POWER LINE COMMUNICATIONS

FOR SMART GRID

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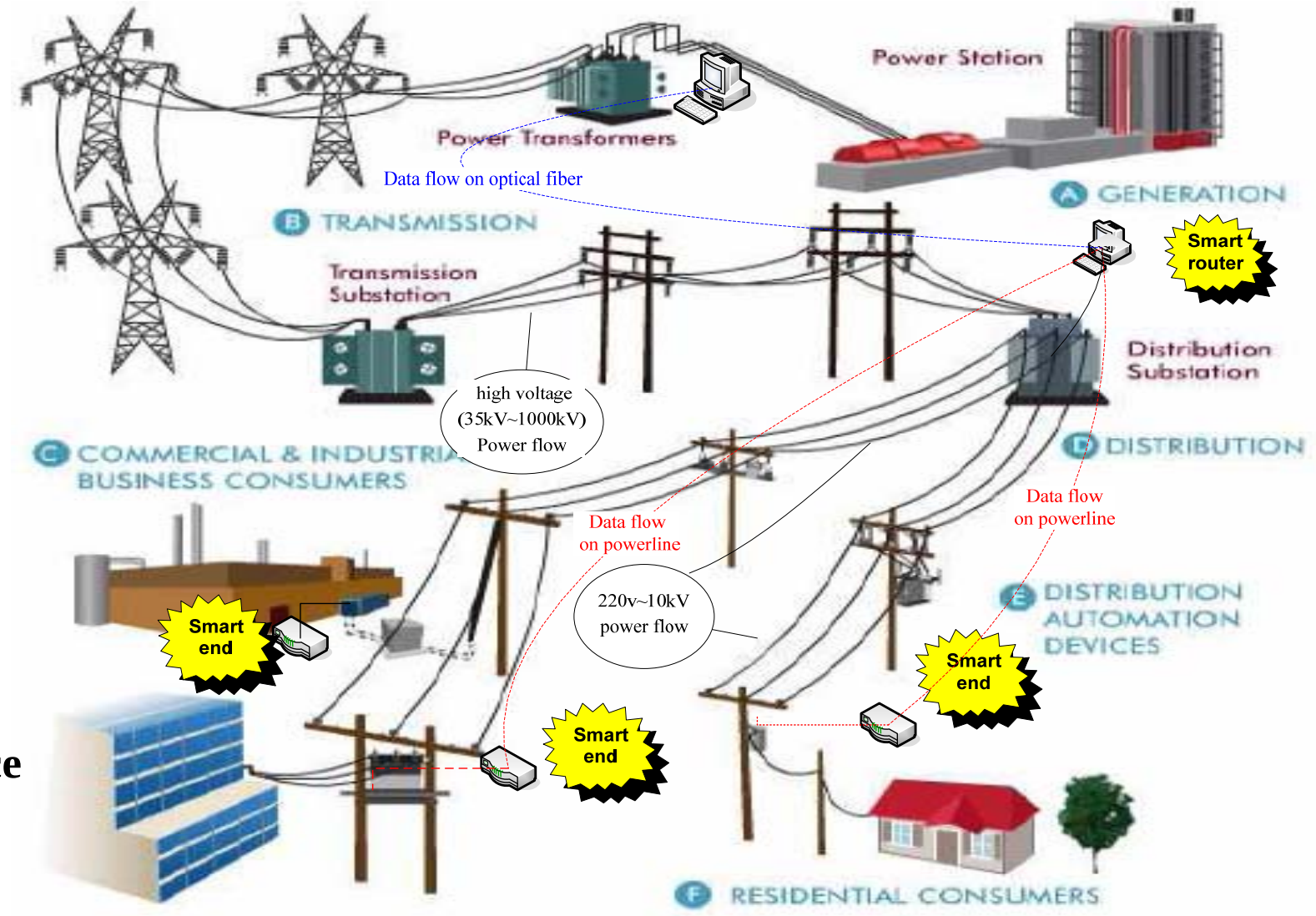
Introduction

PLC for SG Applications

- Remote Control
- Real-Time Power Price
- Equipment Inspection
- Demand Side Management

