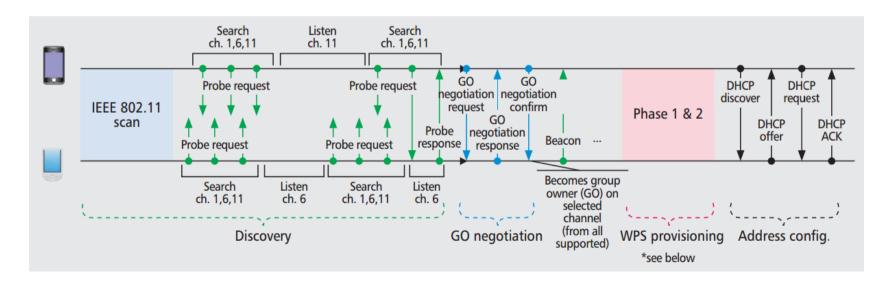


- File exchange between smartphones
- WiFi-Direct based Device-to-device transmission in dense wireless networks

Group formation

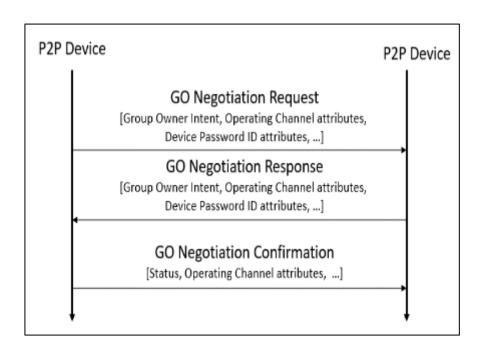


- 3 cases
 - Standard
 - Autonomous
 - Persistent



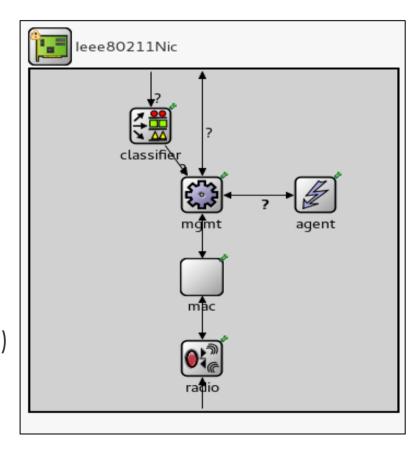
GO Negotiation

■ Device declaring the highest GO Intent value becomes P2P GO



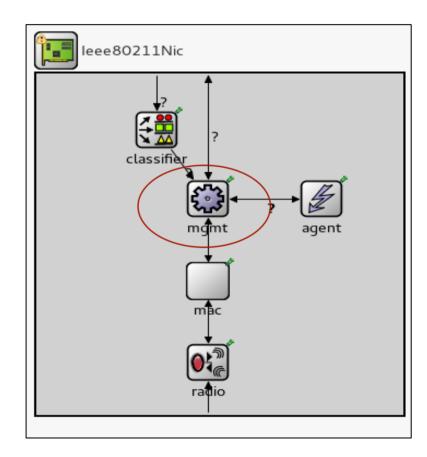
802.11 in INET Framework

- 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

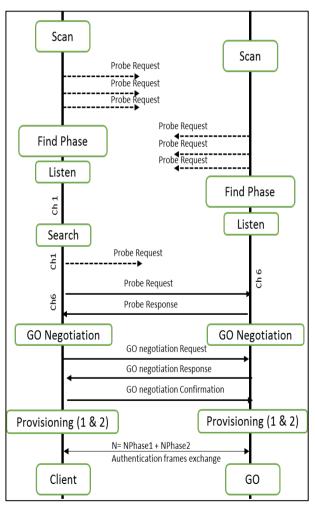


WiFi-Direct implementation (1)

