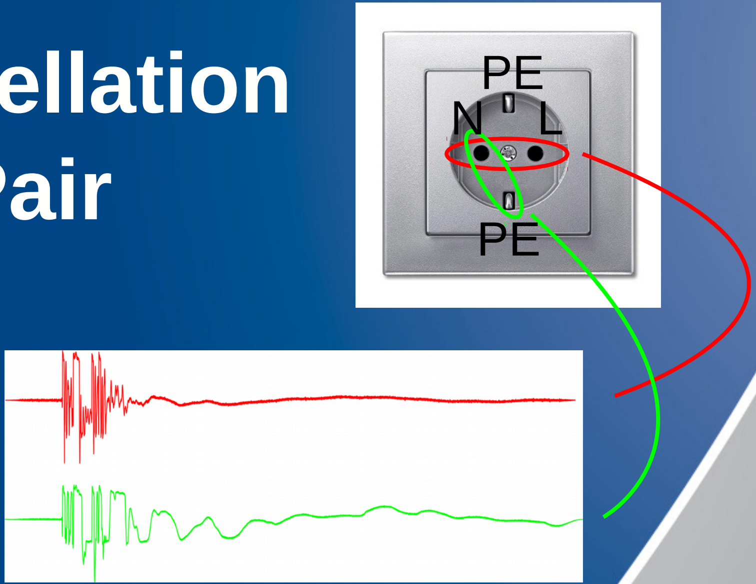
Impulse Noise Cancellation Using a Reference Pair



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Oana Graur, Khodr Saaifan,
Uwe Pagel

WSPLC workshop, Prague, 2017

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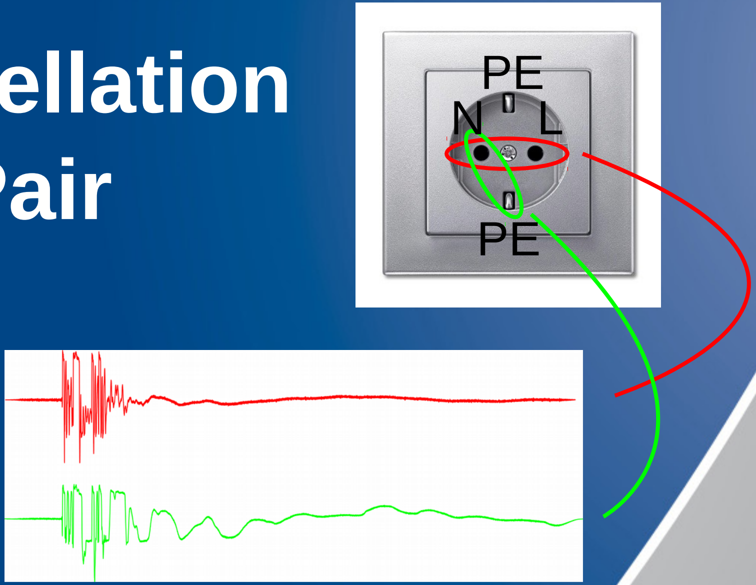