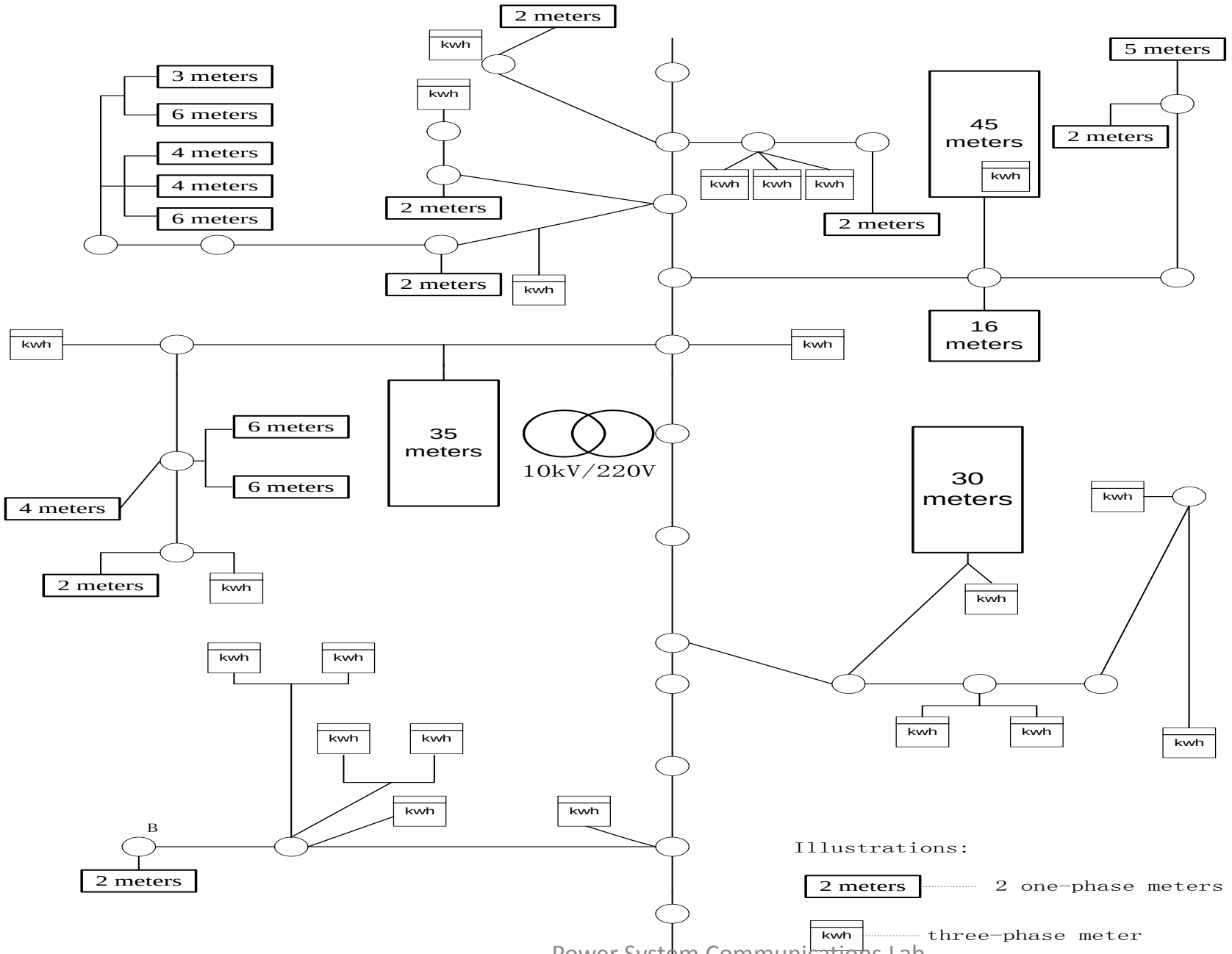
Narrow Band PLC

- Channel Characteristics
- Dynamic resource allocation
- Channel Sensing
- Networking

