Question 1: Do you agree with our proposal to prioritise consideration of the 5725-5850 MHz frequencies for Wi-Fi, subject to appropriate protections to other users, in particular satellite services?

Agree.

Question 2: Do you agree with our proposal to re-examine the requirement for DFS across the 5 GHz band, subject to appropriate protections to other users?
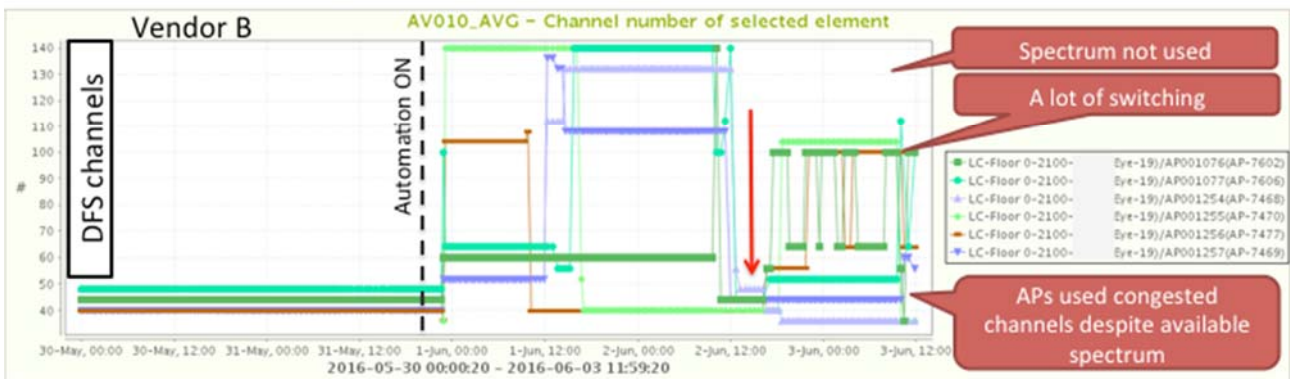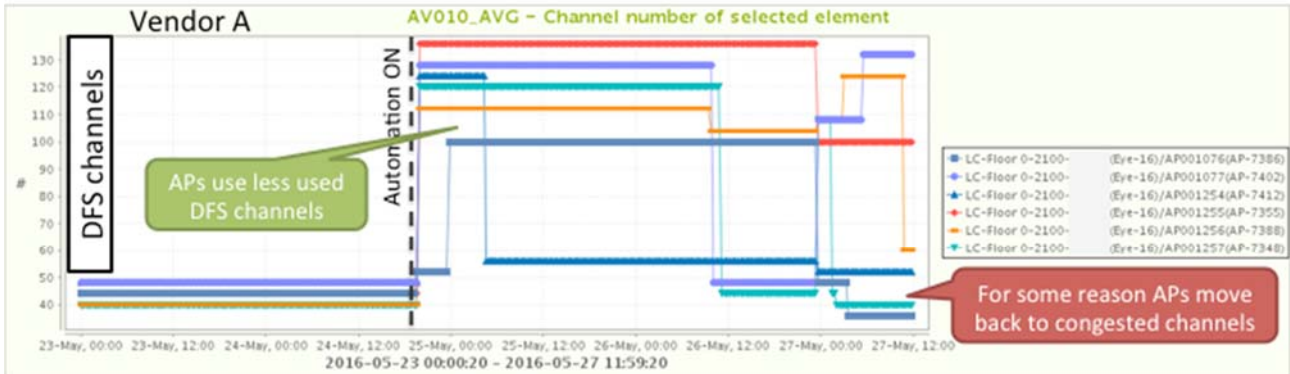
Agree.

Currently the biggest challenge with 5 GHz Wi-Fi is the practical usefulness of already available 5 GHz spectrum. This usefulness is limited currently by two main factors:

1. Wi-Fi access points may falsely trigger DFS protection even in the absence of such signals
2. Automated radio resource management automated channel control do not evenly and efficiently assign channels across the available spectrum.

These two factors are Wi-Fi vendor dependent since implementation efficiency and accuracy is specific to each manufacturer. Even market leading vendors struggle to operate properly.

Below are examples of potential false DFS events and apparently sub-optimal automated channel selection algorithm performance. Data is from a university learning center (indoor area, lowest floor in multi floor building) using enterprise Wi-Fi equipment. Data shows network equipment operation in the same area with vendor A on week 1 and vendor B on week 2. Both vendors are market leading enterprise Wi-Fi suppliers. Test was performed in May-June 2016 with the latest SW and access point models. Test was performed in the Netherlands. Data was collected with 7signal Sapphire Wi-Fi performance management solution.