- Some impulse-noise properties
- Cancellation
- Other possibly treatments

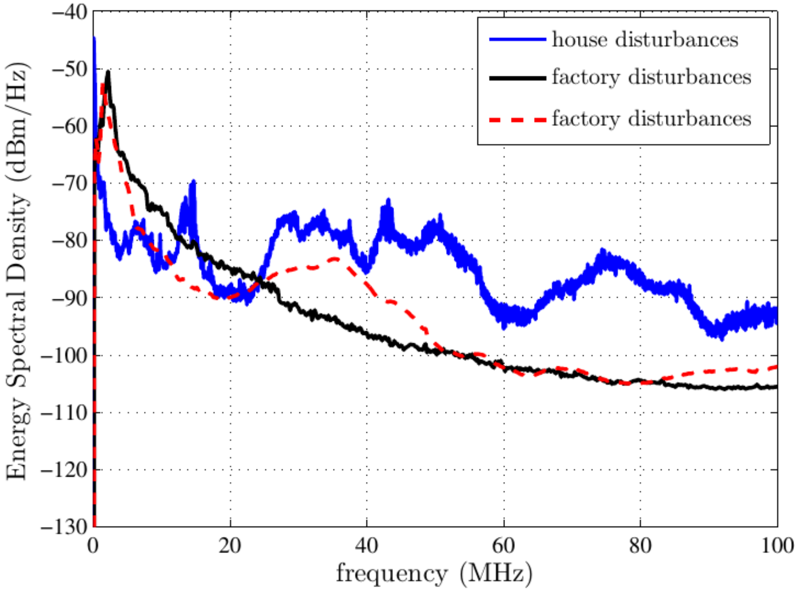
Some impulse noise properties

Zimmermann and Dostert:

1) periodic impulsive noise asynchronous to the mains frequency with a repetition rate between 50 and 200 kHz,

2) periodic impulsive noise synchronous to the mains frequency with a repetition rate of 50 or 100 Hz,

3) asynchronous impulsive noise caused by switching transients.



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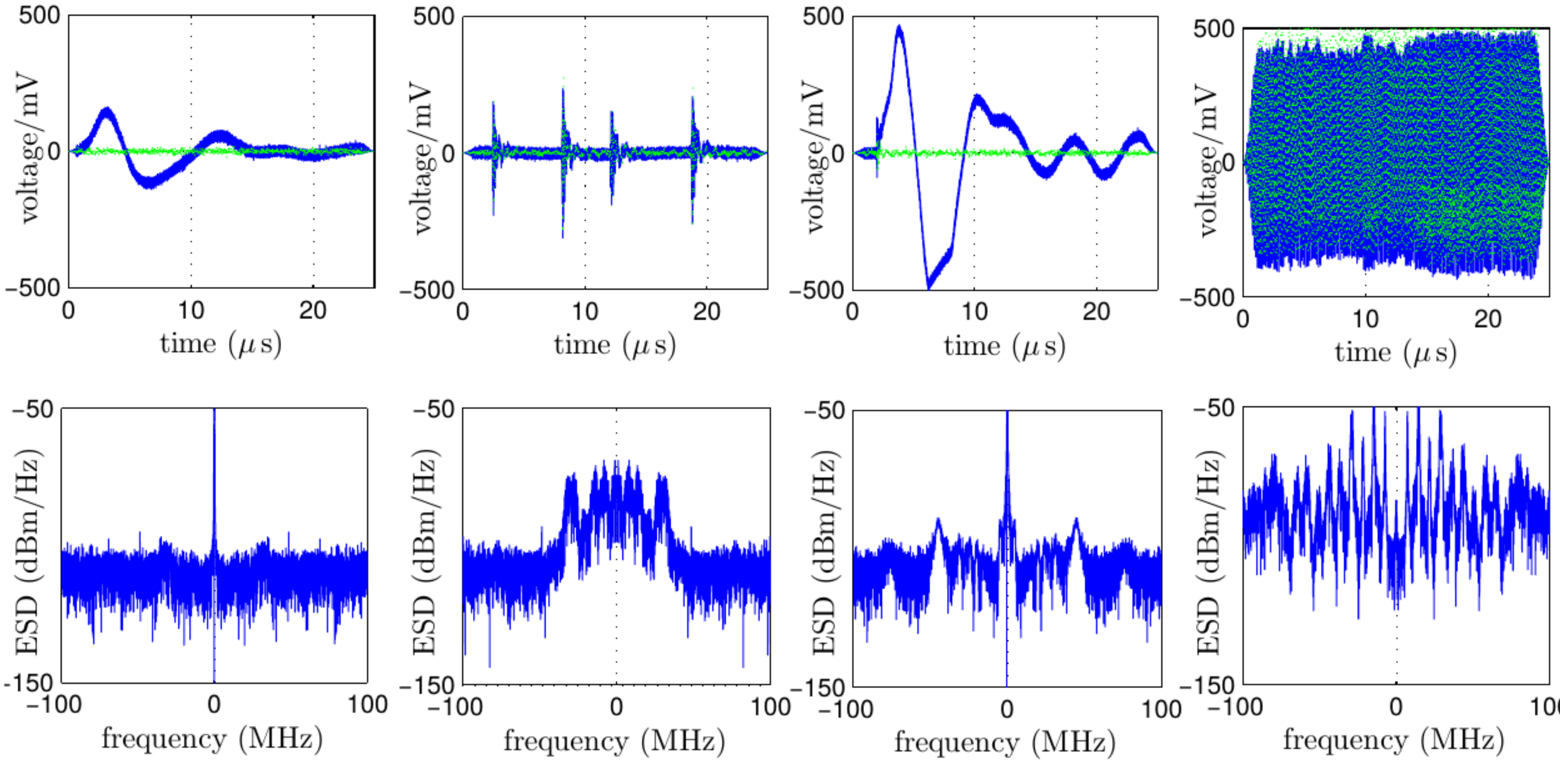
Some impulse noise properties