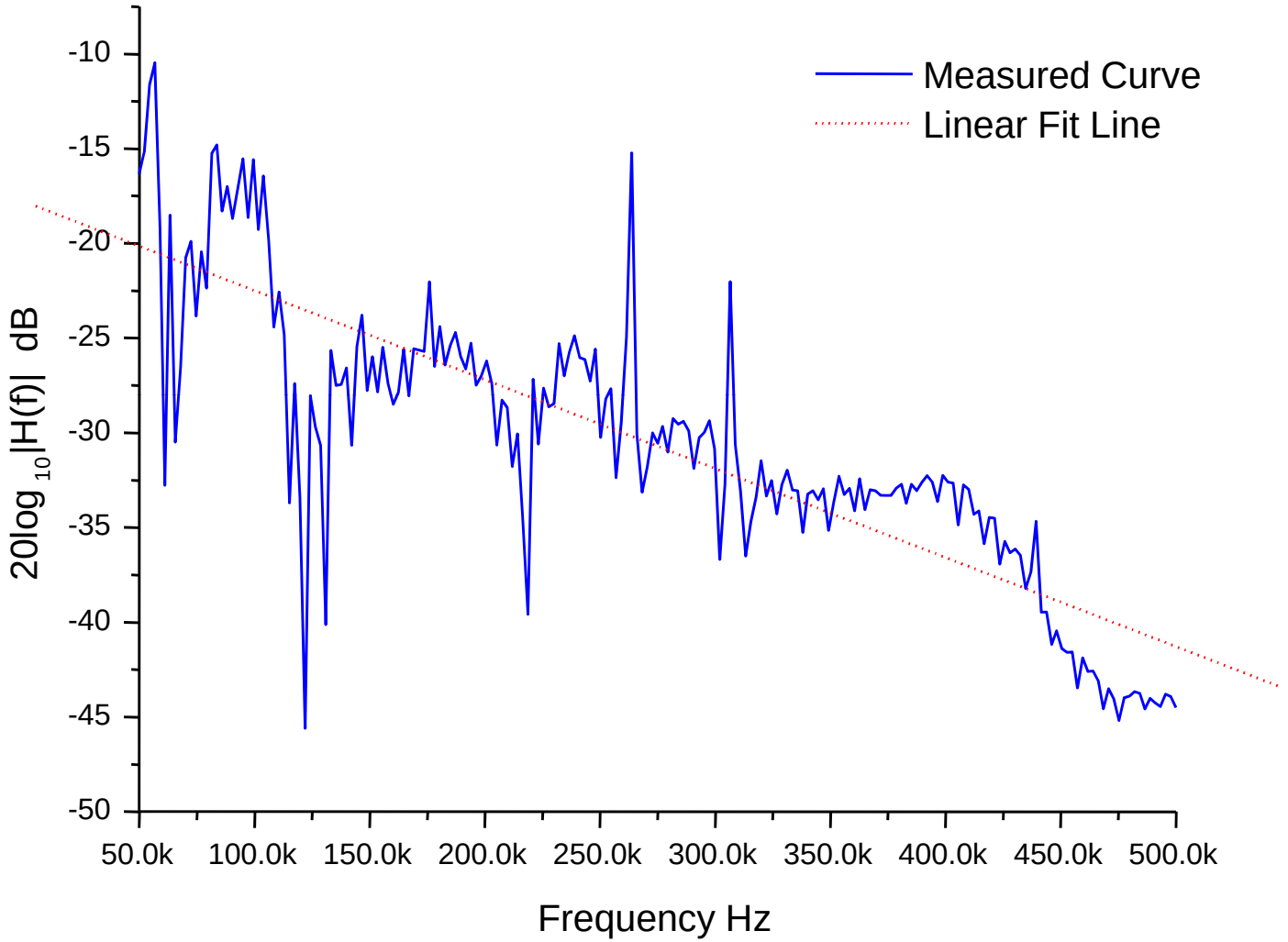


Power Grid Structure （Power and Data flow）

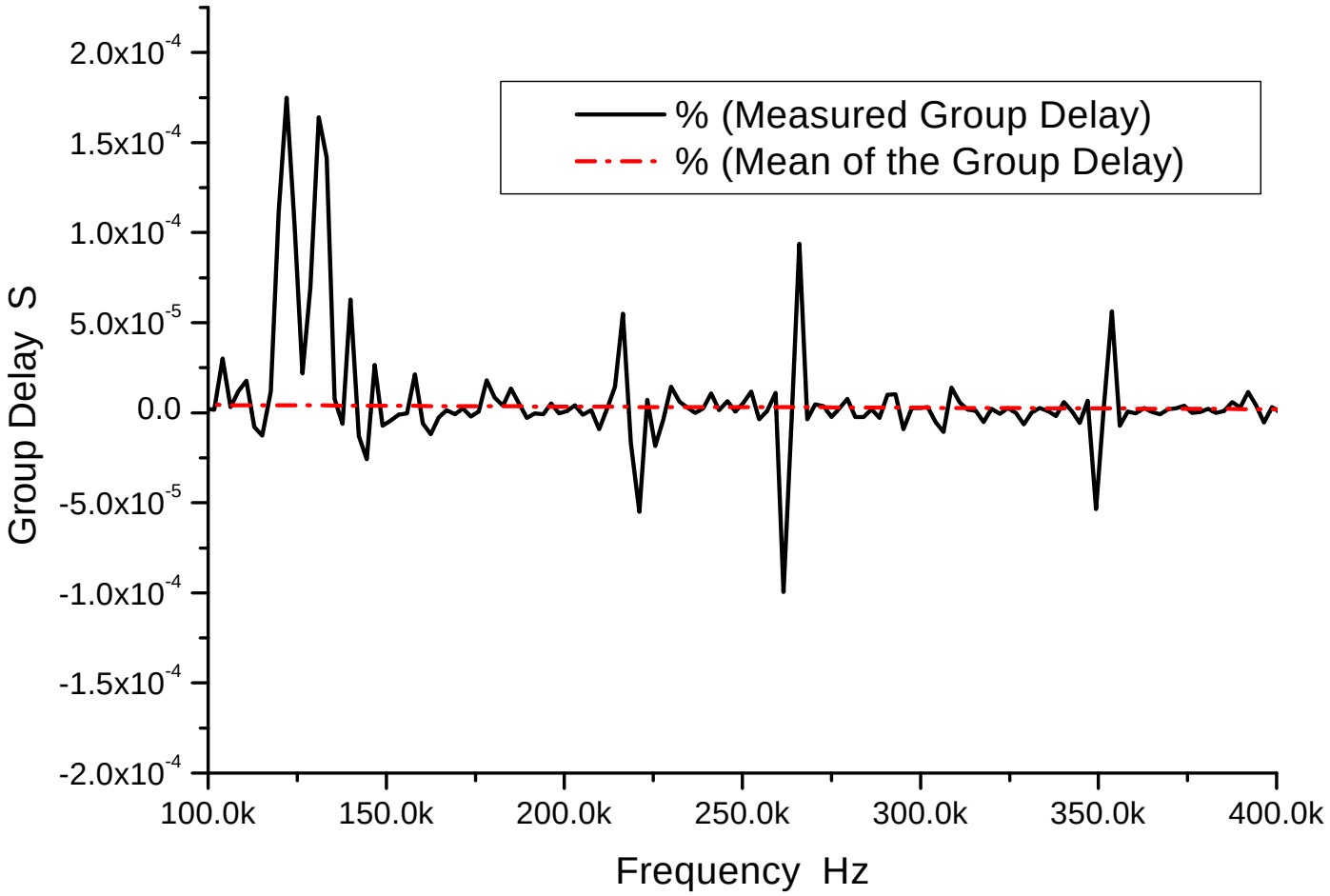
A real power grid in northeast of China in which AMR System is realized by our group.



