DKE spectrum recording in the sphere of professional event production

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„Professional Radio Microphone Systems and Events Technology“
About the DKE WG 731.0.8

„Professional radio microphone systems and events technology“

• Since 2006, DKE has been collecting information on professional event production, the wireless production tools (PMSE) and their typical radio spectrum use.
• It summarizes this information in application reports.
• These reports are made available to regulatory and standardization bodies.
• The working group includes experts from the DACH region.

The issue in a nutshell

Wireless microphones require radio spectrum...
...but how much...
...and how can this be measured?
Before we go in detail

Do we know the limitation...

...in the typical RF channel?

Let’s explain it as a PMSE operation.
PMSE Operation is limited by

- Intermodulation,
- Propagation,
- Body effect,
- Multiple units on actor’s body.

This and some more effect PMSE and spectrum recordings.
IM Simulation of 20 IEM

In a test setup the Intermodulation of 20 audio links was simulated:

This is a typical hardware arrangement:
20 IEM transmitters are combined to one power amplifier and the output signal is radiated by a single stage antenna.
1) PMSE in an IM-free frequency arrangement

Intermodulation products of 20 PMSE

IM level -70dBm

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2) PMSE in a linear frequency grid arrangement

Note: this frequency setup decreases the PMSE link performance by ~30 dB

The problem: in a uncontrolled scanner environment we would record IM’s.
Propagation Effects

This graphic shows a typical receiver input level, considering the statistical distribution on a transmission path.

Note: this simulation shows an optimistic transmission path, but the reality differs.
Lets watch a spectrum scan

Start the PMSE Occupation Recorder

Although the scanner had a direct line-of-view to stage, the recorded signal amplitude is changing frequently.
Body Effect
Measurement in an EMC Test Chamber

A PMSE body-worn unit was measured in a reflection-free room

Test device on a rotary platform

Test person

360° body effect

The combination of propagation and body effect provides hard reproducible spectrum scans
Multiple Units on Actor’s Body

- Several electronics as well as PMSE are often mounted on an actor’s body.
- In addition other actors are in close proximity.
- All are operated in a frequency congested stage environment, e.g. LED walls, that are providing RF interference.
- The spectrum scanner will receive the mix of all this signals.
Multiple electronic units on actor’s body

- Actor mic antenna
- 1st instrument antenna
- 2nd instrument antenna
- IEM antenna on actor’s back
We have just presented:

- Intermodulation effects on multiple PMSE transmitters
- Propagation effects between PMSE transmitter and receiver
- Body effect that reduced the field strength in some directions
- Multiple units on actor's body and their interaction

→ These can appear as a single or a combined effect.

Let's now move to spectrum recordings.
During EuMW2013 we explained in detail the methodology and technology for PMSE spectrum recordings in the context of events.

Today, we have very limited time.

Therefore, we kindly ask you to take a look in this presentations after the today’s event:

Typical technological setup for spectrum monitoring

The DKE WG is using this typically setup:

The results from up to three scanning stations can be combined to a complete spectrum picture of the recorded event.
How can you minimise false measurements?

Spectrum recording is a serious business and...

...but existing measuring devices have their technical limits, which have an impact on the validity of the results.

This needs to be recognised in advance and requires a suitable approach.
Suitability of different measuring devices

In the context of event production, the large signal dynamics represents a significant problem. To address this, a two-tone scenario (70 dB level difference) was evaluated in a laboratory test using different spectrum analysers.

Significant differences in spectrum scanning products have been shown

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Again an old problem - IM

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The simulation confirms the effect of scanner hardware.

The recorded lab scenario could be confirmed in the simulator:

4) Simulation
Changes in UHF spectrum use are associated with the introduction of LTE systems.

Furthermore, content & event production and PMSE spectrum use increases.

We like to present example...
Change in spectrum use by LTE & PMSE

2012

2013

2014

Oktoberfest in Munich

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Wacken is a small village in northern Germany:

- There live about 1800 people in “rural silence”.
- 3 TV stations are the only user in the UHF TV band.
PMSE in the “Middle of Nowhere”
A very high spectrum use by PMSE

Once a year the air is exploding...
...also the RF spectrum.

Wikipedia 2011: “Wacken Open Air is a summer open-air heavy metal music festival...
...With 80000 festival visitors...”
Brief statistics of Wacken event

For all who have any doubts

This graphic compares the number of scanned carrier within the event coordination table:

277 PMSE were coordinated before event, >280 narrowband carrier were scanned

In a linear 600 kHz frequency grid, this requires >168 MHz RF spectrum.
But some PMSE cannot be operated in in a linear grid, e.g. IEM!
Looking in the time after 2017..

This year the 700 MHz spectrum was auctioned. In addition the 700 MHz duplex gap is suggested to be refarmed to PPDR – completely lost for PMSE?

We wonder, have we taken into account the economic effect of this event for the Wacken region? Almost 100,000 visitors for 4 to 5 days!
In the opposite direction
TV's require much RF spectrum

Let's take a look at an event which took part in Barcelona in December 2014:

Before the installation of an 800 MHz LTE network, already 20 TV channels were operated by Broadcast - APWPT has reported this scenario to CEPT -
In future will there be space for PMSE?

Eurovision Contest 2014 in Copenhagen

- this picture shows the indoor spectrum -

Here there are 20 TV channels in operation by Broadcasters from Denmark and Sweden

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DKE spectrum recording
Although events are still being recorded and evaluated, the following trends are clearly evident:

- The use of wireless tools is increasing
- The density of spectrum use is increasing
- The so-called "clean spectrum" is becoming increasingly subject to disruption – in other words, it’s becoming a scarce commodity

➡️ We are continuing to investigate the information concerning these trends.
Where is the DKE data taken into account?

Technical bodies, such as the CEPT or ITU-R, take into consideration and evaluate DKE measurement results and fairly frequently publish them in their own documents.

In addition, APWPT publishes an array of technical documents and DKE reports: [http://www.apwpt.org/technical-papers](http://www.apwpt.org/technical-papers)
Summary

• Spectrum recording in the sphere of events is a particular challenge which can be overcome only through intensive collaboration with the event organisers and/or producers and/or building owners.

• Our aim is to provide information in the greatest possible detail for further use e.g. in the context of standardisation and regulation.

• To this end, the DKE WG 731.0.8 has developed a specialised methodology and associated software.
Thank you very much!

DKE scanning antenna in front of the Vienna Parliament Building (A)

Unfortunately the Philosophers deliberations could not provide better scanning results!

Further information is available at..

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