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Some impulse noise properties

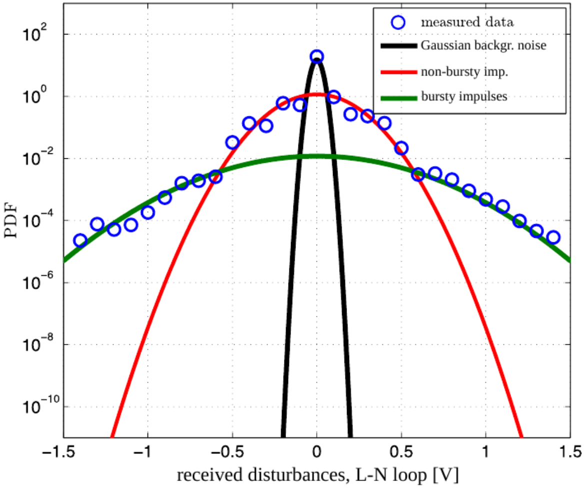
Gaussian mixture modeling

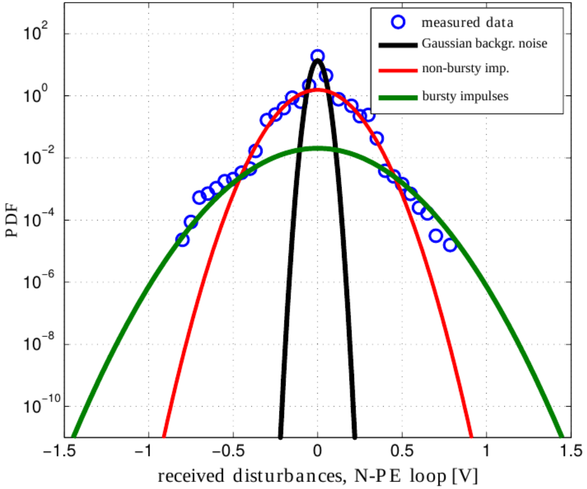
$$p(z) = \sum_{m=0}^{2} \frac{\alpha_m}{\sqrt{2\pi\sigma_m^2}} e^{-\frac{z^2}{2\sigma_m^2}}$$

Linked to Middleton's Class A model

Others…

Generalized Gaussian, SαS





Measured data	$\bar{T}_I$ (μs)	λ_I (pps)	$\bar{E}_I$ (W/Hz)
non-bursty imp.	2.5	23	7.2×10^{-8}
bursty impulses	100	0.05	7.2×10^{-7}

Measured data	$\bar{T}_I$ (μs)	λ_I (pps)	$\bar{E}_I$ (W/Hz)
non-bursty imp.	2.5	23	4×10^{-8}
bursty impulses	100	0.05	2.4×10^{-7}

