Band Steering optimizes Automotive WLAN User Experience

Cars: Home entertainment on wheels

Users have become used to a media rich, on-demand, always connected environment in their homes…

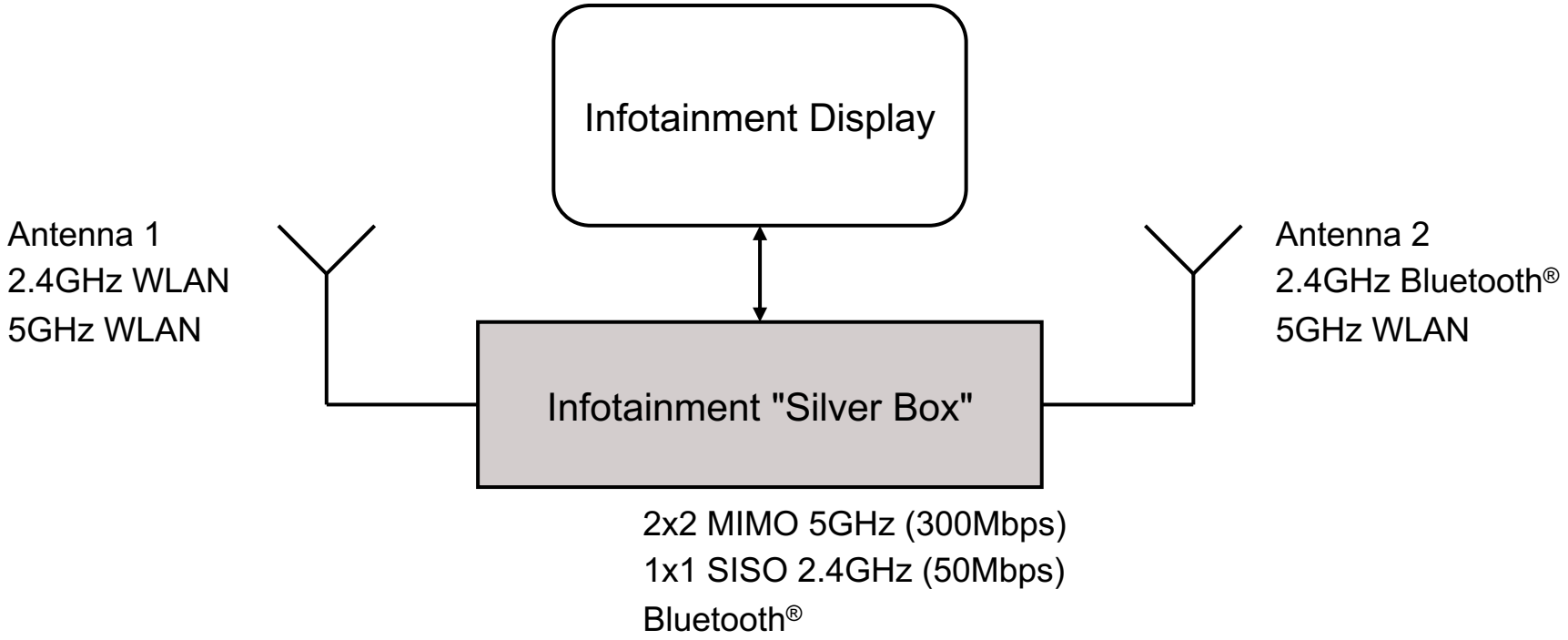
Wireless LAN usage in Cars

- Wireless LAN connectivity as part of an Infotainment system is becoming an increasingly popular option.
- It has the benefit of providing a high speed pipe for streaming of audio or video content to listen or view on the cars media systems.
- Audio and video streams are not necessarily high throughput
  - 1Mbps for studio quality audio, 256kbps is more typical for consumer devices
  - HD quality video can be 10Mbps or less on streaming services
- But this multiplies when multiple passengers all want to do something different, and quite often users are actually carrying multiple mobile devices.

In-Car Wireless LAN Architecture

- In a car, the infotainment takes the place of the home gateway router or access point.
- Mobile devices become a client to the infotainment unit that manages the security and the connection to each of the clients.
- Streaming of content may take place from the client device or by using apps that are built into the infotainment system itself.
- However, Home gateways will use 4-8 antennas/wireless streams to offer very high throughput and capacity for many users. But they consume a lot of power and generate a lot of heat to achieve this.
- In-car systems often use just two antennas for cost reasons and to minimise power consumption and heat generated by the unit.

