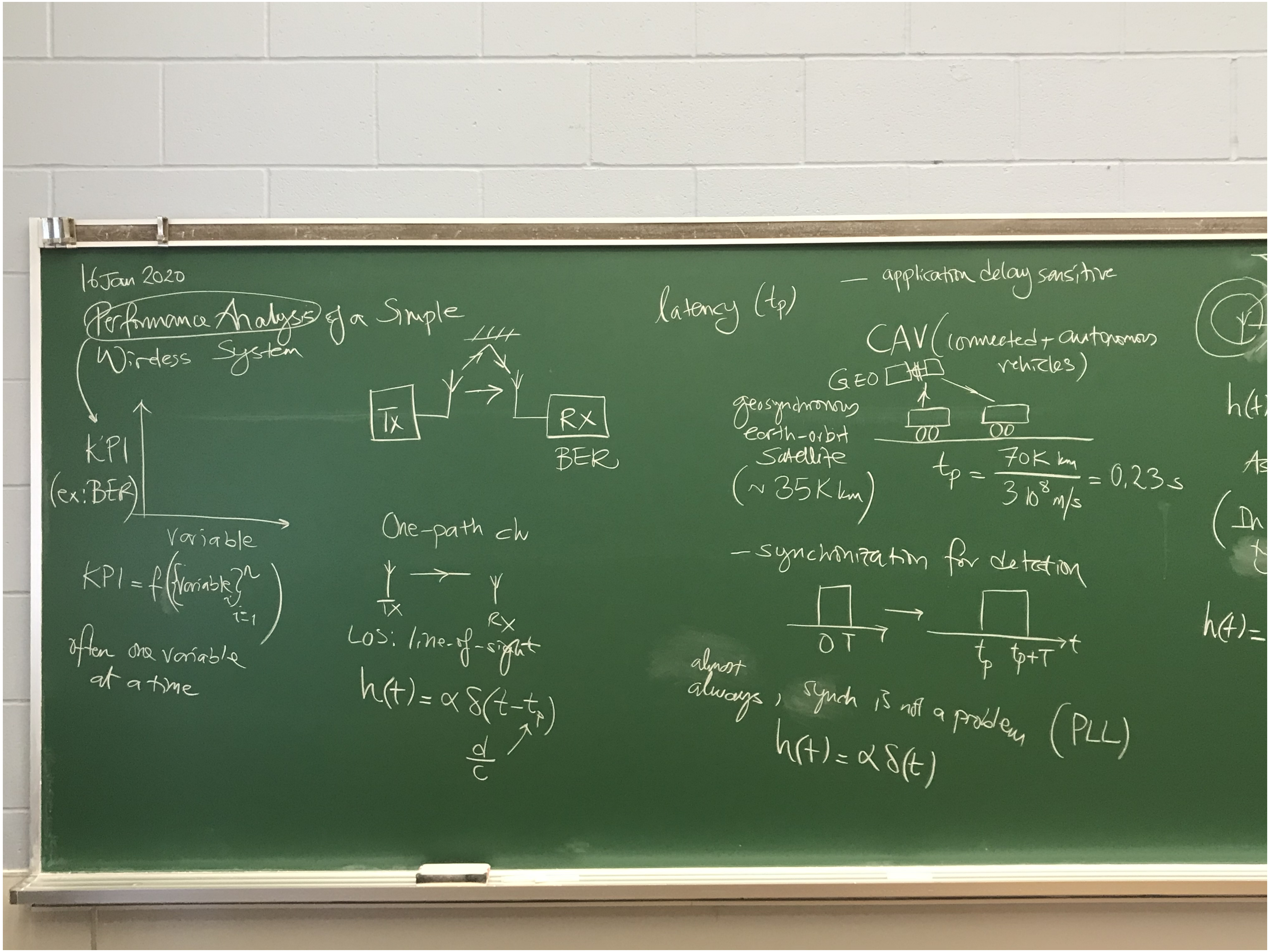
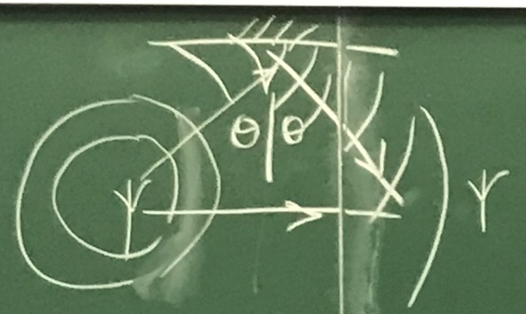


