White Paper

The potential impact of IEEE 802.11ac on copper cabling systems (Part 2)

excel without compromise.

Further to the Whitepaper we published in early 2015 on the impact of the new IEEE 802.3ac wireless systems, Excel Networking commissioned additional testing in conjunction with De Montfort University, Leicester, UK.

This paper will look to outline the initial findings and provide some insights on how any potential effects can be mitigated.

Overview

For obvious reasons the vendors of this new technology, specifically the Ethernet Alliance, do not want to be limited to the number of customers they can sell these devices to because the potential bandwidth implications require an upgrade to the existing cabling installation.

They want to remove the roadblock of legacy cabling effecting higher performance Wifi which has lead to the NGBase-T working group developing new Ethernet speeds.

Therefore the emerging 2.5GBase-T and 5GBase-T standards are designed to support such applications as wireless access points (WAPs). The intended target is for 2.5GBase-T to operate over Category 5e and 5GBase-T over Category 6, whilst there is current debate about whether Category 5e cable should actually be used at all for such applications due to the uncertainty of whether the Category 5e cable (and to extent unscreened Category 6) would not only be effected by the external interference induced by the WAP or other WAPs in the vicinity of the cable, but whether they can support the level of remote powering required to drive the units.

Furthermore, where data cables are used to support intentional radiators, such as wireless hotspots, the cable may become an antenna in its own right and signals will couple to the cable and can be transmitted along it, which could cause a potential problem further down the link.

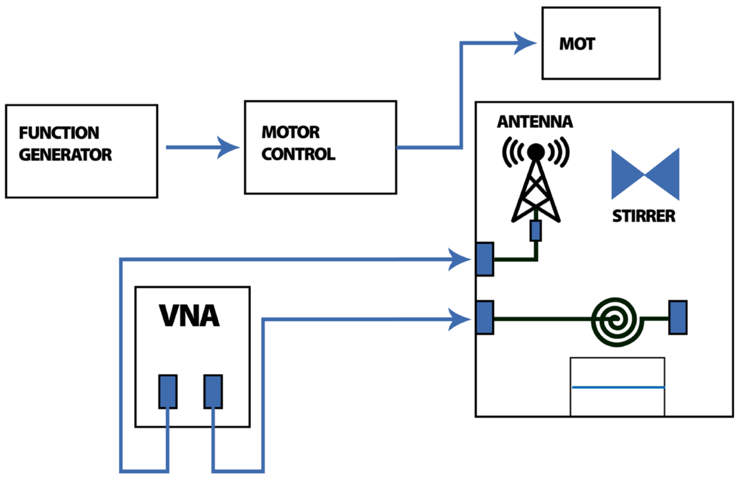
Method Used

A mode stirred reverberation chamber is a useful environment in which to assess cables for such interference because it provides a statistically uniform 'worst case' environment in which to place a cable under test. In this case, the reverberation chamber provides noise coupling to the entire length of the cable under test, finding the most vulnerable coupling points, as might happen in an actual installation.

Because of the unpredictability in the real world environment, a high frequency test method was required rather than using a current probe or the tri-axial method. The reverberation chamber approach was chosen as it is very accurate over a large frequency range and is tolerant to minor changes.

In using the reverberation chamber, a rotating reflective stirrer altered the 'boundary condition' within the chamber; the purpose of which was to cause large amounts of changes in the standing wave patterns.

Test Reverberation Chamber



- Frequency range- 100MHz-6GHz
- Mode tune operation was used.
- Transmitter antenna excited the chamber.
- Receive antenna measured the generated field.
- VNA was used to measure the coupling between the transmit antenna, the receive antenna and the twisted pair under test.

In laypersons terms, we induced a signal to the chamber. We used a stirrer to induce fluctuation into the signal and then we tested the impact on the cable sample.

Given the understanding that screened cable would be fundamentally immune to the effects during this test, both Category 5e and Category 6 unscreened cable were used and the impact was further modified and sampled by just screening the point of termination.

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Testing

The frequency range used was between 100 MHz-6GHz and the peak value at each frequency was obtained and that provided the worst case response.

First, all the measuring instruments used in this test were calibrated. Next, the noise floor measurement of the network analyzer was taken. This was done with no source of signal connected to the vector network analyzer. The noise floor is the level of background noise in a signal or the level of noise introduced by the system below which the signal being coupled cannot be isolated from the noise.