Typical In-Car Topology

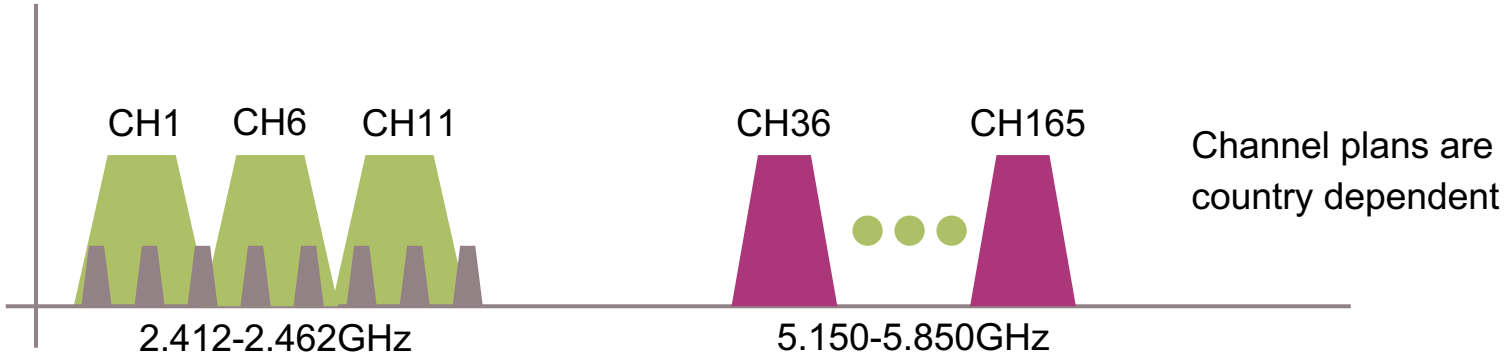


WLAN bands for automotive applications

- As in most home networks, Wireless LAN is available in several bands in the 2.4GHz range and in the 5GHz range. In future, 6GHz may also be available.
- In the 2.4GHz band, a single stream wireless LAN offers typically 50Mbps using 802.11n. But there are a limited number of usable channels.
- 2.4GHz wireless LAN has to co-exist, and often share the antenna, with Bluetooth® systems in the car which can reduce its throughput and capacity.
- In the 5GHz band a single stream wireless LAN offers typically 150Mbps using 802.11ac. 5GHz offers a much larger range of usable channels with wider bandwidths.

The 5GHz band user benefits

- The 5GHz band offers a much greater number of channels than the 2.4GHz band.
- It also offers concatenated channels up to 80MHz wide for greater throughputs.
- And it is far away from any interference from Bluetooth®.



Band-steering, utilising standards based optimisation

- When a mobile device establishes a connection to a WLAN enabled infotainment system a process of discovery takes place.
- The Head Unit (Access Point) and the mobile device (Client) exchange a series of service capability parameters to determine what bandwidths, and radio channels are common to both of them and can be used.
- Within this exchange the mobile device will indicate if it is older and only single band capable (2.4GHz only) or most likely today, dual band (2.4/5GHz) capable.

- Mobile devices will make a roaming decision for which network to connect to.
- Some will go for highest speed connection, some will go for highest signal strength.

Band Steering – automatically connecting the user to the best band

- With band-steering, we have developed a simple, user friendly, automatic way to connect users to the best band for the application they are using.

- 2.4GHz is OK for applications not expecting something to happen in a specific time, such as checking email.
- 5GHz is the better band to use for Media Streaming applications that rely on sending packets of data according to a synchronous schedule to avoid annoying clicks and glitches and head unit manufacturers want to keep memory buffer sizes as small as possible.