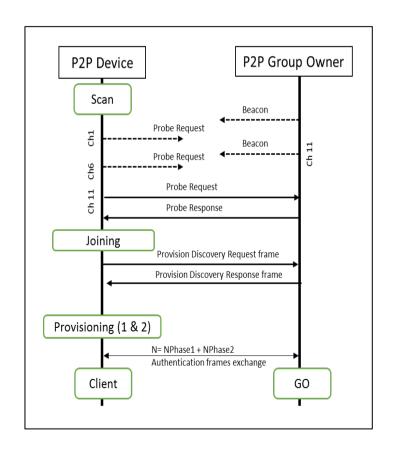
- .../inet/linklayer/ieee80211/mgmt
 - Modified
 - leee80211MgmtFrame.msg
 - leee80211MgmtBase.cc
 - leee80211MgmtBase.h
 - New
 - leee80211MgmtSTAWifiDirect.cc
 - leee80211MgmtSTAWifiDirect.h
 - leee80211MgmtSTAWifiDirect.ned
- .../inet/linklayer/ieee80211
 - leee80211Nic.ned



WiFi-Direct implementation (2)



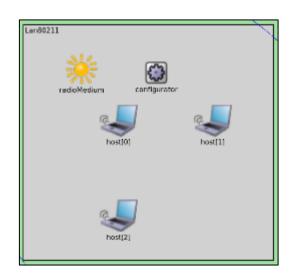
Group formation



Group joining

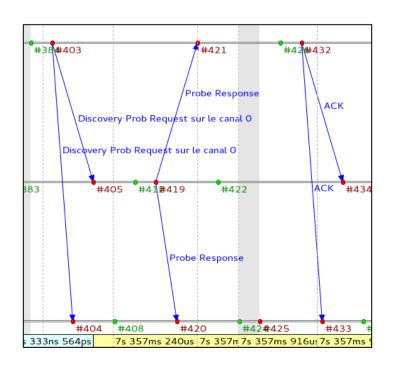
Validation tests

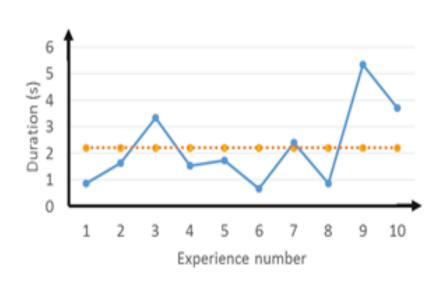
- Topology
 - 3 WiFi-Direct hosts
- Scenario 1 : Standard group formation
 - Stations start scanning
 - Finding a peer
 - GO negotiation between 2 peers
 - One becomes GO
 - The other becomes client
 - GO starts sending Beacon messages
 - The 3rd station joins the group
 - Ping for connectivity test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





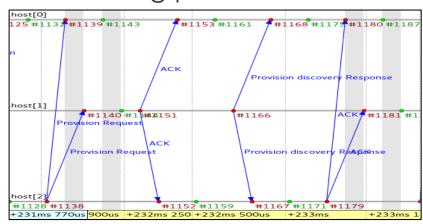
host[0] and host[1] discovers each other Discovery time measurement

Scenario 1: Standard group formation (2)

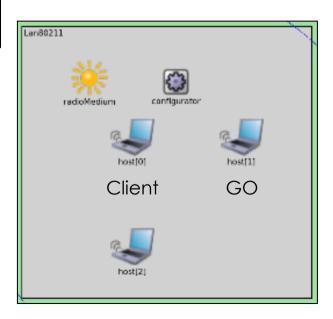
GO Negotiation

	0110022001010	HOSELEJ - HOSELEJ	Tiert
#288	6.40348094346	host[1]> host[0]	GO Negotiation Request Frame
#288	6.40348094346	host[1]> host[2]	GO Negotiation Request Frame
#301	6.40379541519	host[0]> host[1]	ACK
#301	6.40379541519	host[0]> host[2]	ACK
#316	6.40414941519	host[0]> host[1]	GO Negotiation Response Frame
#316	6.40414941519	host[0]> host[2]	GO Negotiation Response Frame
#329	6.40446388692	host[1]> host[0]	ACK
#329	6.40446388692	host[1]> host[2]	ACK
#374	6.405726554048	host[1]> host[0]	GO Negotiation Confirmation Frame
#374	6.405726554048	host[1]> host[2]	GO Negotiation Confirmation Frame
#386	6.406041025778	host[0]> host[1]	ACK
#386	6.406041025778	host[0]> host[2]	ACK
#414	6.431719516371	host[1]> host[0]	Beacon
#414	6.431719516371	host[1]> host[2]	Beacon