❑ Channel Characteristics: in-phase Transmission

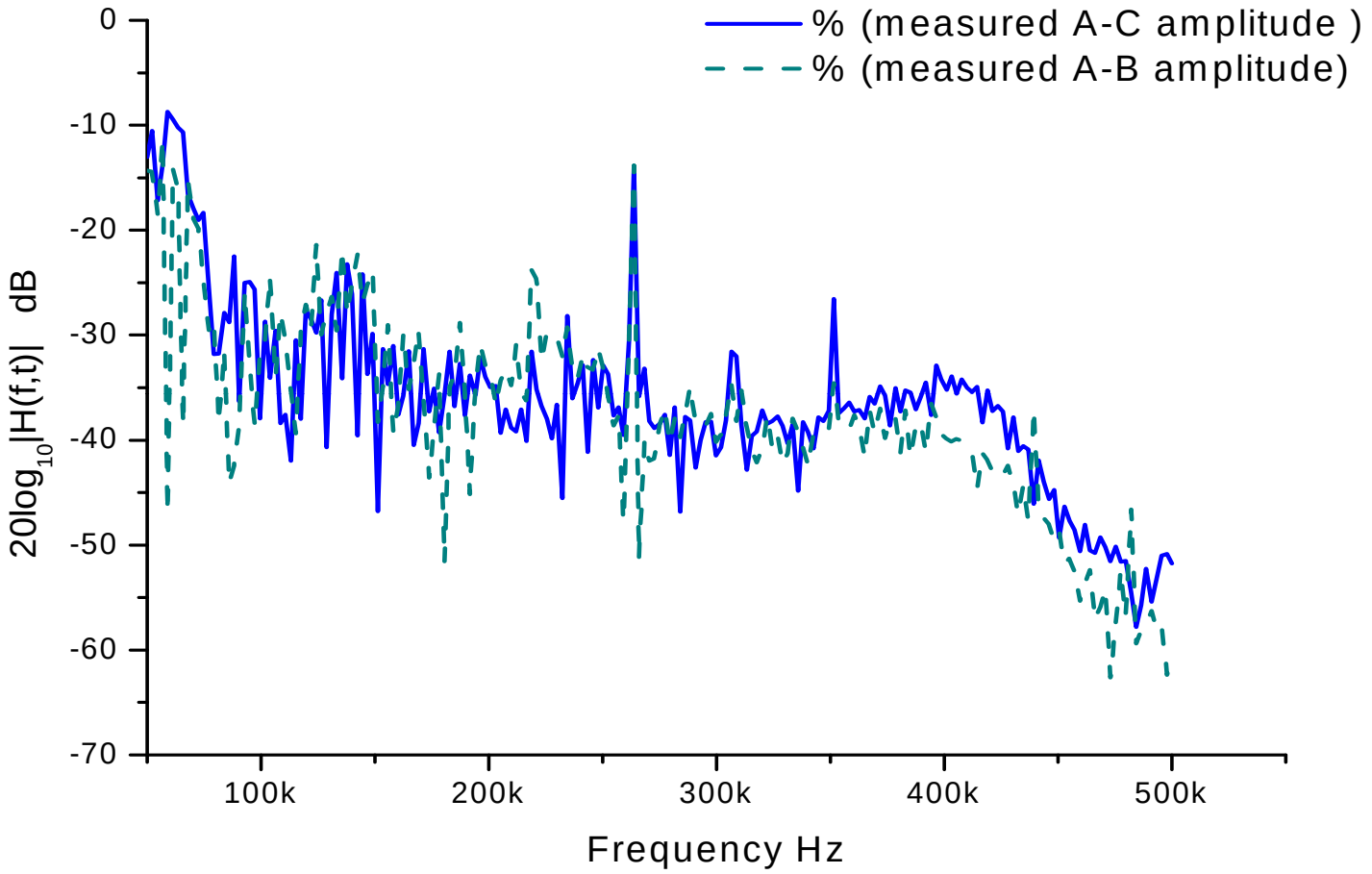


❑ Channel Characteristics: in-phase Transmission

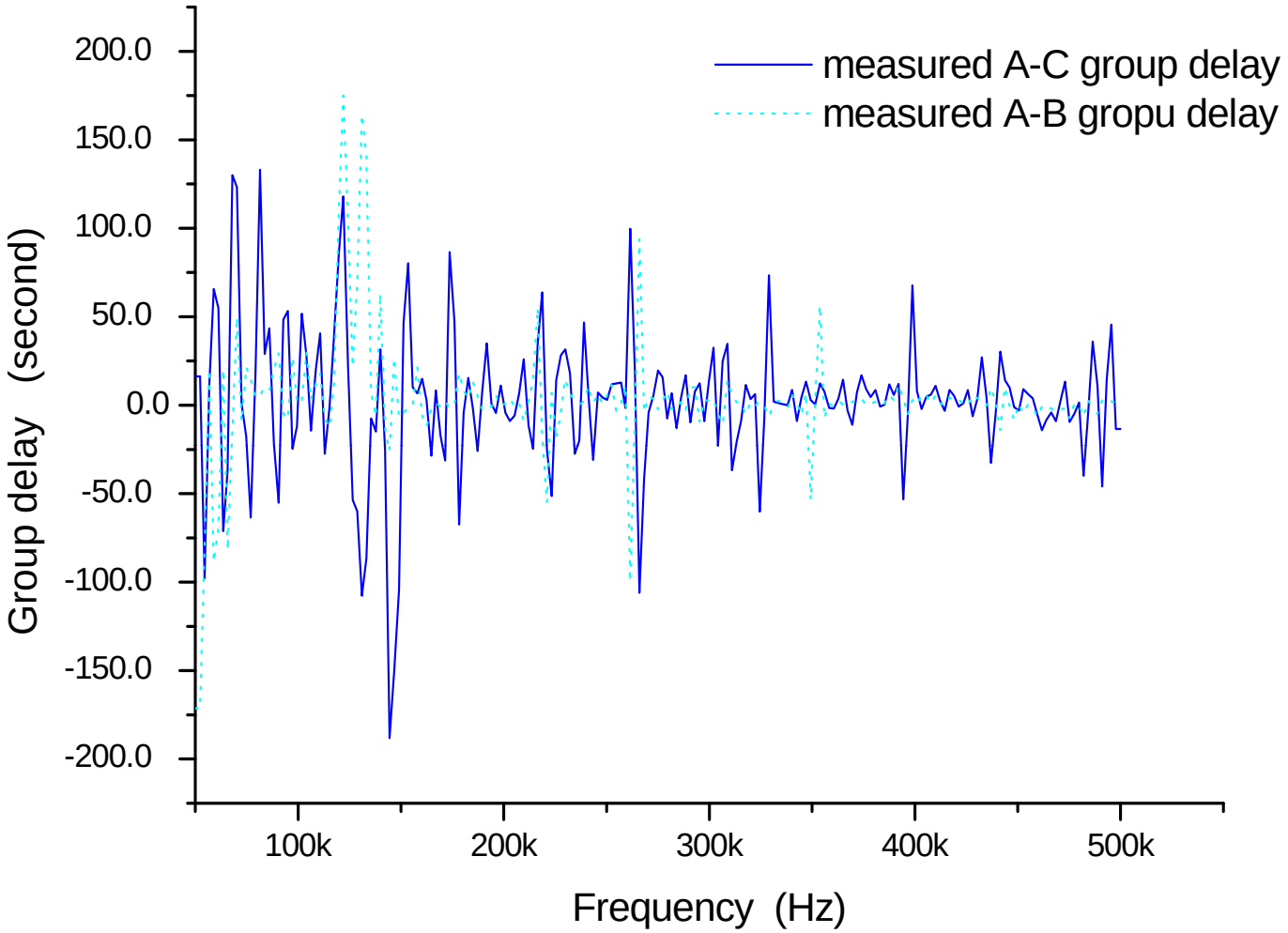


The Group delay-frequency of in-phase Transmission

❑ Channel Characteristics:Cross-phase transmission