Head Unit WLAN Management

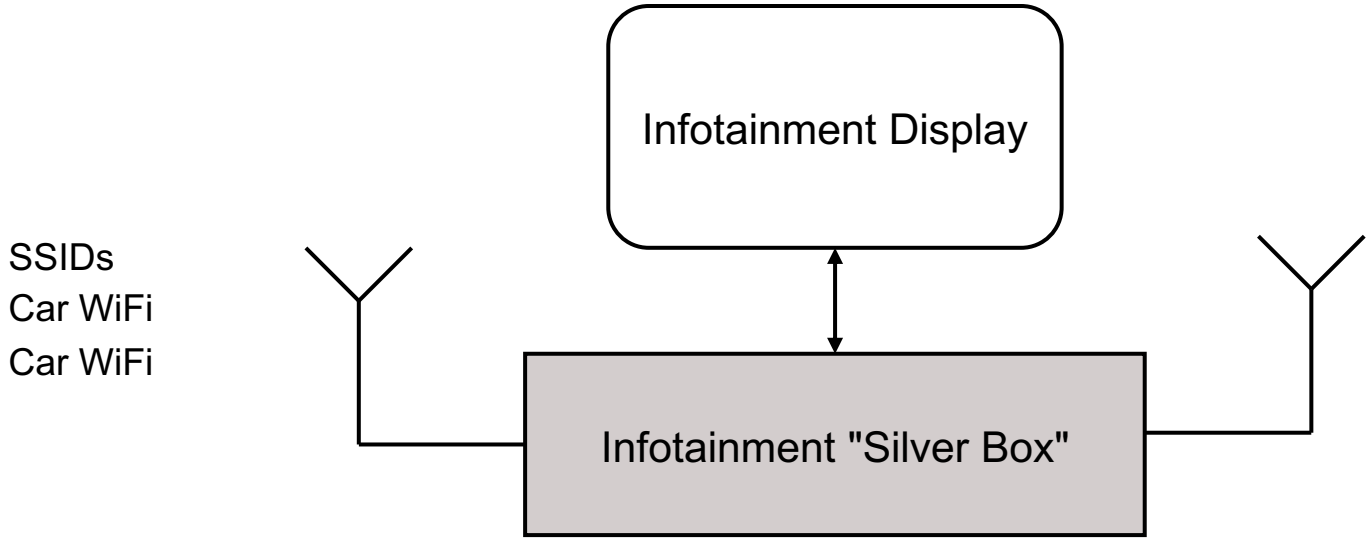
- By monitoring the number of users (clients) in the 2.4G band and checking their capabilities.
- The Head Unit Access Point can now determine if the mobile device is dual band capable, and if it is, it can be directed to connect to the 5GHz band through a Wireless Network Management (WNM) message sent from the AP to the Client.
- Optionally, it is possible to then blacklist a client on the 2.4GHz band so that it only ever connects to the 5GHz AP, thereby overriding the roaming decision on the mobile device.

Wireless Network Management – 802.11v

- Wireless Network Management is part of 802.11v
- A standardised protocol for optimising the wireless network for the benefit of the clients
  - Network assisted roaming
  - Network assisted power saving

- Introduced in 2011, and revised in 2012, it has become another tool for network designers and automatic network managers.
- Being a standard it works simply with mobile devices.
- It is a valuable tool in the confined and cost sensitive environment of automotive.

