Wifi 802.11n Support in Linux

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IEEE Std 802.11n® - 2009

- October 2009 IEEE approved and published the 802.11n
- High throughput extension to the 802.11 standard
- Wireless adapters can achieve throughput up to 300 Mbps
- Physical layer data rates of 600 Mbps

Overview

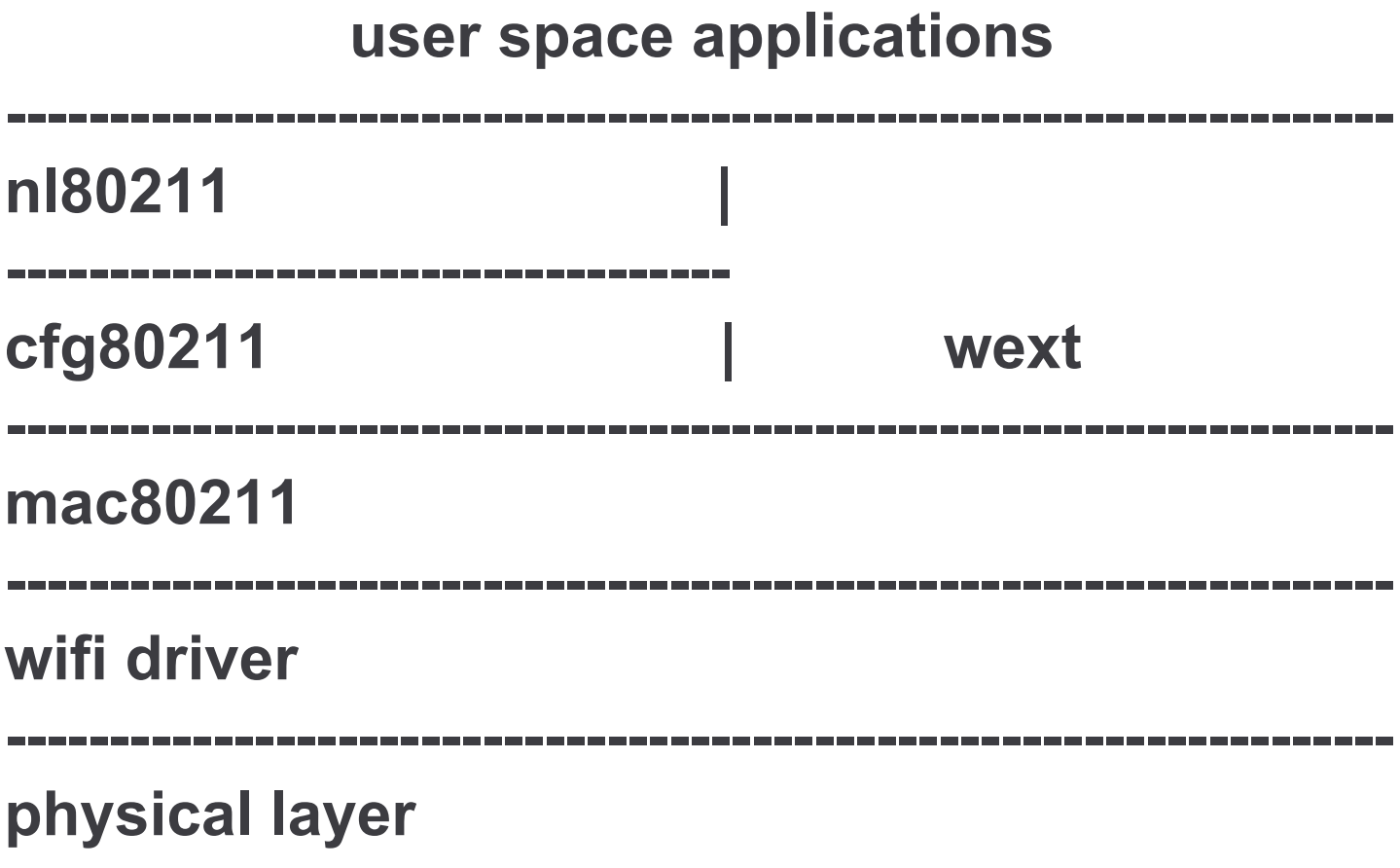
- Features
- Implementation
- Deployment
- Troubleshooting

