

# **Research of experimental methods to simulate** propagation channels in modal reverberation chamber

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## **General context**

•the quality of the communication link is the key role in the performance of the wireless systems

•having knowledge of the channel parameters, a system can adapt itself to the conditions of transmission

## **Objectives**

•characterize the channel in a reverberation chamber, particularly for multi-antenna systems, investigating different dimensions - time, position, frequency, angle of departure, angle of arrival and polarization, and compare the results with specific cases



## **Measurements in RC**

## The distribution of Energy

EMC - all the energy injected into the chamber is contained in a scattered component

WPC - energy is distributed between a specular component and scattered components

### **Frequency Bandwidth**

EMC – the measurements are done in a narrow bandwidth, and at various frequencies with a step of some MHz. WPC – depending on the transmission system, the measurements are done in a narrow or broad bandwidth

### **Domain of measures**

EMC – analysis is usually done in frequency domain WPC – it uses frequency, temporal, or spatial domain

### **Reverberation Chamber Model**

EMC – it is an ideal model in which the density of modes of the cavity is infinite (working frequency should be high)

and reproduce in the reverberation chamber •control various characteristics of wireless channels encountered different transmission scenarios, based on identified parameters

WPC – it requests the controls of various parameters to recreate an transmission environment

#### **Trials independence**

EMC – it must use independent measurements between successive observations

WPC - the temporal autocorrelation is an important feature of the channel

## **Measurements of parameters**

Signal to Noise ratio, Power Delay Profile (average delay, delay spread, ...), coherence bandwidth, coherence time, doppler spectrum, K factor, shadowing factor,

The influence of distance





The fading effect

Mean of sent and received power over 100 stirrer positions in frequency interval 900-1100MHz $_{50}$						
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$$h(\tau,t)$$

$$TF \swarrow TF^{-1} \qquad TF^{-1} \swarrow TF$$

$$S(v,\tau) \qquad H(f)$$

$$TF \searrow TF^{-1} \qquad TF^{-1} \swarrow TF$$

$$T(f,v)$$

Signal Modeling

 $y(t) = h(\tau, t) * x(t) = \int_{-\infty}^{+\infty} h(\tau, t) x(t - \tau) d\tau$  $\boldsymbol{f,t} \quad H(f,t) = \int_{-\infty}^{+\infty} h(\tau,t) e^{-j2\pi\tau f} d\tau = \int_{-\infty}^{+\infty} T(f,v) e^{j2\pi t v} dv$  $T(f,v) = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} h(\tau,t) e^{-j2\pi t v} dt \cdot e^{-j2\pi\tau f} d\tau$  $S(\tau, v) = \int_{-\infty}^{+\infty} h(\tau, t) e^{-j2\pi t v} dt = \int_{-\infty}^{+\infty} T(f, v) e^{j2\pi f \tau} df$ 

The effect of the multipath fading on the envelope of the received signal is modeled as a random process with Rayleigh distribution, when a specular component does not exist, or with Rice distribution in the presence of a specular component.







## Measurements of K

 $A = \sqrt{\frac{K\Omega}{K+1}} \qquad \sigma = \sqrt{\frac{\Omega}{K+1}}$ 

•It is the ratio of the local average power of the specular component (the

deterministic component) to the local average power of the scattering (random







### It depends on different parameters of the communications link,

- heights and separation of the antennas, beamwidths and gains of the antennas,
- nature of the intervening terrain, distribution of scattering,....

•It indicates the severity of the small-scale fading on signal reception.

#### It is used for

component)

- channel characterization,
- link quality,
- link budget calculations,
- MS velocity estimators,
- geolocation applications,
- Evaluation of the propagation on transceiver designs.
- resource allocation and link-adaptive designs (MIMO)
- the estimation of the Nakagami parameter





#### **Experimental Results**







## **Future Work**

•Continue to estimate and measure different parameters in RC •Introducing in the model, artificially, the parameters which are not present in RC -Finding an equivalent model in RC to simulate correctly, and in a controllable way, the transmission channels, so the effects can be predicted





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