7SIGNAL®
THE WI-FI PERFORMANCE COMPANY

7signal Solutions, Inc.
526 S. Main Street
Akron, Ohio, 44311
www.7signal.com

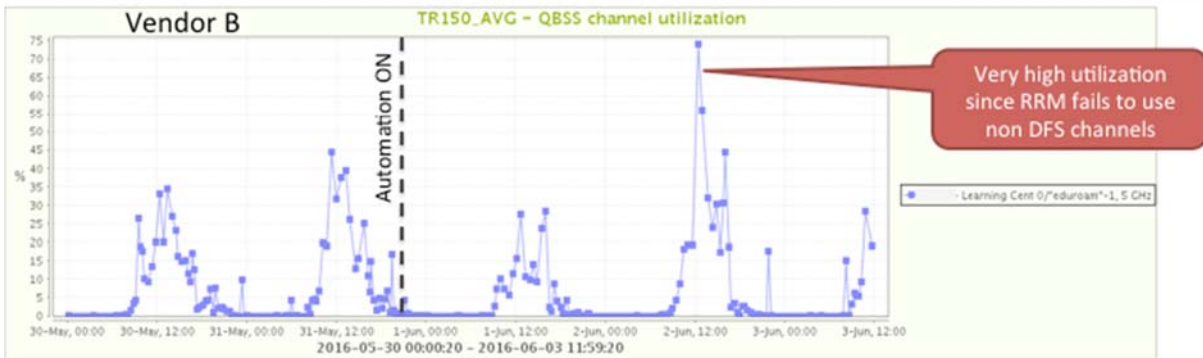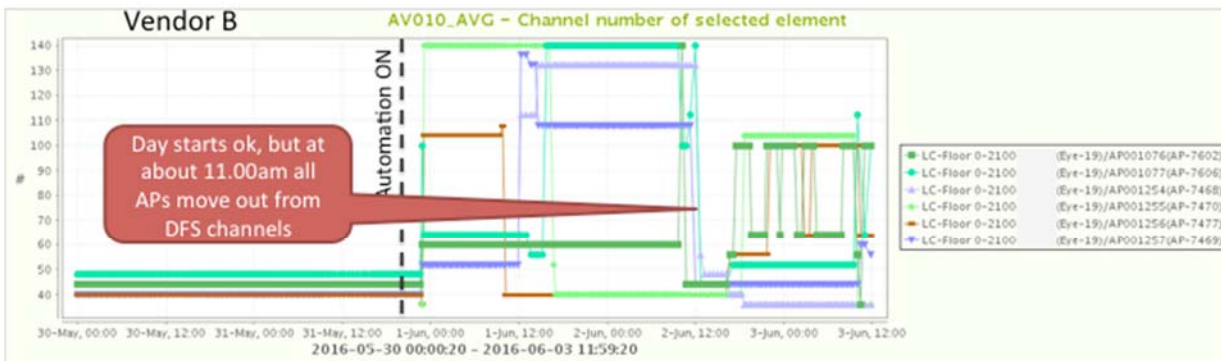*Channels over time. Vendor A vs. vendor B. Vendor A operates clearly better than vendor B.*