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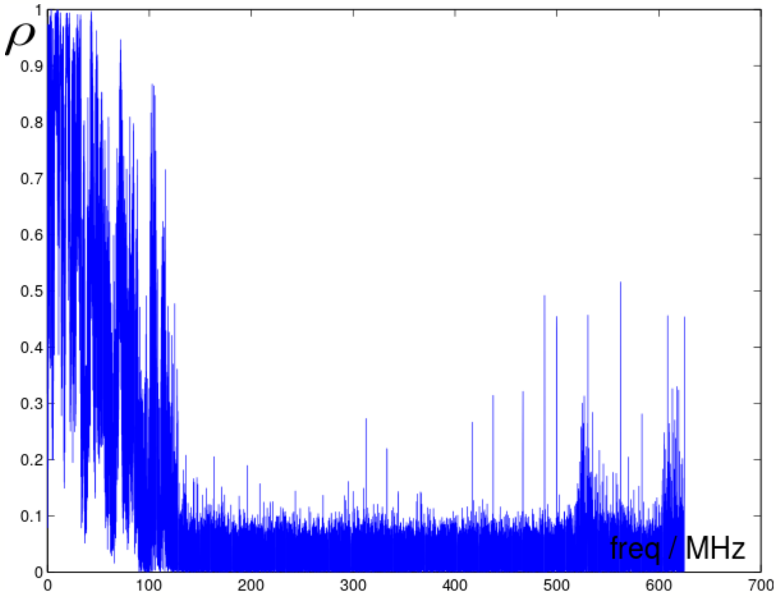
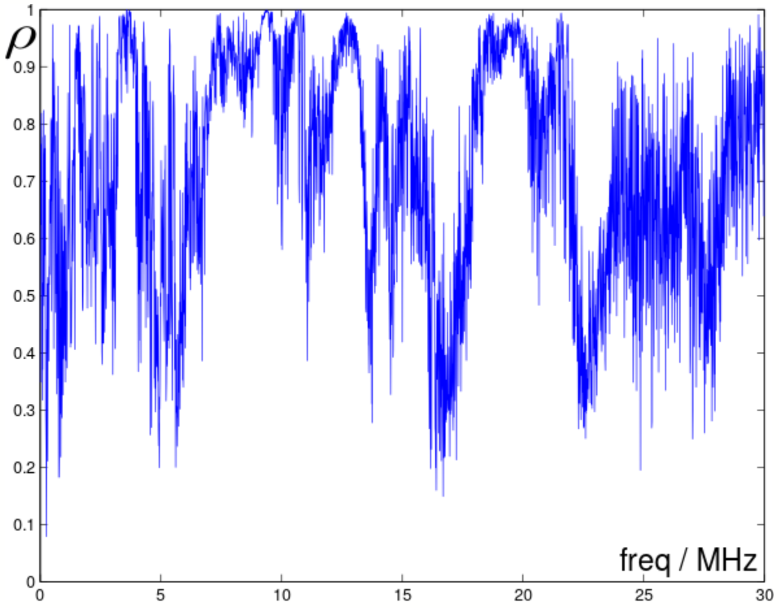
Some impulse noise properties

L-N – N-PE correlation

correlation coeff.	$m = 0$ Gaussian backgr.	$m = 1$ isolated imp.	$m = 2$ bursty imp.
$\rho_{m,L-N,N-PE}$	0.6	0.86	0.89