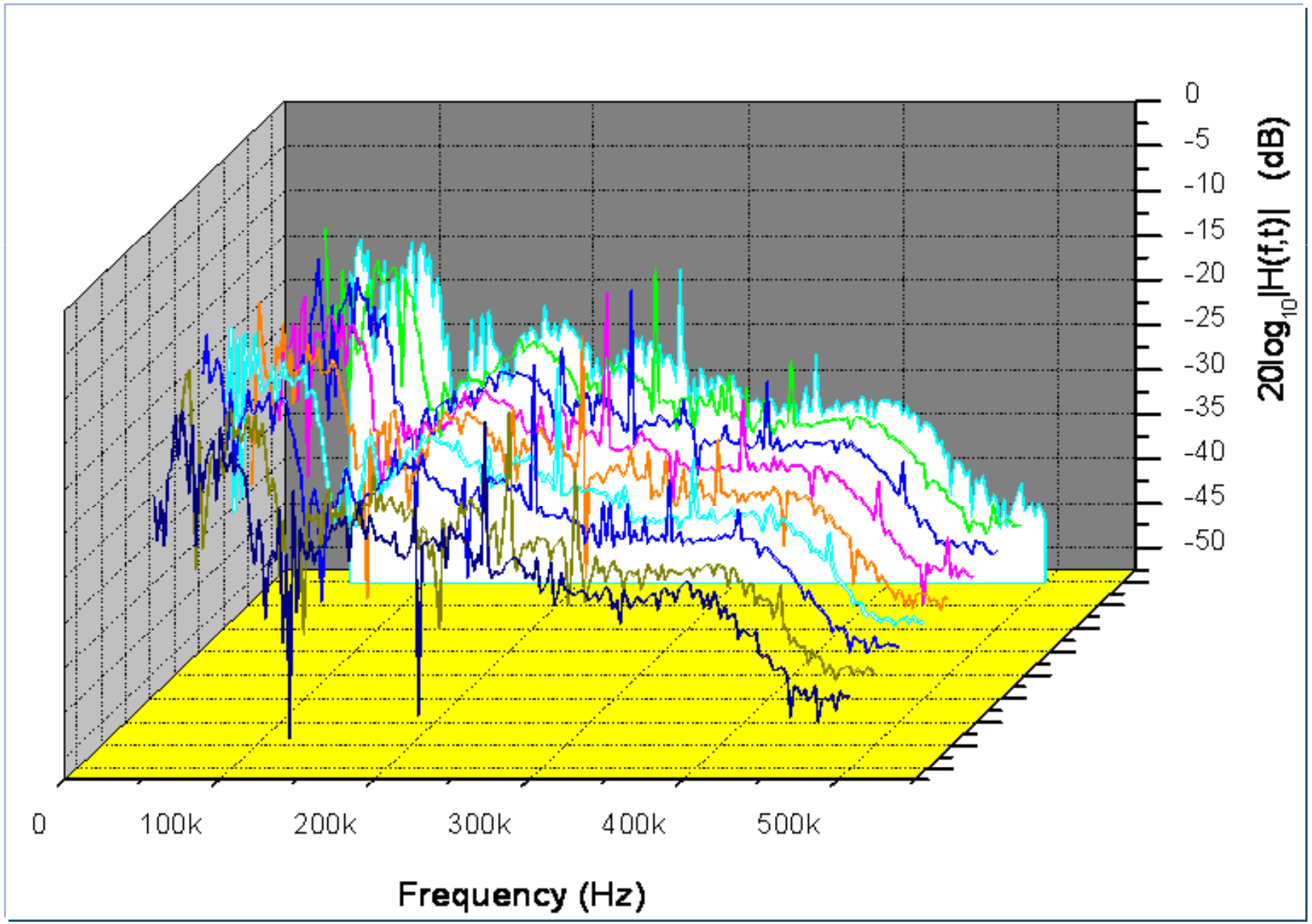


❑ Channel Characteristics: Cross-phase transmission



The Group delay-frequency Characteristics of Cross-phase Transmission

❑ Channel Characteristics: Stationary Property



❑ Dynamic resource allocation

For Stationary Channel, Not need to Allocate Every Transmission. ONLY ADJUST!

