Co-existence studies in WP1A

- Concerns about various items of electrical and electronic equipment causing interference to radiocommunications have been growing for some time
- Becoming even more acute as various non-radio devices have come to market that use or produce RF energy as an essential part of their operation

Drivers for studies in WP1A

Two developments around 20 years ago were the main drivers of studies:

- Digital Subscriber line (DSL) technology for providing broadband connections over telephone wiring initially at LF/MF, but quickly expanding to HF and VHF

- Power Line Telecommunication (PLT) systems communicating over mains wiring, both inside and outside buildings, firstly in the MF/HF ranges but soon going to VHF and even UHF

Experience with ISM

- Previous experience with equipment using high levels pf RF energy for heating and suchlike was tackled through the regime established between ITU-R and CISPR for ISM equipment
- The main feature of the ISM regime is to confine the use of high levels of RF energy to particular frequencies thus minimizing the risk of interference to radiocommunication services

Further considerations on ISM

Also the use of ISM equipment originally tended to be intermittent and was not common in locations where reception of radio services is always expected to be available; the main examples being:

- Reception of aeronautical services around airports
- Radio astronomy observations
- Reception of broadcasting services around living areas
- Conducting communications in the amateur service

Challenges with DSL and PLT

A wide range of radiocommunication systems exposed to RF emissions over wide areas:

- Systems widely deployed for residential and business premises
- Systems in operation for extended periods of time and, in principle, continuously for many applications
- Wide ranges of frequencies used, organized around blocks of subcarriers

Response in ITU-R

- ITU-R responded to these developments in 2000 by initiating studies under:
  - **RESOLUTION ITU-R 46** – Compatibility between radiocommunication systems and high data rate telecommunication systems using electricity power supply or telephone distribution wiring
  - **QUESTION ITU-R 218-1/1** – Techniques for measurement of radiation from high data rate telecommunication systems using wired electrical power supply

Conduct of studies in ITU-R

- Initially studies took place within Study Group 1
- However, the proliferation of devices operating in broadcasting bands on an ad-hoc basis, combined with concerns on emissions from DSL and PLT in broadcasting bands led Study Group 6 to take a direct interest.
- The spread of devices and equipment causing significant levels of RF radiated and conducted emissions in residential areas posed an obvious risk to the reception of broadcasting

SG 6 studies on noise like emissions

- An early result of SG 6 studies: **RECOMMENDATION ITU-R BS/BT.1786** – Criterion to assess the impact of interference to the terrestrial broadcasting service
- This recommended that *the total interference to systems operating in the broadcasting service, from all sources of interference [as specified], should at no time exceed one per cent of the total receiving system noise power*

Focus on interference from PLT

The main concern on interference from non-radio devices remained focussed on PLT for many years with WP1A continuing to lead in ITU-R

- A Rapporteur Group was set up to coordinate activities on PLT by WP1A in 2010 to address the concerns of several radiocommunication services, led by Reiner Liebler
- Concerns were brought to the fore through ITU Forum on "**Technical Compatibility between Power Line Telecommunication systems (PLT) and Radiocommunication Services**" held in Geneva, on 27 May 2011