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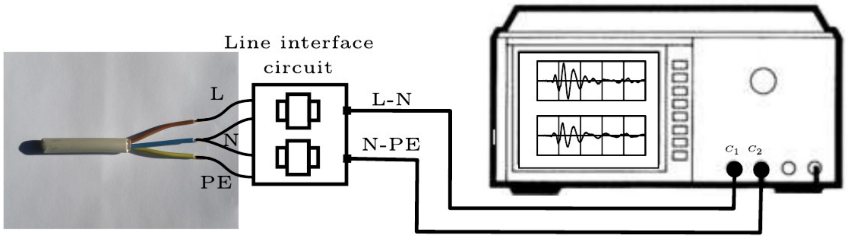
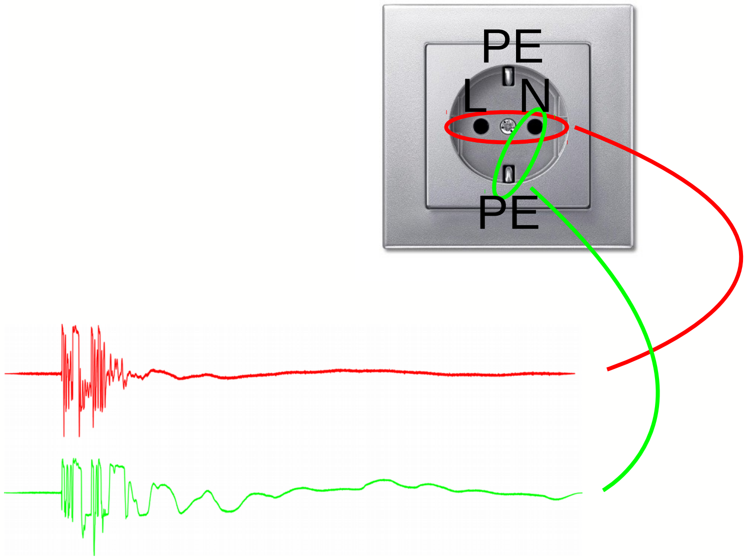
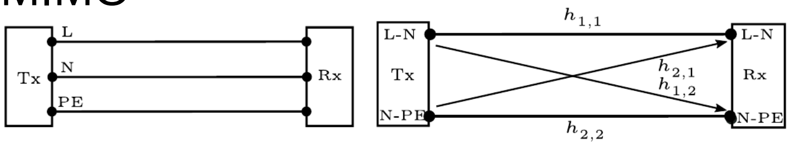
Impulse noise cancellation

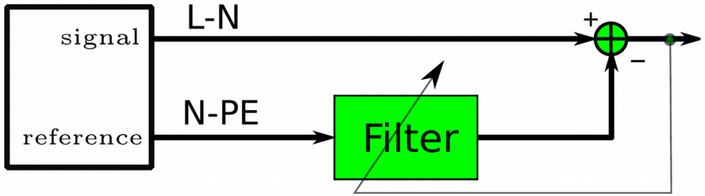




MIMO



correlation coeff.	$m = 0$	$m = 1$	$m = 2$
	Gaussian backgr.	isolated imp.	bursty imp.
$\rho_{m,L-N,N-PE}$	0.6	0.86	0.89