TEST 1

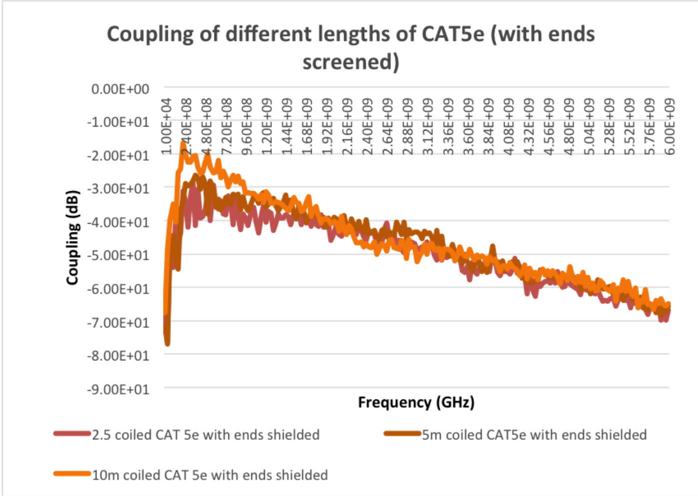
In the first test, 2.5m, 5.0m and 10.0m coiled lengths of Category 5e and Category 6 cables were prepared as described and tested for noise coupling in the chamber with the terminals and connections exposed to electromagnetic waves in the chamber. This test was to investigate if there was any length dependence on the coupling to the cables.

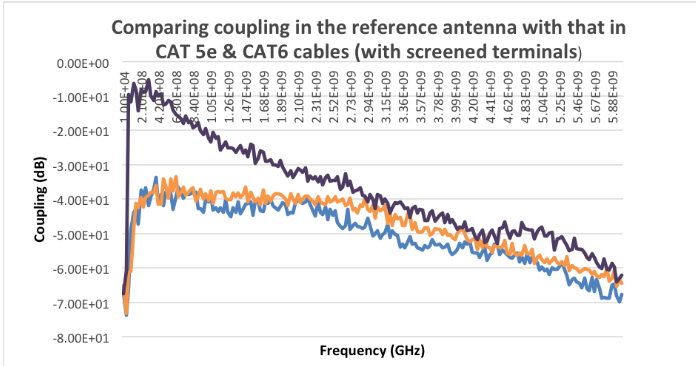
TEST 2

In the second test, 2.5m, 5.0m and 10.0m lengths of Category 5e and Category 6 cables were laid straight instead of coiled (change of orientation) and the same coupling tests were repeated. Here the test was to investigate whether there was any limitation on the way the cable is laid out in the chamber.

TEST 3

In the third test, the same 2.5m, 5.0m and 10.0m lengths of coiled Category 5e and Category 6 cables were tested with the cable ends and terminations screened. Here the aim was to investigate the influence of exposing the cable ends and terminations from dominating the coupling.

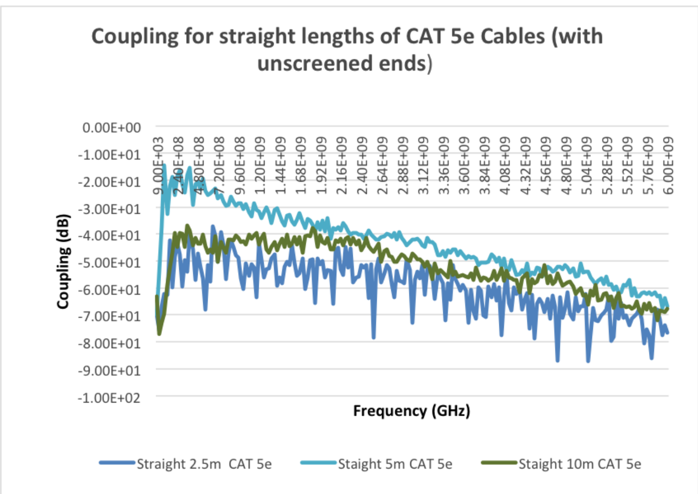




Reference Antenna

Category 5e

Category 6



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Conclusion

- The result of test 1 showed that the coupling of noise conducted in the reverberation chamber is length independent. This is shown clearly from the very close resemblance and trend of the couple signals in the three lengths of cables tested. From the result of test 2, there is marginal difference in coupling between Category 5e and Category 6 cables when laid straight rather than when coiled. However, in this test Category 6 coupled less than Category 5e.

- Screening the cable ends and terminations resulted in less coupling in the category cables. This result can be seen in the results from test 3. By screening, the ends and terminations were protected from dominating the coupling.

- Finally, coupling in both category cables were compared with a reference antenna. The result showed that Category 6 coupled less noise than Category 5e.

- Overall, while the rate of coupling is strongly dependent on frequency, the shape of the coupled noise did not significantly change much with respect to cable category.

This research demonstrates that high power wireless APs operating at 5GHz have the ability to induce noise coupling with the cabling. However it is unclear as to the scale of the potential problem this might cause when combined with the higher bandwidths of 2.5Gb and 5Gb, also whether this level of noise coupling will cause an increase in the BER (bit error rate) encountered.

It is commonly accepted that the higher the frequency the structured cabling is operating at, the higher the risk of interference from outside sources, therefore it is clear that screening the terminations and ultimately the cable itself has a significant impact.

The next step for this research is to actively test a permanent link whilst it is being subjected to the same levels of signal as used in this initial research.

Additional Credits

- **Edwin C Arihilam** is currently reading for a PhD in EMC. His main research interests are in EMC, Antenna systems at De Montfort University (DMU), Leicester

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