Features

Overview of Features

- Physical layer diversity techniques
- Channel bonding
- Frame aggregation

Overview of Features



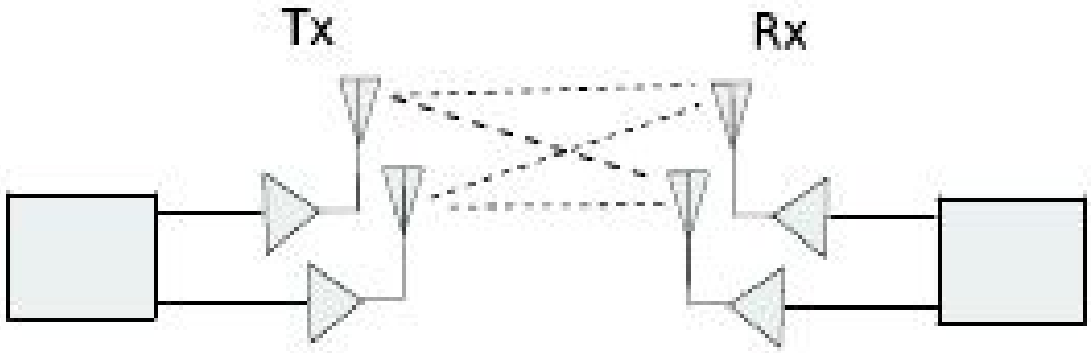
Features

Physical Layer Diversity Techniques

- Radio sending/receiving with multiple antennas
- Multiple-input and multiple-output (MIMO)
- Spatial multiplexing
- Maximum Ratio Combining (MRC)
- Improved Signal to Noise Ratio (SNR)

Features

Physical Layer Diversity Techniques



Features
Channel Bonding

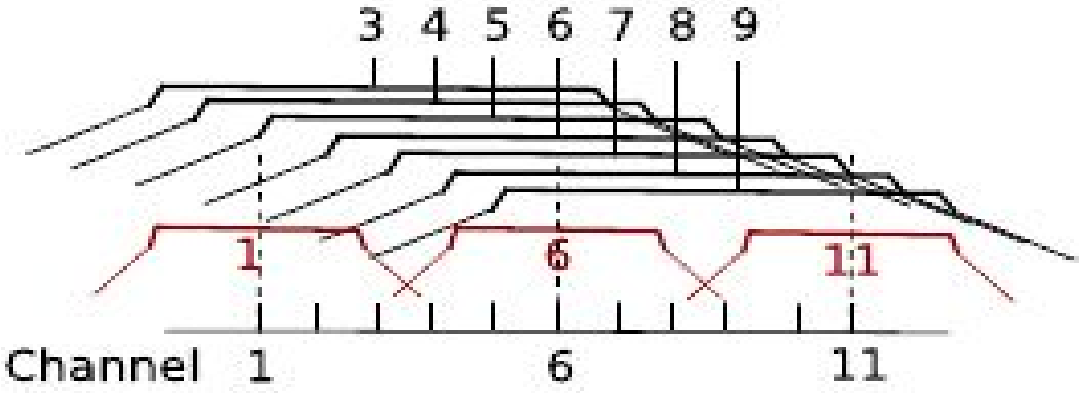
- Single channel is 20MHz in width
- Two bonded channels are 40MHz wide
- Both in 2.4GHz and 5GHz spectrum
- Limited number of non-overlapping channels in the 2.4GHz band (1,6,11)

Features
Channel Bonding

- Channels in 2.4 GHz with 22MHz bandwidth 802.11 b/g/n
- Only channels 1,6,11 without overlap

Channel	Frequency (MHz)
1	2412
2	2417
...	
14	2484

Features
Channel Bonding



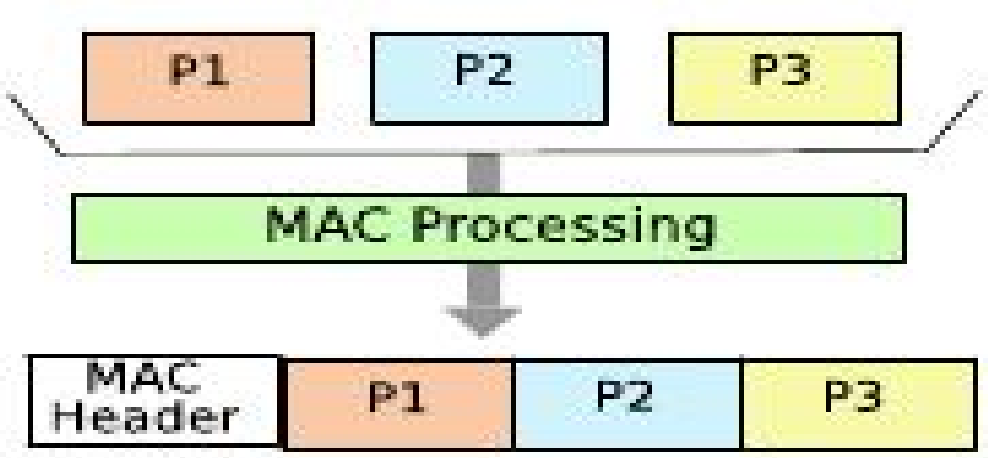
Features
Channel Bonding

- Channels in 5 GHz with 20/40MHz bandwidth 802.11 a/n
- 40 channels in the frequency range 4915 – 5825 (Mhz)
- Many different restrictions
- Countries apply their own rules

Features
Frame Aggregation

- Media Access Control (MAC)
- Transmit more data frames with “Block ACK”
- Burst
- Reduced overhead

Features
Frame Aggregation



Features
Summary

- 600Mbit/s physical transfer rate
- More antennas
- Max. 4 spatial streams using a 40MHz-wide channel
- Preferably in 5GHz band

Implementation

Overview of Implementation

- kernel.org
- linuxwireless.org
- New core mac80211 and cfg80211 components
- In-kernel nl80211 configuration interface
- nl80211 user-space applications