NLMS trained canceller

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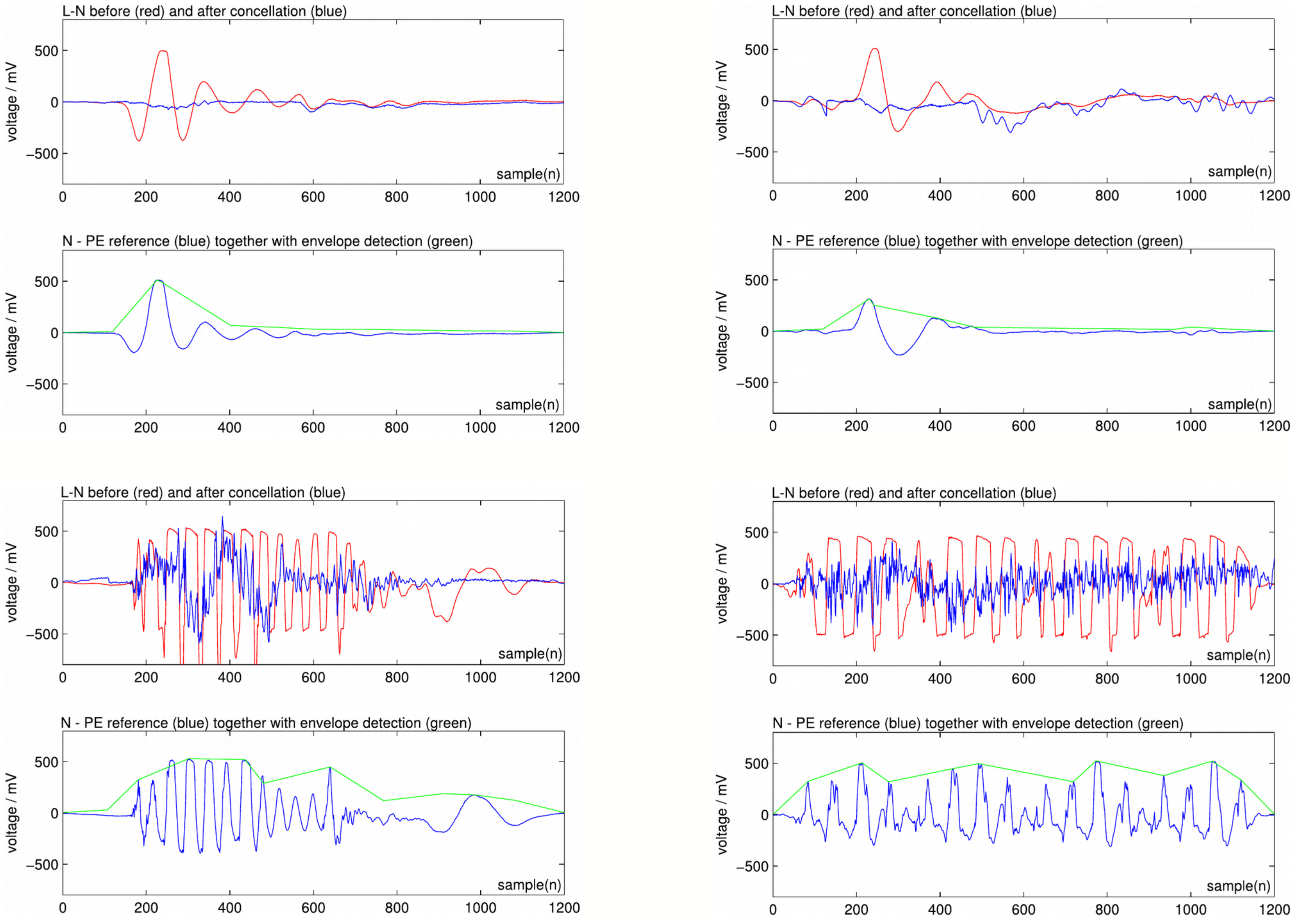
Impulse noise cancellation



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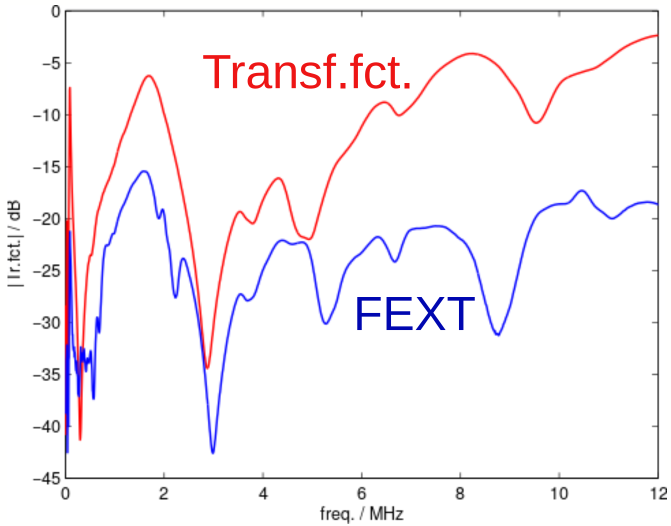
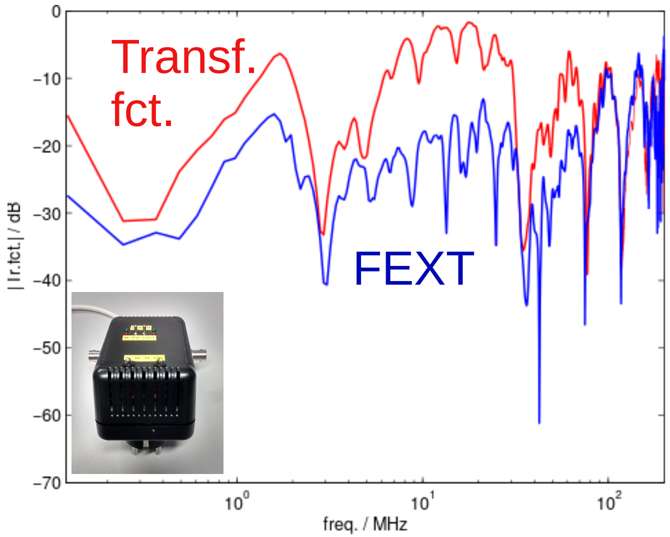
Impulse noise cancellation