$$R = \frac{1}{2N}\sum_{n=1}^{N}\log_2(1+\frac{|H(f_n)|^2\varepsilon_n}{\Gamma\sigma_n^2}) = \frac{1}{2N}\sum_{n=1}^{N}\log_2(1+\varepsilon_n g_n)$$

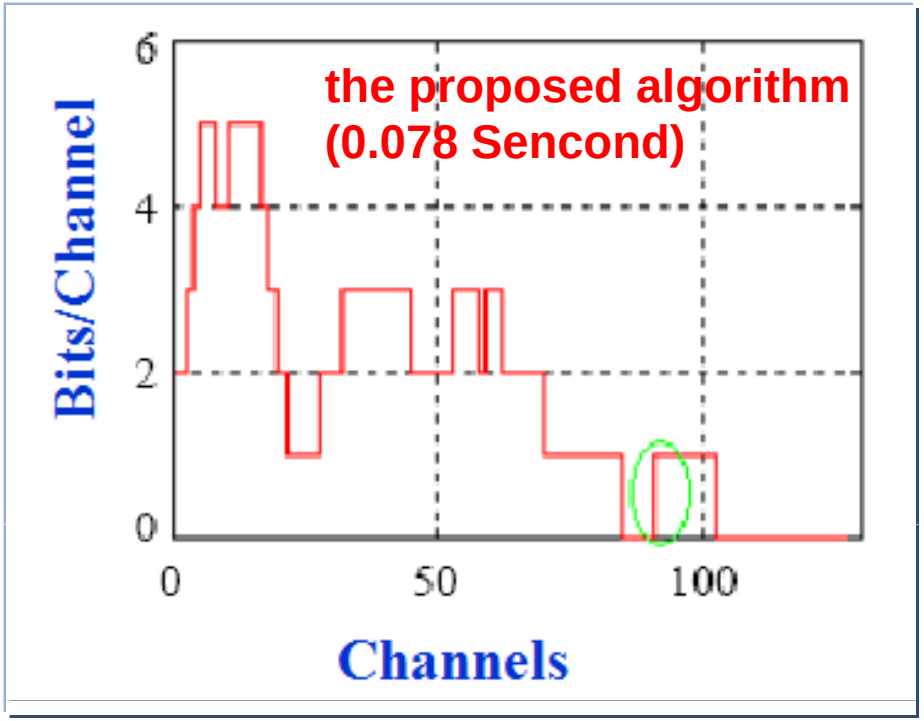
$$b_n = \log_2(1+g_n\varepsilon_n)$$

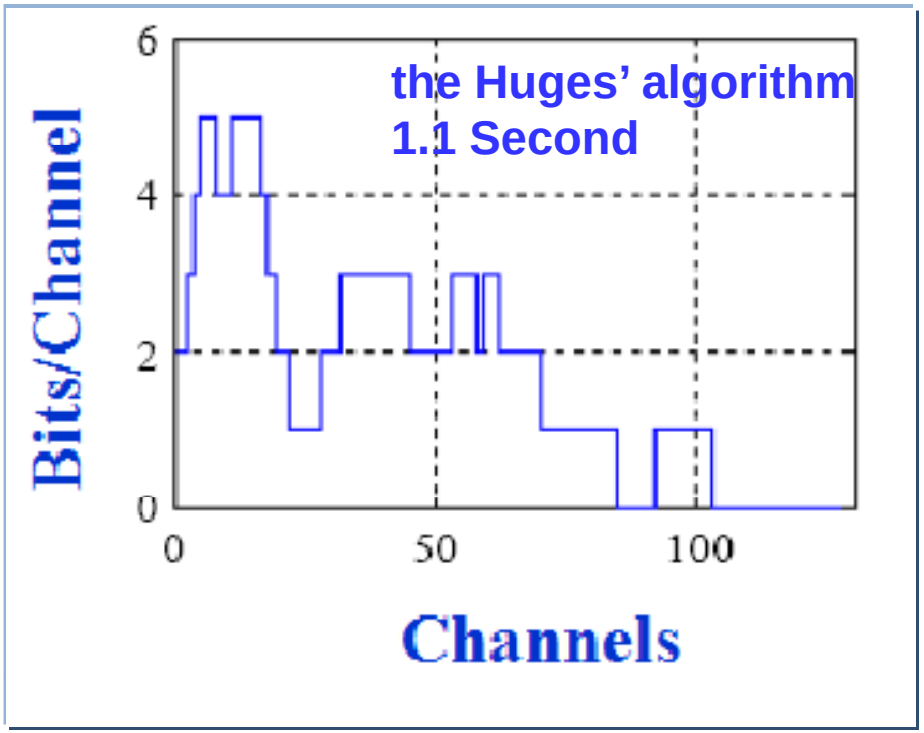
$$\varepsilon_n(b_n) = (2^{b_n}-1)/g_n$$