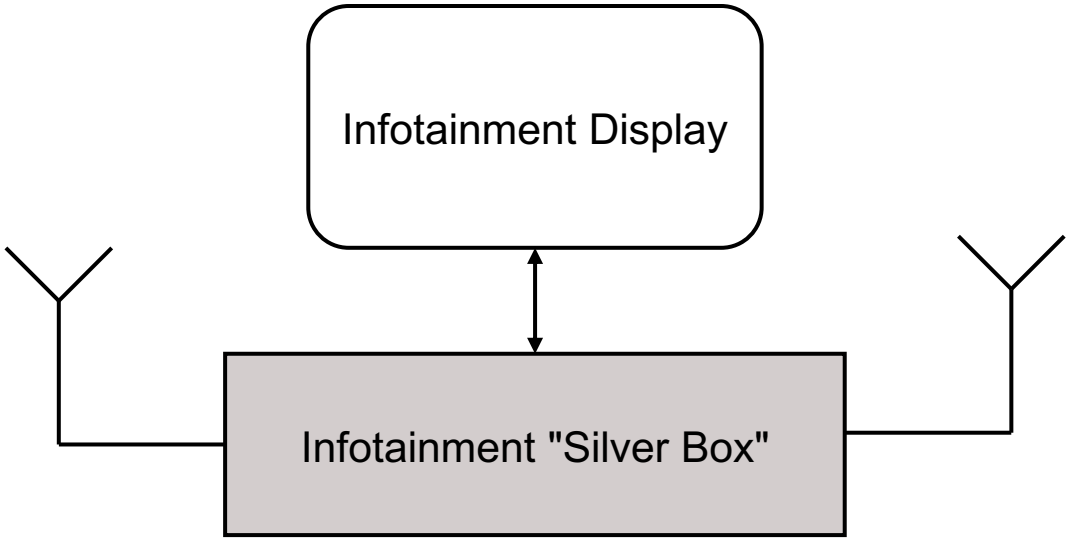
Typical Operation



WiFi Scan
…
Networks Found
Car WiFi |||||
Car WiFi |||

For simplicity, car OEMS often create Access Points with the same SSID on both 2.4GHz and 5GHz. So two networks appear with the same name, but they may have different signal strengths.