Critical can be signal cancellation due to a high FEXT contribution, at least for high bandwidths





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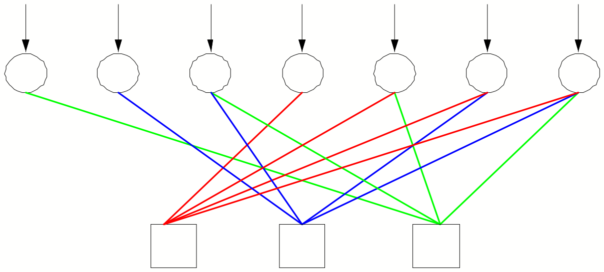
Other options for impulse noise treatment
... using impulse noise CSI information in decoding

RS coding: erasure marking for bytes hit by impulse noise

Soft decision decoding, e.g., for Turbo and LDPC codes:

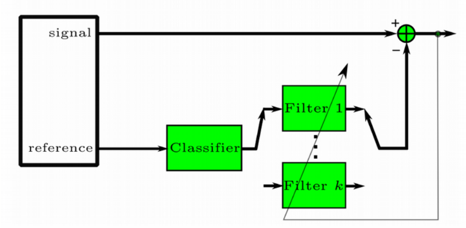
One has to estimate the state of the noise, i.e., the standard deviation, since the intrinsic LLR is

$$LLR = \frac{2a}{\sigma^2} \cdot y$$

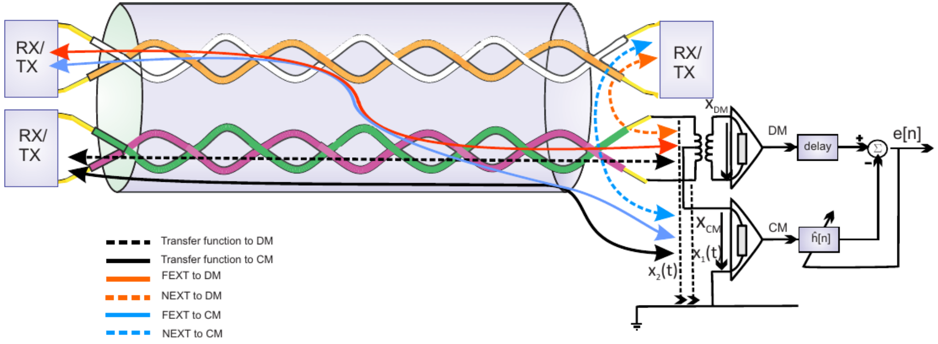


Other options for impulse noise treatment

- Impulse type detection and canceller selection



- Common mode reference, just as with twisted pairs



Other options for impulse noise treatment

- Lechleider‘s coordinated transmission / noise whitening
- DFT-domain per-tone cancellation
- Sparsity-based approaches, i.e., compressive sensing

$$\text{minimize} \|\mathbf{e}\|_1$$
$$\text{subject to } \|\mathbf{w} - \mathbf{F}_{\mathrm{S}}^{\mathrm{H}}\mathbf{e}\|_{\infty \text{ or } 2}$$

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