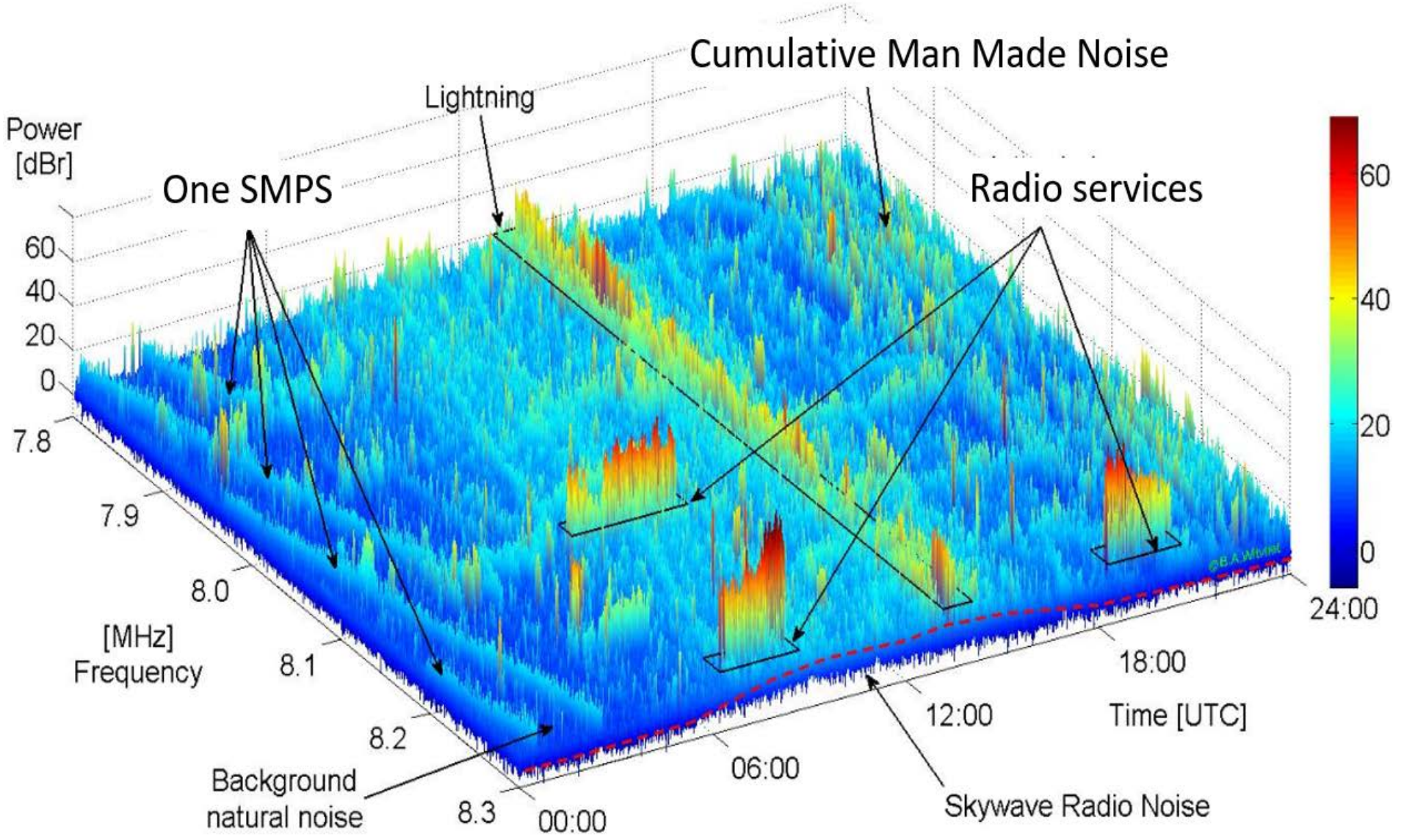
Closer liaison on equipment standards

- This was in fact getting near the peak of PLT development for broadband access and in-home networking on account of its limited performance and technical drawbacks in the face of increasing expectations on internet throughput and speed
- Nevertheless, concern remains on further developments with PLT – one result being the development of an effective liaison relationship being established with between ITU-R and CENELEC a few years ago.

Evidence of ubiquitous noise-like emissions

- The cooperation with CENELEC coincided with increasing concerns that nearly all items of electronic and electrical equipment were radiating significant amounts of noise-like emissions as well as feeding back RF energy into the mains wiring
- The common element identified is use of high speed switching in the power supplies and power conversion stages almost universal nowadays in every item of equipment

RF noise in the 7.8-8.3 MHz range



RF noise effects

- The liaison with CENELEC proved particular useful in highlighting the problems caused by increasing RF noise levels
- Their studies have reveal that RF noise on mains wiring can affect connected equipment in a variety of unexpected ways. In effect, nearly all items of electrical and electronic equipment could be both sources of mains borne RF noise and victims of various noise induced disturbance mechanisms
- There have, for example, been instances of microprocessor controlled equipment carrying out uncommanded actions

Re-focus on interference studies in Study Group 1

- Cooperation with CENELEC has influenced the work in WP1A, steering it more towards the long term risk to all radiocommunication services coming from increasing levels of RF noise in the environment
- WP1A therefore started a campaign to gather evidence on the prevalence and impact of RF noise from other Working Parties and stakeholder groups.
- These efforts have been supplemented by work in ITU-R by WP 1C and WP3L to measure, characterize and predict RF noise levels in the environment

Impact of mains borne RF noise

- RF noise on mains wiring has be found to reduce the lifetime of filter components in switch mode power conversion stages through overheating, and resulting in more RF feeding back on the mains wiring, which then causes the same failures in other connected devices and so on – a vicious circle of degradation
- The most alarming effects discovered were with LED lighting systems and units. It must be emphasized that the problem is not with the light producing elements but the power conversion stages, coupled with the sheer numbers of LED light fittings in use

Impact of mains borne RF noise

- The problems found with LED lighting in the CENELEC studies seemed to be confined to the LF range and safety concerns on overheating.
- However, as these findings were coming through, EBU brought some investigations to the attention WP1A showing that radiated emissions from LED lighting units extended up to VHF and were interfering with DAB reception

