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Title: **Toward a System Impairment Model**

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none

Purpose:

Toward a System Impairment Model

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With thanks also to:

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Lucille Rouault, ENST/NIST

Val Rhodes, Intel

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Process

- Identify primary performance degradation sources
- Model and parameterize these sources
- Establish performance metrics
- Establish baseline characterization techniques

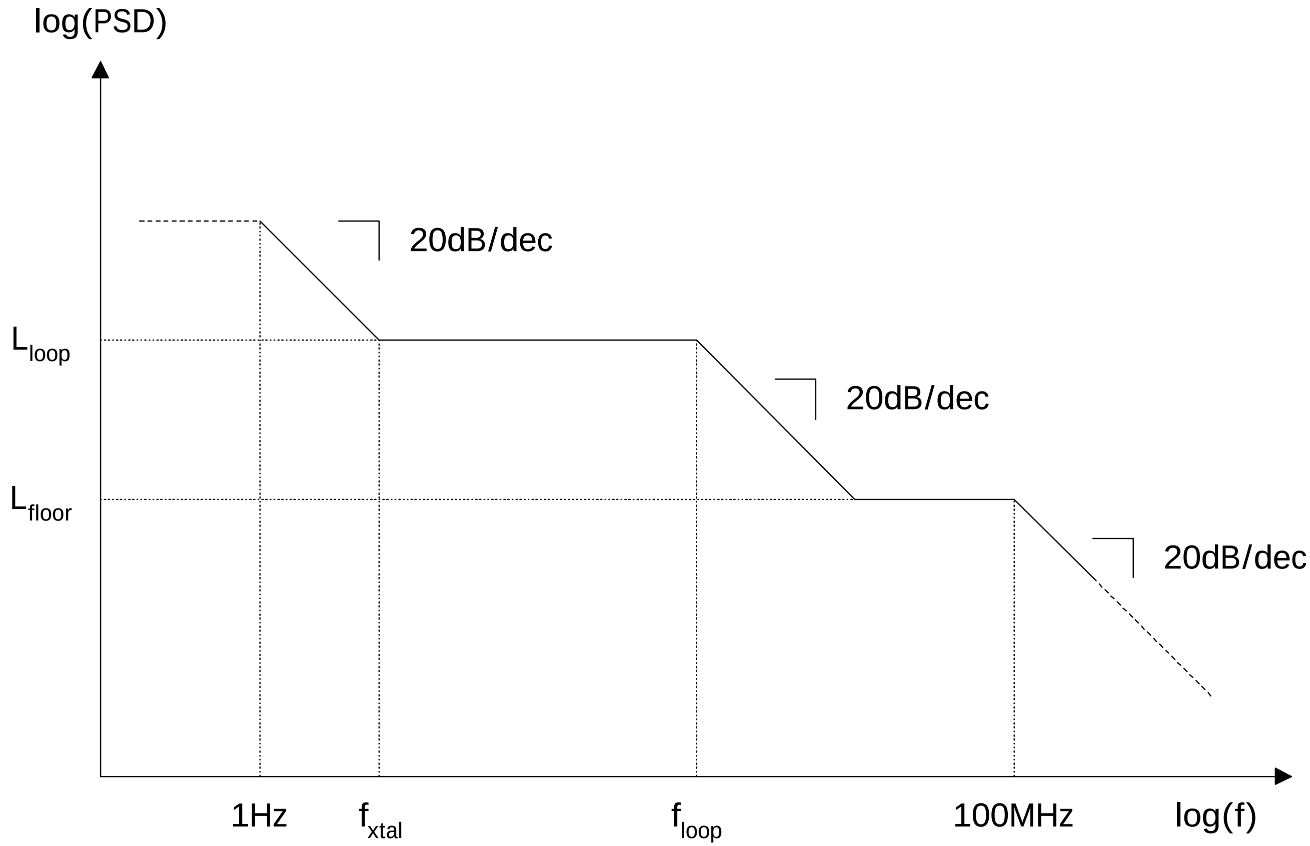
Performance degradation sources

- Phase noise
- Power amplifier
- Multi-path
- Model parameters may be
  - Set by group and simulated by contributors
  - Stated and simulated by contributors