Roaming Decision to 2.4GHz

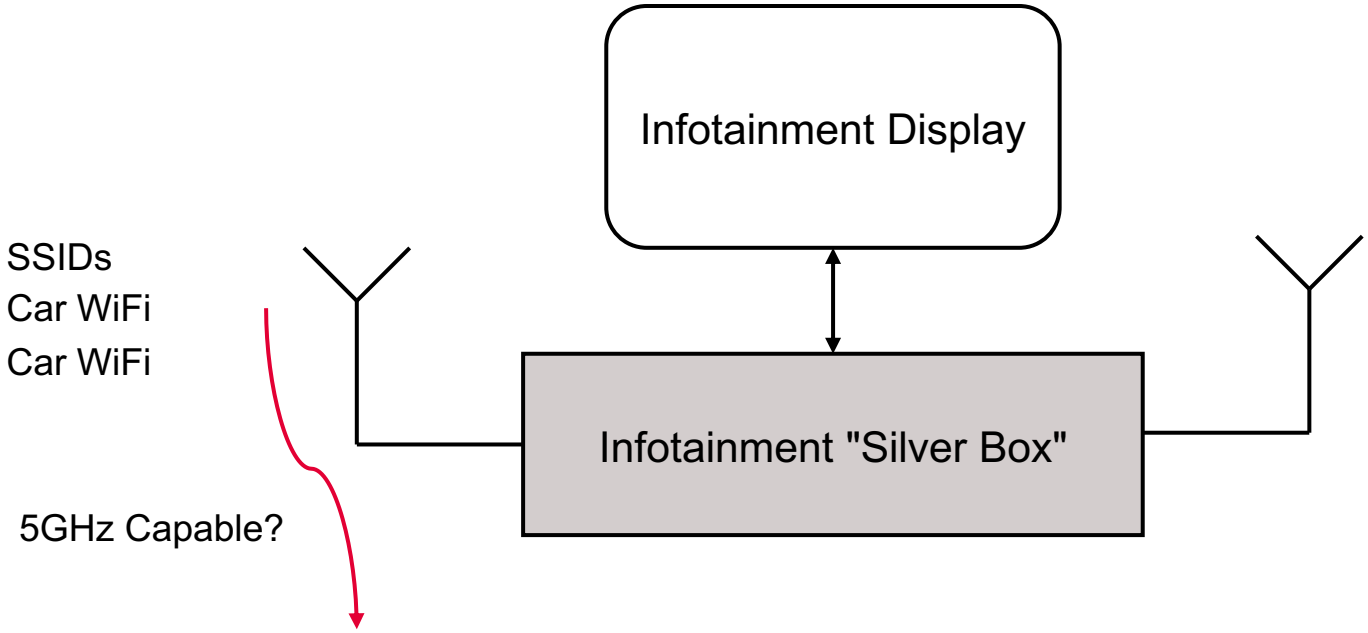


SSIDs
Car WiFi
Car WiFi

Connected to WLAN
…
Car WiFi |||||

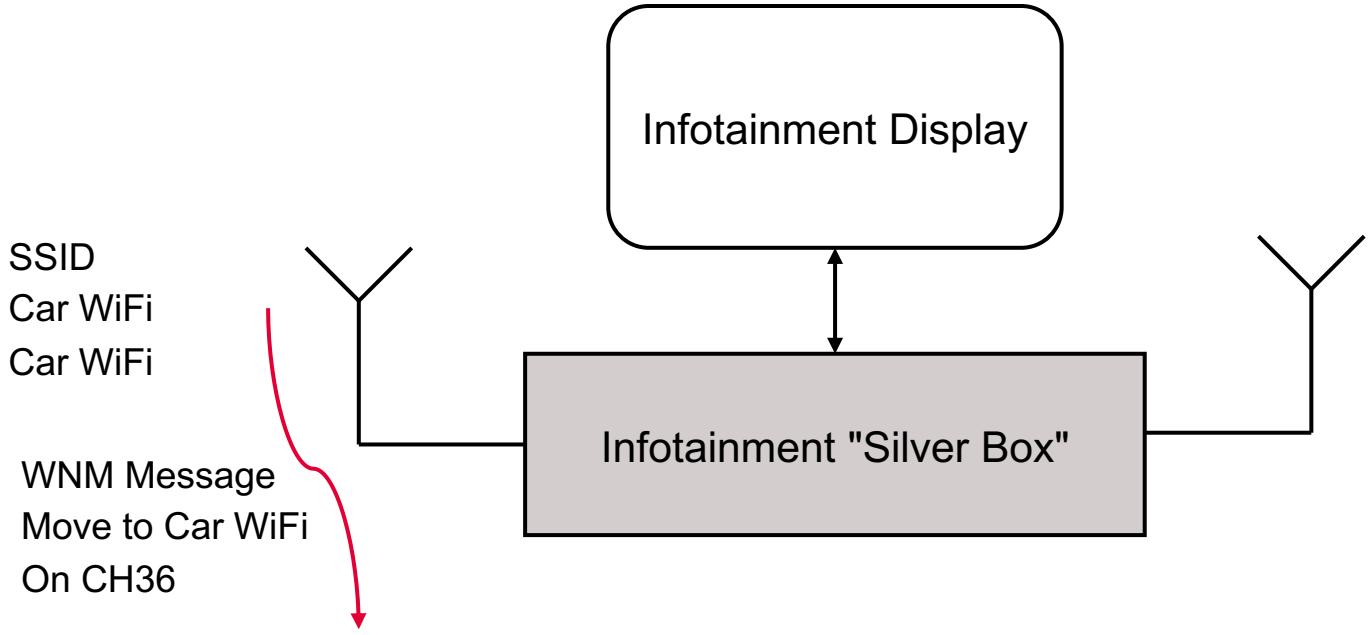
Mobile roaming decision connects to 2.4GHz band