$$e_n(b_n)=\varepsilon_n(b_n)-\varepsilon_n(b_n-1)$$

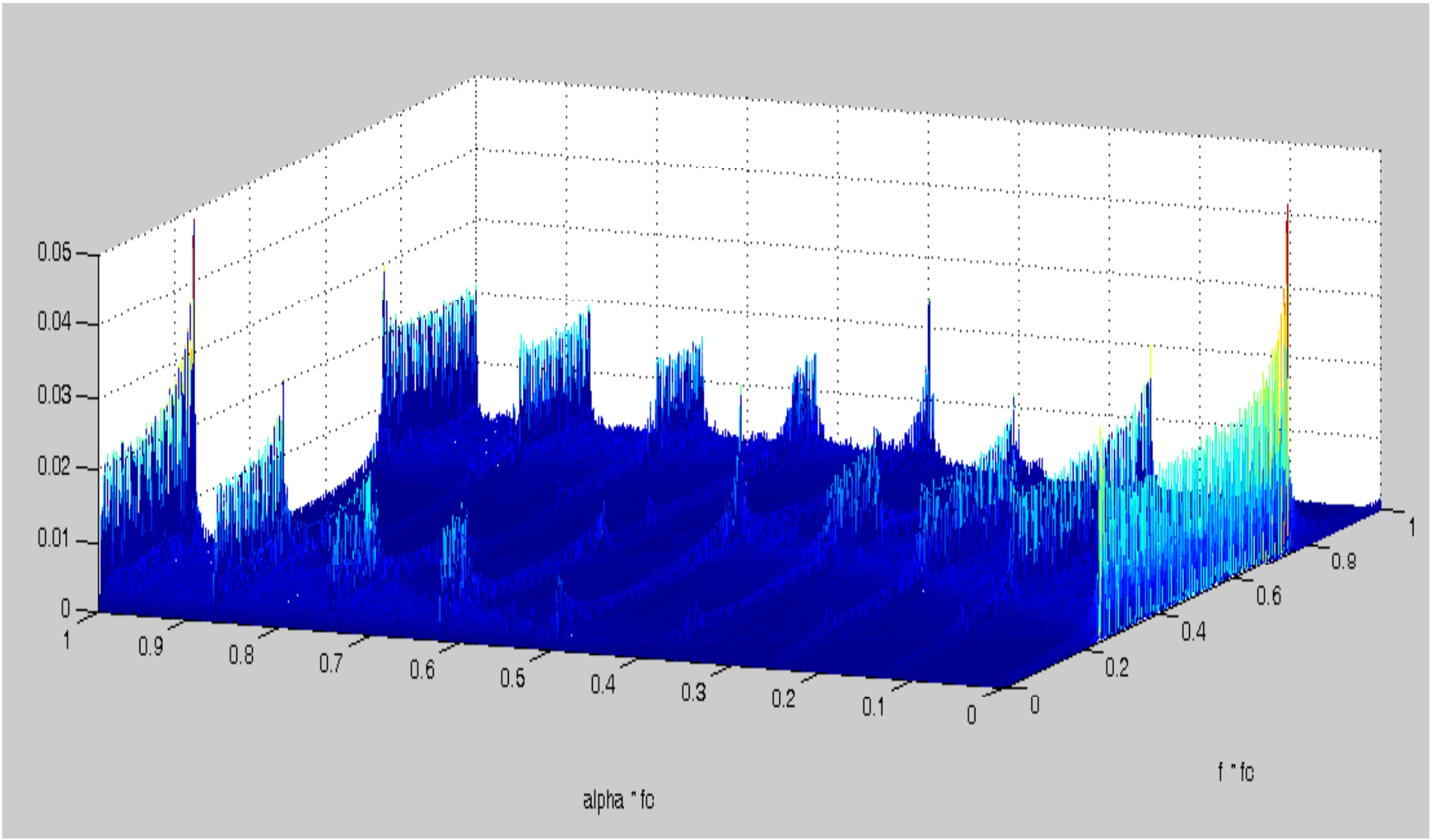
$$\max_{n=1\ldots N}[e_n(b_n)] < \min_{m=1\ldots N}[e_m(b_m+1)]$$

Tang Bo-Jin, Guo Jing-Bo, a novel non-iterative dynamic bit-loading algorithm for stationary channels and its application in OFDM power line communication, Proceedings of the Chinese Society of Electrical Engineering, December, 2005,25(24): 8-13.