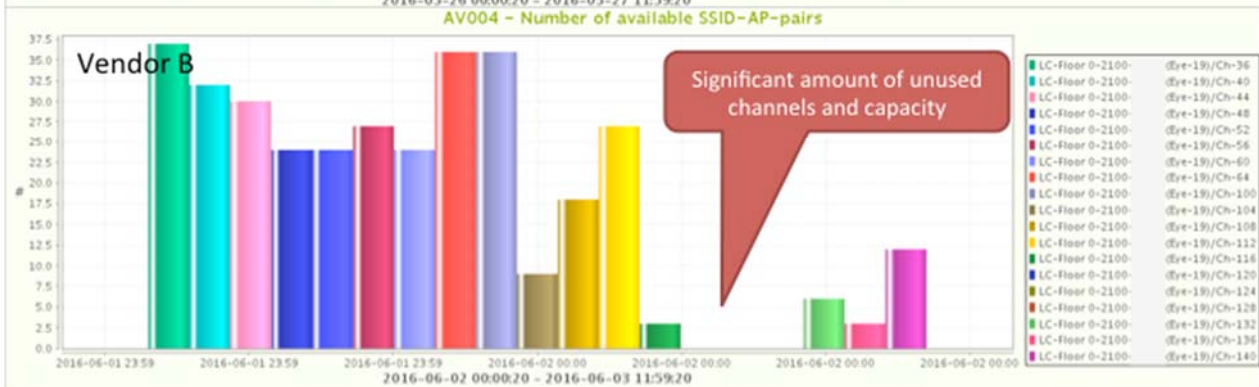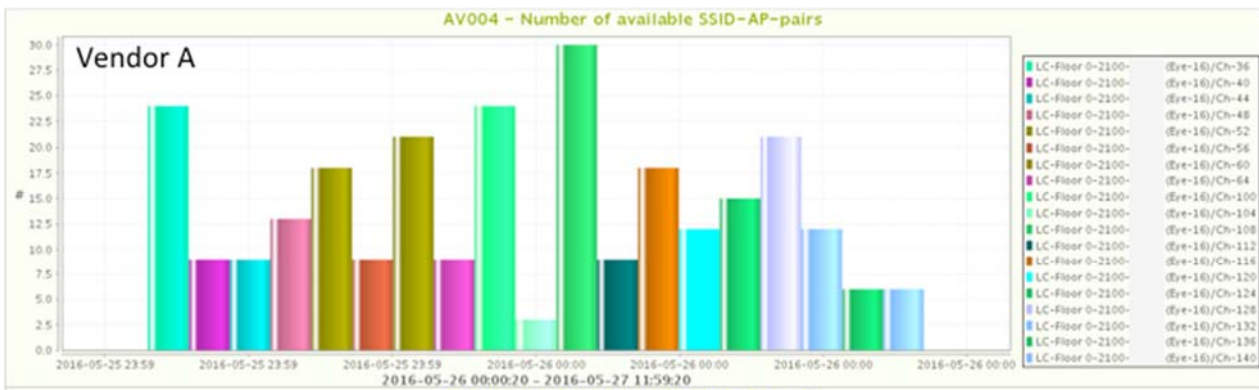
Channel allocations. Number of BSSIDs/certain channel. While not perfect, vendor A operates clearly better than vendor B.
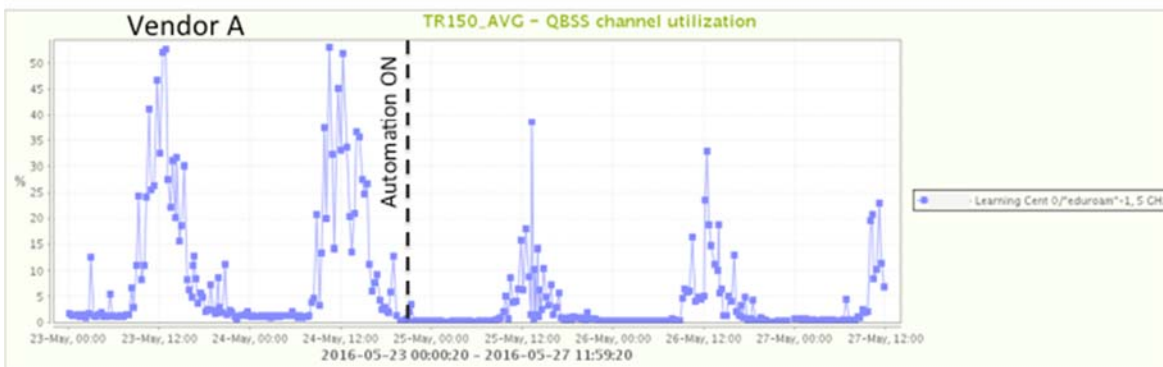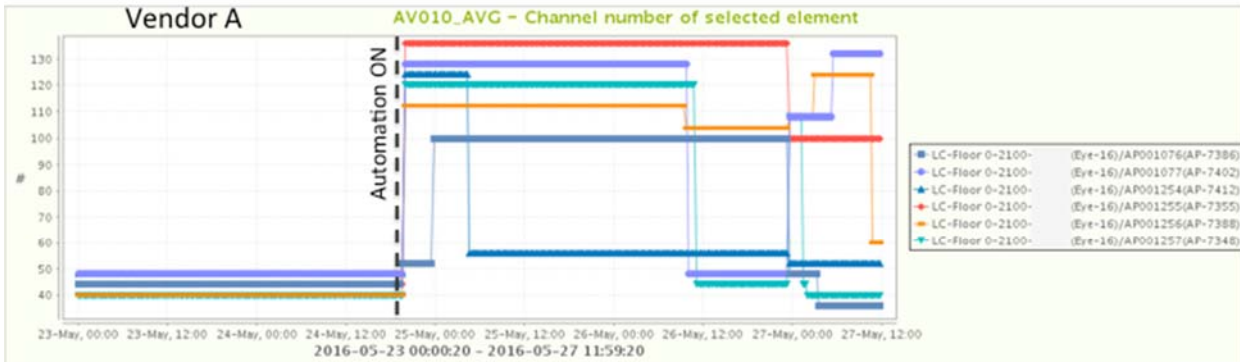
Vendor A channel allocations and resulted air utilization