Phase noise assumptions

- Purpose: weighing sensitivity of different proposals to phase noise – **not an interface specification**
- Transmitter mmW up-converter and receiver mmW down-converter are expected to dominate phase noise
- Based on PLL-oscillator model

SSB phase noise PSD, L(f)



Phase noise model

- The model has four parameters
  - Corner frequency for crystal phase noise
  - Corner frequency for PLL loop
  - LO noise floor level
  - PLL phase noise level
- Two parameters for ease of simulation are a zero at 1Hz, and a pole at 100MHz
- To ease simulation, 1/f noise is not accounted for

Phase noise notes

- Thermal noise, discrete spurs and demodulator induced phase noise are **NOT** included in this model.
- Model is to be used for comparison purposes, **NOT** for precise performance evaluation

Power amplifier model

- Two model are proposed
  - Saleh model
  - Rapp model

Saleh model

- Characterize non-linearity in terms of AM/AM and AM/PM conversion functions
- Complex PA envelope is given by
  $Z = A(r)\cdot\exp\left\{ j\cdot(y + f(r))\right\}$
- AM/AM conversion $A(r) = 2r/(1+r^2)$
- AM/PM conversion $f(r) = 2f_0\cdot r^2/(1+r^2)$
- A.A.M.Saleh “frequency-independent and frequency-dependant non-linear models of TWT amplifiers” IEEE trans. Commun. Vol COM-29, pp. 1715-1720, Nov 1981

Rapp model

- A family of saturation curves

$$v_{OUT} = v_{IN} \Big/ \left(1 + \left(|v_{IN}| / v_{SAT}\right)^{2P}\right)^{1/(2P)}$$

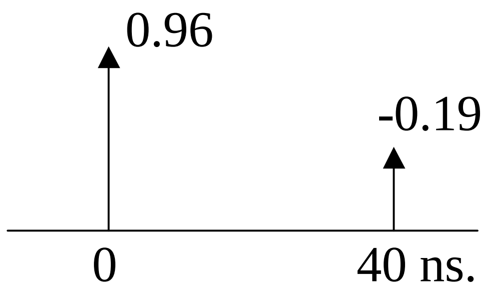
- Where $P_{SAT} = |v_{SAT}|^2$ is the saturated power of the amplifier (P=2)
- The performance metric is lowest backoff, where $Backoff = -10\log\left(Avg\left(|v_{OUT}|^2\right) / P_{SAT}\right)$

Review of Channel Models and/or Measurements for mm-Wave Fixed Wireless Channels with Highly Directional Antennas

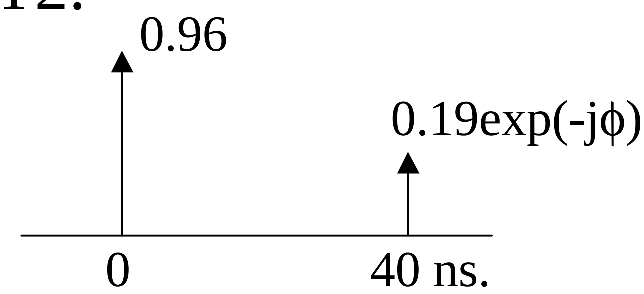
- Papazian et al. measurements in Northglen:
  - P.B. Papazian et al., "Study of the Local Multipoint Distribution Channel", IEEE Trans. Broadcasting, June 1997.
- ETSI/BRAN models:
  - ETSI/BRAN document HAPHY151TL03**,** "Channel model suitable for bands over 20 GHz", 21 Sept. 1999.
- 802.11 model adapted to BBW (N. Chayat):
  - "Some Models for Comparing PHY Proposals", N. Chayat, IEEE80216pc-YY/nn, Jan. 12, 2000
- CITR measurements in Ottawa:
  - "Multipath Measurements and Modelling for Fixed Broadband Wireless Systems in a Residential Environment", D. Falconer, IEEE80216pc-00/01, Dec. 20, 1999.