Implementation
Hardware

- Physical layer (PHY) implemented in the adapter
- Firmware delivered by the producer
- http://linuxwireless.org/en/users/Devices/
- http://intellinuxwireless.org/

Implementation
kernel.org

- Source code development trees linux/kernel/git/pub/scm
- wireless-testing - On-going wireless integration tree
- iwlwifi - Intel Wireless WiFi Link driver
- net/wireless
- driver/net/wireless

Implementation
wireless-testing

- linuxwireless.org
- mac80211 subsystem for SoftMAC wireless devices
- cfg80211 new Linux wireless configuration API
- nl80211 new 802.11 netlink interface public header

Implementation
cfg80211

- Driver for wifi adapter can use cfg80211 operation callbacks and fill in the wiphy struct to store the device capabilities
- Bridges userspace and drivers

Implementation
nl80211 user-space applications

- Intended to replace Wireless-Extensions used by
- iw – manipulate configuration of wireless devices
- crda – central regulatory domain agent
- hostapd – AP implentation with authentication
- wpa_supplicant (with -Dnl80211)

Deployment

Overview of Deployment

- iw utility to manipulate and configure wireless devices
- crda central regulatory domain agent
- wireless regulatory database
- changes to the configuration of openSUSE

Deployment
iw utility

Can show and manipulate objects

- **phy – physical layer of the device**
- **dev – network interface**
- **reg – regulatory database settings**

Deployment

iw utility can show/manipulate physical layer

```
# iw phy
<snip>
Frequencies:
* 2412 MHz [1] (15.0 dBm)
* 2417 MHz [2] (15.0 dBm)
* 2422 MHz [3] (15.0 dBm)
* 2427 MHz [4] (15.0 dBm)
* 2432 MHz [5] (15.0 dBm)
* 2437 MHz [6] (15.0 dBm)
* 2442 MHz [7] (15.0 dBm)
* 2447 MHz [8] (15.0 dBm)
* 2452 MHz [9] (15.0 dBm)
* 2457 MHz [10] (15.0 dBm)
* 2462 MHz [11] (15.0 dBm)
* 2467 MHz [12] (15.0 dBm) (passive scanning, no IBSS)
* 2472 MHz [13] (15.0 dBm) (passive scanning, no IBSS)
<snip>
```

Deployment

iw utility can manipulate devices

```
# iw dev
phy#0
Interface wlan0
ifindex 3
type managed
```

Deployment

iw utility can manipulate regulatory settings

```
# iw reg set DE
# iw reg get
country DE:
        (2400 - 2483 @ 40), (N/A, 20)
        (5150 - 5350 @ 40), (N/A, 20), NO-OUTDOOR, DFS
        (5470 - 5725 @ 40), (N/A, 26), NO-OUTDOOR, DFS
```

Deployment

crda central regulatory domain agent

- intended to be used by udev scripts
- triggered by the wireless kernel subsystem
- regulatory domain is read by crda from the regulatory.bin file

```
> cat /lib/udev/rules.d/85-regulatory.rules
KERNEL=="regulatory*", ACTION=="change", SUBSYSTEM=="platform",
    RUN+="/sbin/crda"
```

Deployment
wireless regulatory database

- wireless-regdb.rpm
- Provides regulatory.bin file
- wireless.kernel.org/download/wireless-regdb/
- Integrity of regulatory file is ensured by signing

Deployment
changes to the configuration of openSUSE

- /etc/sysconfig/network/config

- WIRELESS_WPA_DRIVER='wext' by default
  will be replaced with
- WIRELESS_WPA_DRIVER='nl80211'
  for wlan drivers that are nl80211 ready

- WIRELESS_REGULATORY_DOMAIN=''
- Yast2 network changes

Deployment

summary of changes in the user-space

g-standard	n-standard
iwconfig	iw
wpa_supplicant -D wext	wpa_supplicant -D nl80211
	crda
	wireless-regdb

Troubleshooting

Overview of Troubleshooting

- NetworkManager, wpa_supplicant, ifup/ifdown
- Interface setup to sniff the packets
- wireshark
- bugzilla.novell.com

Troubleshooting
NetworkManager, wpa_supplicant, ifup/ifdown

- en.opensuse.org/SDB:Tracking_down_wireless_problems
- Try to reduce the complexity and localize the problem

- /var/log/NetworkManager
- /var/log/wpa_supplicant
- /var/log/messages

Troubleshooting
Set debug options

- Wlan driver options
  > modinfo iwlagn | grep parm

- Set debug option
  > cat /etc/modprobe.d/50-iwlagn.conf
  options iwlagn debug=0xffffffff

Troubleshooting

Interface setup to sniff the packets

```
> iw dev wlan0 del
> iw phy phy0 interface add mon0 type monitor
> iw dev mon0 info
> ifconfig mon0 up
> tcpdump -i mon0 -w dump
```

Troubleshooting
wireshark

- wireshark.rpm

> wireshark dump

Troubleshooting

bugzilla.novell.com

openSUSE
bug reports can be posted to

bugzilla.novell.com

Have Fun !