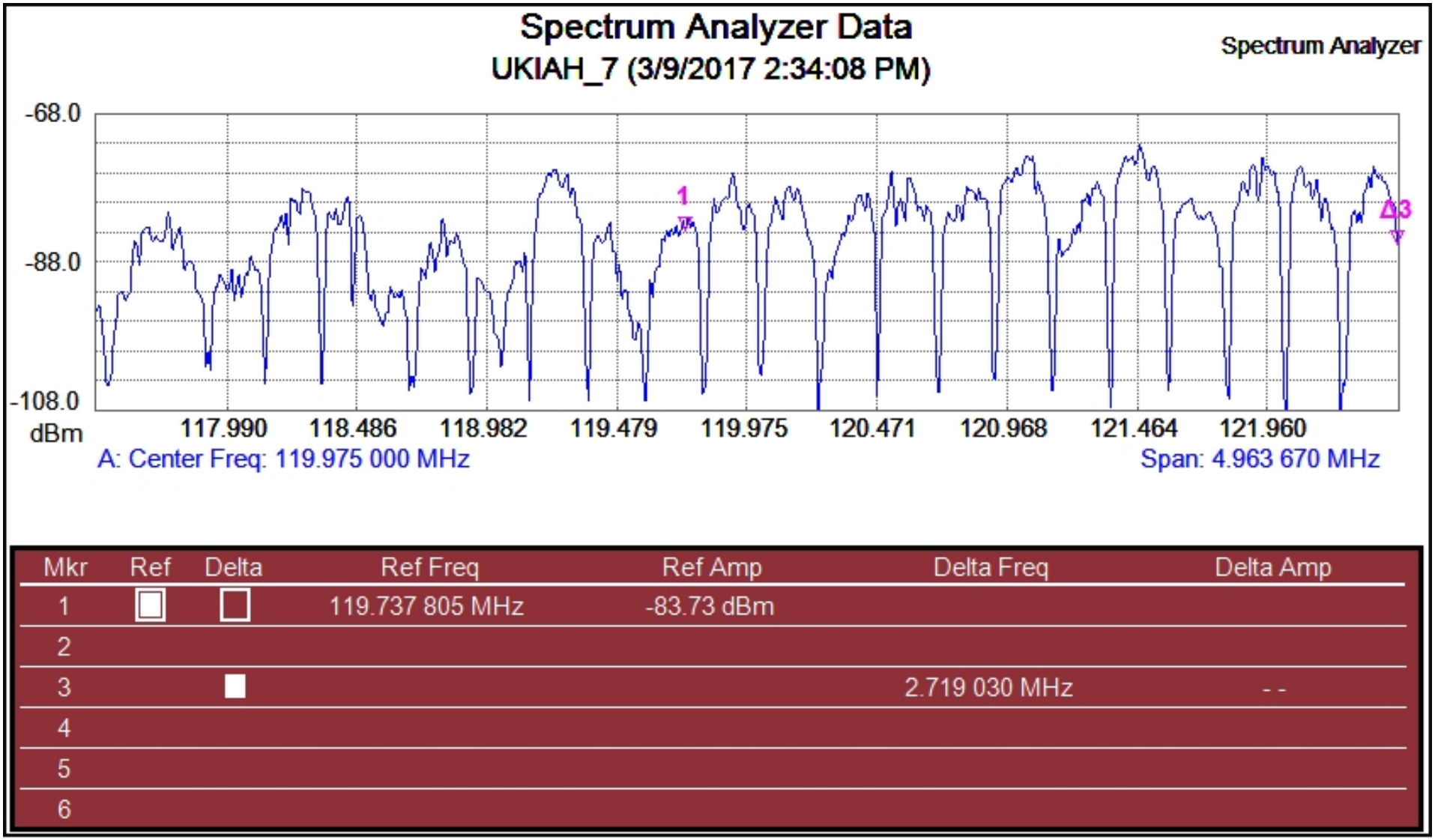
Liaison with CISPR on interference from LED lighting

- The response of WP1A to these serious and unexpected findings was swift, immediately bringing the problem to the attention of CISPR/F in June 2016, which acted quickly by initiating amendments its CISPR 15 standard during November 2016 CISPR block meetings to include LED lighting systems
- Unfortunately there will be a time delay before the amended standard takes full effect and there are many LED lighting systems already installed that are causing interference to radiocommunication services, not just broadcasting

Further investigations on LED lighting systems

- In further investigations, LED lighting has been identified as a repeat offender in evidence gathered by WP1A and WP1C as causing interference and raising noise levels in the environment
- One really unexpected instance was interference to aircraft systems at flight level reported through ICAO
- More evidence on interference from LED lighting systems to DAB has now come in as you have seen during the workshop

LED emissions in aeronautical radionavigation bands



Mkr	Ref	Delta	Ref Freq	Ref Amp	Delta Freq	Delta Amp
1	☐	☐	119.737 805 MHz	-83.73 dBm		
2						
3		☐			2.719 030 MHz	- -
4						
5						
6						

Conclusions

- The presentation has shown the advantages of cooperating with standards developing organizations and actively seeking evidence of RF interference and increasing RF noise levels
- It is the case that many adverse effects had been noticed previously in several fora, but the information had tended to remain compartmentalized without the various strands of work being brought together to reveal the overarching problems
- For the future, the studies in ITU-R are also starting to show evidence that the assumptions underlying how emission limits have been set need to be reviewed