ETSI/BRAN

T1:



T2:

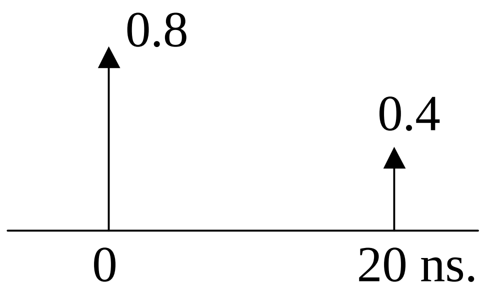


$$\varphi = \pi(1 - 0.8(40\ \text{ns.})/T_{symbol}))$$

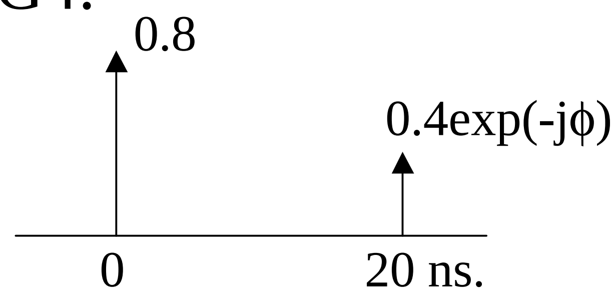
Based on measurements in Europe by Telia

ETSI/BRAN (cont.) and Papazian

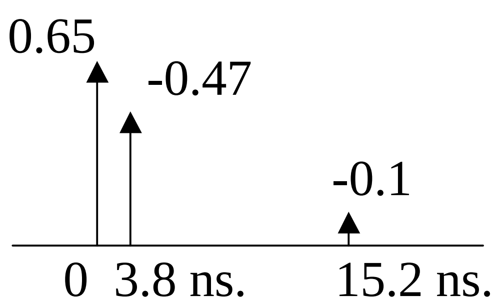
G3:



G4:

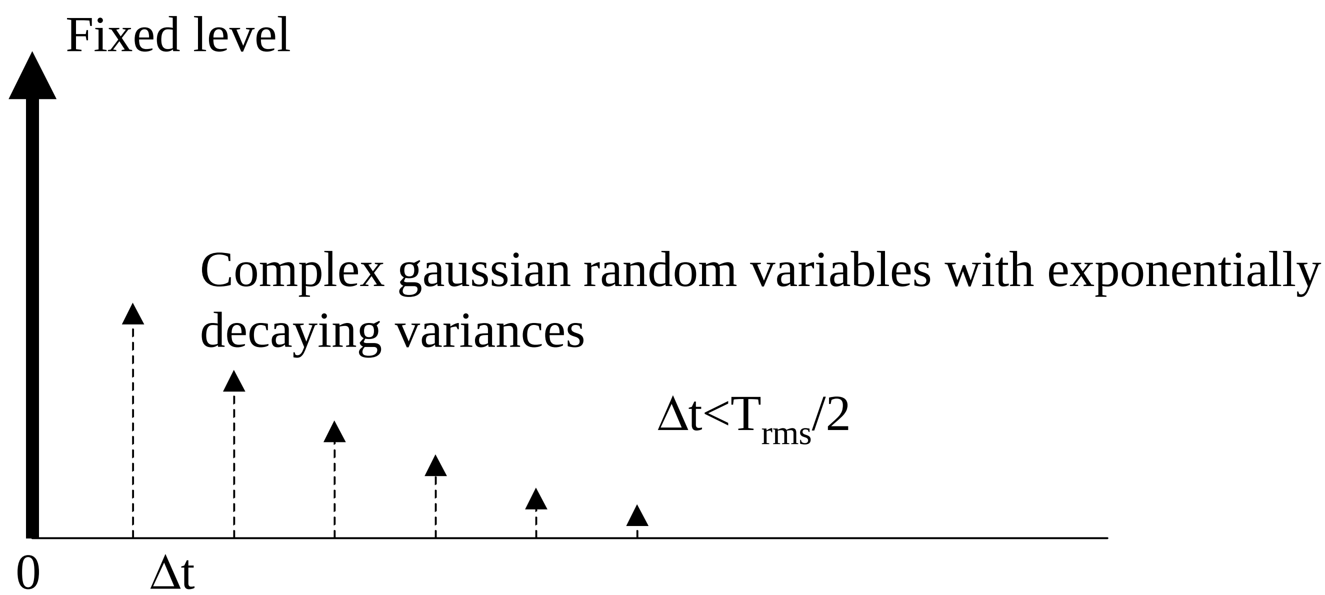


L7/Papazian:



$\varphi=\pi(1-0.8(20 \text{ ns.})/T_{symbol}))$

Adapted 802.11 Model

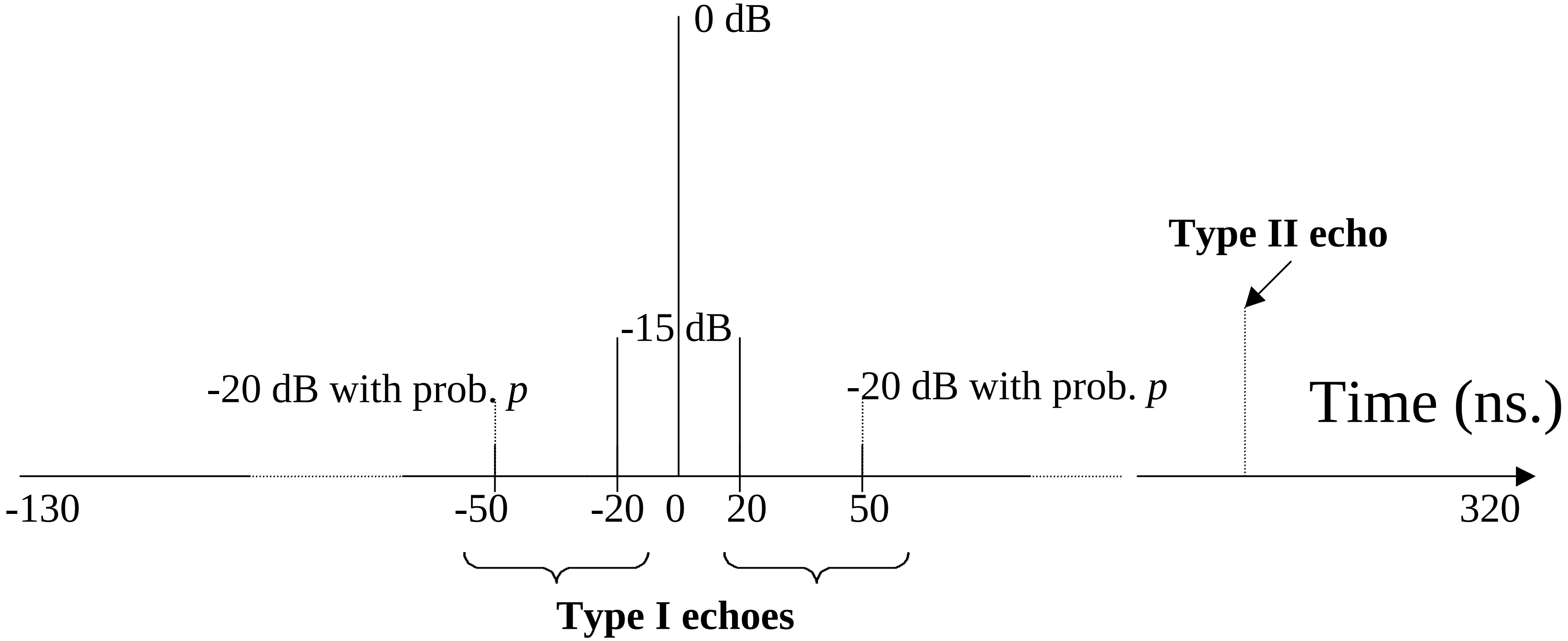


Suitable for:

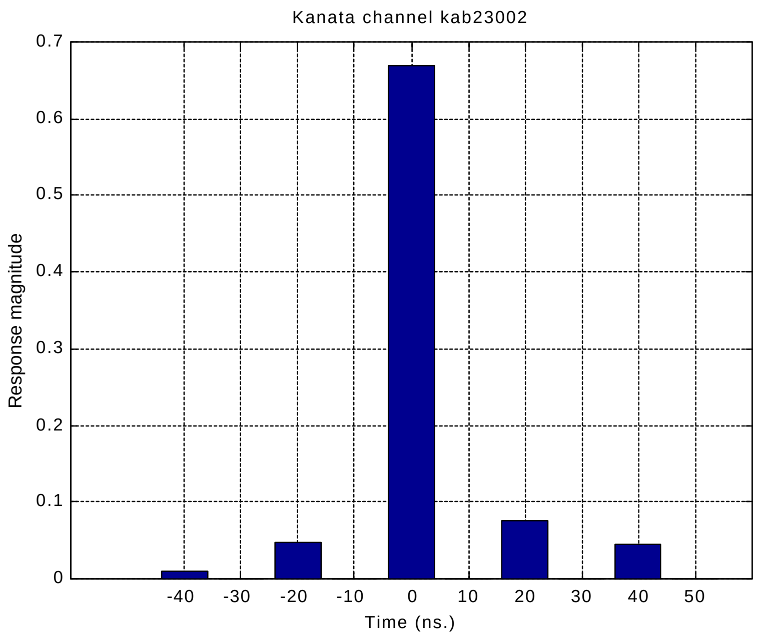
- Low antennas/ non LOS with <u>many</u> incoming echoes
- Or wide antenna beams

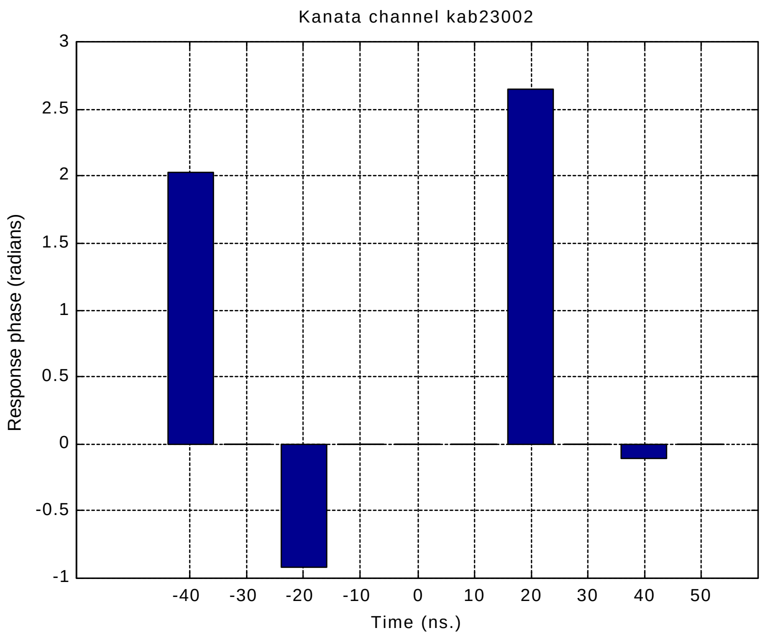
Model Suggested in IEEE802.16tc-00-01

- Based on deviations of measured responses from their means.
- Echoes are zero-mean complex gaussian.