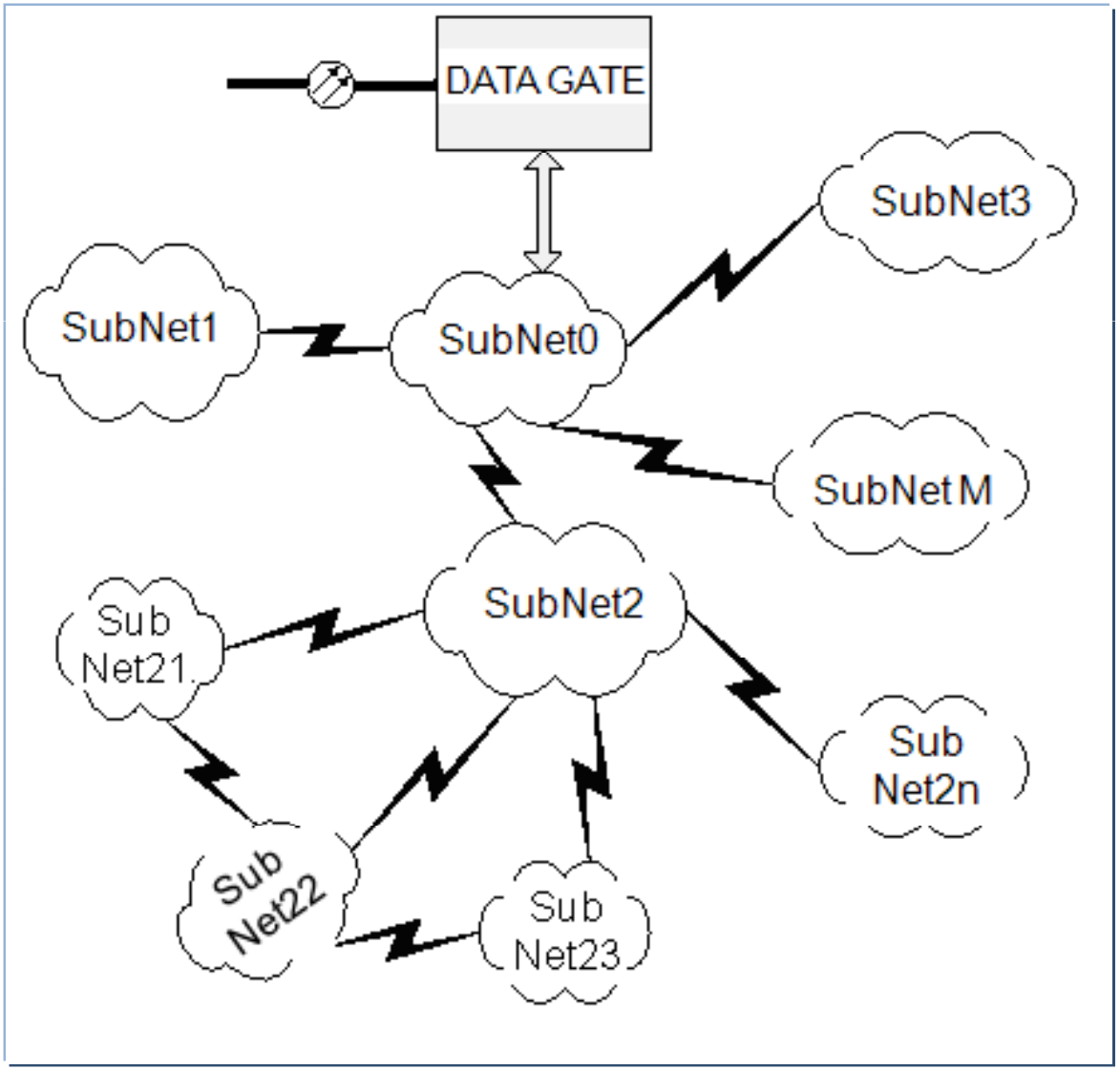


❑ Channel Sensing-Utilizing the Circular Stationary Property



$$s(t)=\mathrm{Re}\{\sum_{i=0}^{N-1} d_i\, p(t-t_s)\, \mathrm{e}^{j2\pi f_i (t-t_s)}\}, t_s \le t \le T+t_s \qquad R_x^{\alpha}(\tau)=\begin{cases} E\left\{|c_{n,j}|^2\right\}\dfrac{\sin(\pi t)}{T_0 \sin(\pi t/N_c)} e^{-j\pi\frac{N_c-1}{N_c}t} \displaystyle\sum_{t=0}^{T_0-1} g(t-t_0)g(t+\tau-t_0)e^{j2\pi\alpha t} \\ 0, \text{others} \end{cases}$$

❑ Networking


DATA GATE
SubNet3
SubNet1
SubNet0
SubNet M
SubNet2
Sub Net21
Sub Net2n
Sub Net22
Sub Net23

❑ Conclusion

Narrow Band PLC

- **Channel Characteristics: In-phase Transmission (Constant Group delay)**
- **Dynamic resource allocation: non-iterative dynamic bit-loading algorithm for stationary channels .**
- **Channel Sensing: Sensing-Utilizing the Circular Stationary Property.**
- **Networking: SubNET and routing.**