Provisioning phase



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

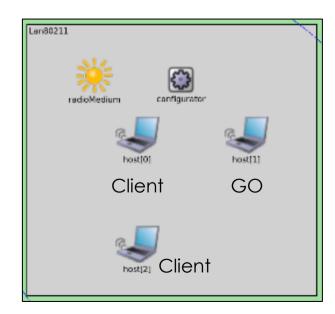


Scenario 1: Standard group formation (3)

Group joining & connectivity test

#2342 9.531/195163/1 host[1]> host[2] Beacon #2362 9.548813502304 host[0]> host[1] ping9 #2375 9.549495974034 host[1]> host[0] ACK #2375 9.549495974034 host[1]> host[0] ACK #2390 9.549949974034 host[1]> host[0] ping9 #2407 9.550632307598 host[1]> host[0] ping9 #2407 9.550632307598 host[2]> host[1] ACK #2422 9.551066307598 host[2]> host[1] ACK #2422 9.551066307598 host[2]> host[1] ping9-reply #2435 9.551748641162 host[1]> host[0] ACK #2435 9.551748641162 host[1]> host[0] ACK #2436 9.552122641162 host[1]> host[0] ACK #2450 9.552122641162 host[1]> host[0] ping9-reply #2450 9.552122641162 host[1]> host[0] ping9-reply #2465 9.552805112892 host[0]> host[0] ping9-reply #2465 9.552805112892 host[0]> host[1] ACK #2493 9.592844616388 host[1]> host[0] ping9 #2510 9.593527088118 host[0]> host[1] ACK #2525 9.593961088118 host[0]> host[1] ACK #2526 9.594643559848 host[1]> host[0] ping9-reply #2540 9.594643559848 host[1]> host[0] ACK #2540 9.594643559848 host[1]> host[0] Beacon				
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#2465 9.552805112892 host[0]> host[2] ACK #2493 9.592844616388 host[1]> host[0] ping9 #2510 9.593527088118 host[0]> host[1] ACK #2510 9.593527088118 host[0]> host[1] ACK #2525 9.593961088118 host[0]> host[1] ping9-reply #2525 9.593961088118 host[0]> host[1] ping9-reply #2526 9.593961088118 host[0]> host[1] ping9-reply #2527 9.593961088118 host[0]> host[1] ACK #2528 9.593961088118 host[1]> 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				
#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 #2526 9.593961088118 host[0]> host[2] ping9-reply #2540 9.594643559848 host[1]> host[0] ACK #2540 9.594643559848 host[1]> host[2] ACK				
#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				
#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		01002011020000		
#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				
#25259.593961088118		21222221000220		
#2540 9.594643559848 host[1]> host[0] ACK #2540 9.594643559848 host[1]> host[2] ACK				
#2540 9.594643559848 host[1]> host[2] ACK		01000002000220		
#2561 9.631719516371 host[1]> host[0] Beacon		21221012222010		
	#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.



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.WiFiDirectG0=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

#2112 #21#21#91#2127

#2111 #2115

ACK

#2128 #2135

#2129 #2137

#2144 #21#2155

ing7-reply

#2142

ping7-reply

#2143 #2147

#2170

#2157 #2165

#2156 #2163

ping7-reply

+718ms 10+718ms 2(+718ms 470 +719ms 150us 975r+719ms 16

#2171 #21#21#21#2179 #2185

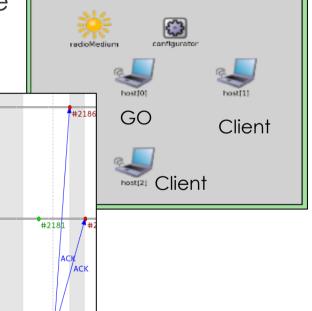
#2083 #2087 #2095

#207 ping 7 #2084 #2088

#2110

#2097 #2105

#2096 #2103



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?