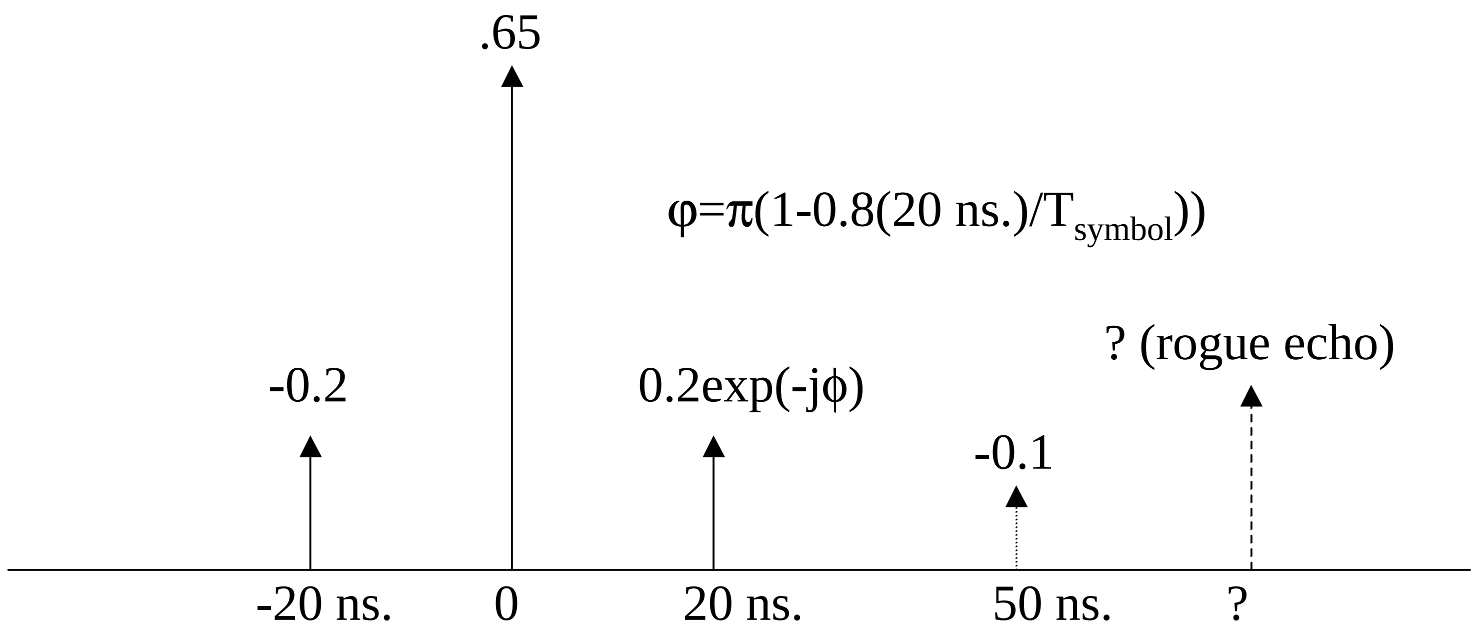


A Measured Kanata Response



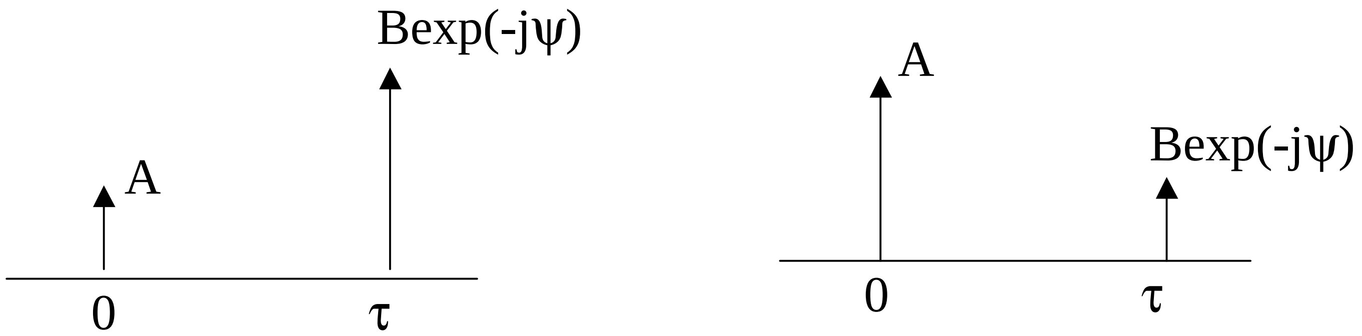


A "Straw Man" Model



Time variation? -- slow compared to symbol rate

A “Straw Man” Model (cont.)



A=0.4, B=0.8

$-\pi<\psi<\pi$

$0<\tau<100$ ns.