Vendor B channel allocations and resulted air utilization. Vendor B implementation leads to high utilization due to use of too few channels.

Vendor B APs seem to prefer usage of non-DFS channel. This limits efficiency of spectrum use and leads to high air utilization and lower user experience.

It also seems that vendor B APs completely clear the DFS channels at certain times. Vendor A access points in the very same location do not have similar behavior. This may be caused by DFS events detected by vendor B as vendor A equipment does not similarly trigger DFS protection.

=> Since practical DFS implementations seem unreliable, this likely has a severe negative impact in operating networks.

Possible improvements:
- Equipment certification should also validate DFS operation from accuracy point of view. Currently testing only includes positive case detection in case of known standard DFS event. Testing should cover avoidance of wrong triggering.
- Channel allocation algorithms are not standardized, tested and there are no requirements at all. Proper operation should be required in certification testing since it has significant impact on overall spectrum use efficiency. This is in the best interests of frequency allocator like OFCOM or FCC.

=> => Relaxing DFS detection requirement would help to make spectrum use more efficient by making product implementation easier. This could be done for example by increasing required signal level for positive DFS event.

Question 3: Do you think we should pursue the other options we have identified: opening up 5850-5925 MHz; outdoor Wi-Fi use at 5150-5350 MHz; and opening up the 'centre gap' at 5350-5470?

Agree.

Since Wi-Fi is also improving its efficiency with 802.11ax, combing additional spectrum and new standard gains will provide good amount of additional capacity.

It's important to notice that this gain will be reduced due to planned LTE-U deployments which most in turn may lead to degradation in efficiency. It may be difficult to develop a solution which does not add overhead while operating two fundamentally different technologies in the same band.

Question 4: What are your views on the future growth in demand for Wi-Fi? In which use scenarios do you expect to see the greatest pressure for delivery of high quality Wi-Fi access? What evidence do you have to support your views?

Enterprises, hospitals, financial institutes and higher education require high quality Wi-Fi more than individual home user or free Wi-Fi in shops and cafeterias. This does

not mean that those users would not expect or deserve good user experience. Increase in quality cannot be met without improvements to Wi-Fi equipment performance management capabilities and appreciation of associated skill set. Similarly as mobile networks, also Wi-Fi networks require careful management and proper tools for that. This area in Wi-Fi has been significntly lacking compared to mobile networks.

Question 5: Do you think technology improvements and densification of access points will be sufficient to meet demand or will there also be a need for more spectrum beyond that which we propose to make available? What evidence do you have to link between demand for data and demand for additional spectrum?

This heavily depends on the rate of LTE-U take off. High take off rate means spectrum will be consumed faster.

Question 6: What real life speed and quality of experience can consumers expect in practice from devices using the 5GHz spectrum as authorised in the UK now? What changes can we expect as the number of devices increases and technology improves? What difference in speeds and quality of experience would additional spectrum make?

No opinion, limited visibility to consumer markets.

Question 7: How important is contiguous spectrum? How wide should channels be to support future demand?

Currently well informed enterprises use maximum 40 MHz channels because this allows proper rotation between access points. Continuous spectrum does not seem very important factor. Total spectrum allocation is significantly more improtant.

Question 8: Do you believe we have correctly identified the incumbent services in 5150- 5925 MHz which need to be taken into account in considering opening up more 5 GHz spectrum for Wi-Fi? Are there any other services which will need to be taken into account in future studies?

No opinion.

Question 9: What coexistence studies, measurement campaigns and mitigation techniques do you believe would be most effective for demonstrating coexistence between Wi-Fi and incumbent users?

Use of proper automated Wi-Fi performance management products is absolute requirement for making measurement campaigns and assessments. Undersigned works for 7signal Solutions which offers such products.

Question 10: Do you intend to participate and provide technical material into the ITU and CEPT work? In what way?

Not sure yet. I did participate to 802.11ax standardization work.