Establish Capabilities



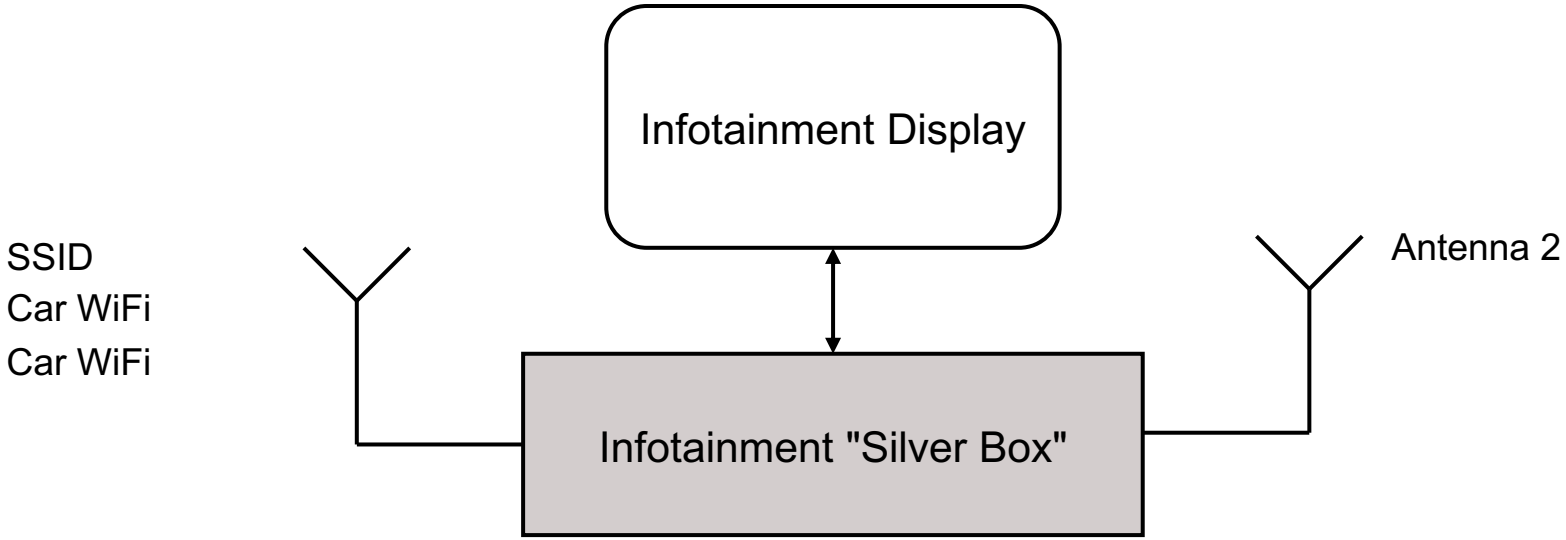
Probe request and response establishes capabilities

WNM message to switch bands



If mobile device is 5GHz capable,
WNM message sent to move to 5GHz

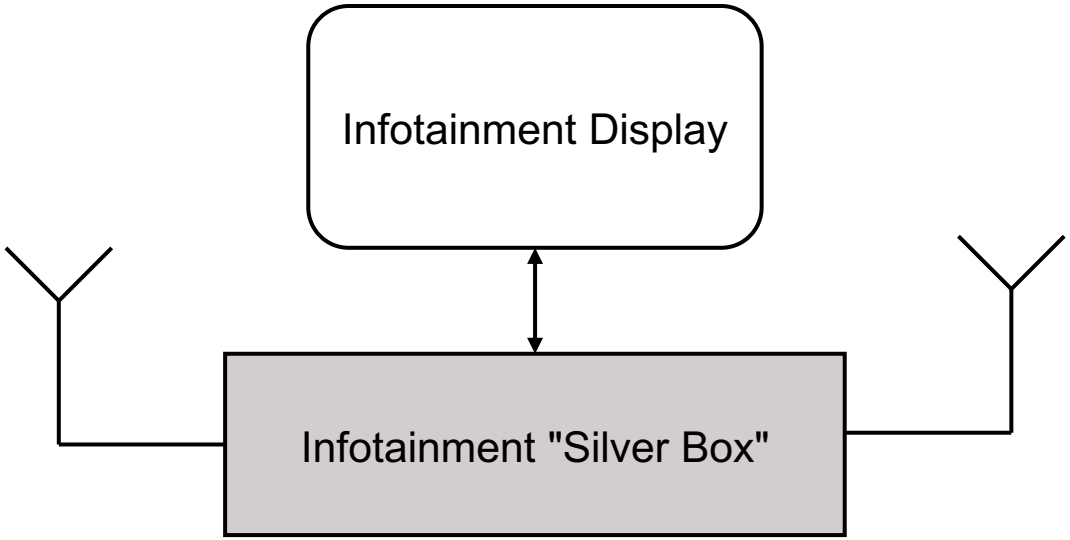
Re-connect to 5GHz



Connected to WLAN
…
Car WiFi |||

Switches automatically to 5GHz Access Point

Scan after optional blacklist



SSIDs
Car WiFi
Car WiFi

WiFi Scan
…
Networks Found
Car WiFi |||

Blacklisted from 2.4GHz,
so it disappears from scan

Infineon Auto Wireless Solutions – The Link between the Real and Digital World

- Users expect similar performance from their WLAN in the car as at home.
- Car WLAN is cost optimized due to the number of passengers who will connect within a small area.
- Utilising the 5GHz band and standard network management tools can optimize the user experience for media rich applications.
- And it's provided free as part of our firmware.

Part of your life. Part of tomorrow.