16 Jan 2020
Performance Analysis of a Simple Wireless System
KPI
(ex: BER)
Variable
KPI = f({Variable_i}_{i=1}^n)
often one variable at a time
Tx
Rx
BER
One-path ch
Tx
Rx
LOS: line-of-sight
h(t) = α δ(t − t_p)
d/c
latency (t_p)
— application delay sensitive
CAV (connected + autonomous vehicles)
GEO
geosynchronous earth-orbit satellite
(~35K km)
t_p = 70K km / 3 10^8 m/s = 0.23 s
— synchronization for detection
0 T
t_p t_p+T t
almost always, synch is not a problem (PLL)
h(t) = α δ(t)

…nomous

0.23 s



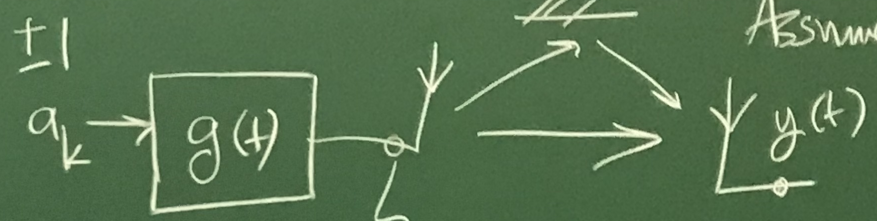
$$h(t) = \alpha\,\delta(t - t_1) + \beta\,\delta(t - t_2)$$

Assume $t_1 = 0$, $\alpha = \beta$

(In reality typically $\beta \leq \alpha \ll 1$)

$$t_2 - t_1 = \frac{\Delta d}{c}$$

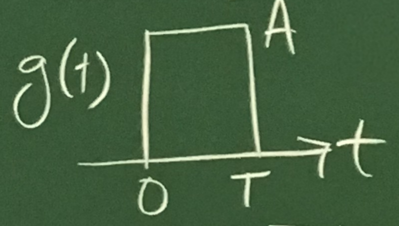
$$h(t) = \alpha\,\delta(t) + \alpha(t - \Delta t)$$



$$\sum_{k=-\infty}^{\infty} a_k\,\delta(t - kT)$$

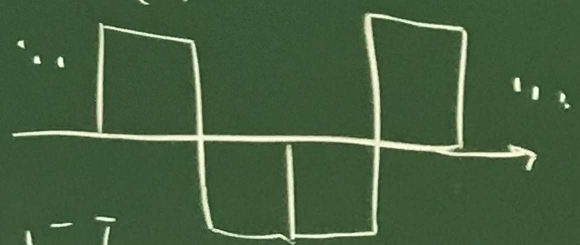
$$x(t) = \sum a_k\, g(t - kT)$$

Assume



T: bit duration

$x(t)$



$R = \frac{1}{T}$ b/s

Assume n…

$h(t) = \alpha$…

$y(t) = x($…

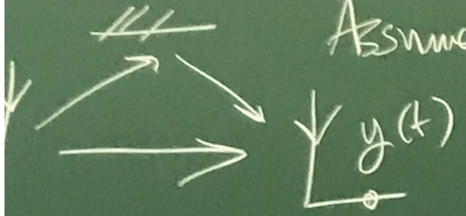
$= \alpha$…

$= \alpha \sum a_k$…

Assume…

$= \alpha \sum ($…

Assume



Assume $n(t)=0$

$$h(t) = \alpha\,\delta(t) + \alpha\,\delta(t-\Delta t)$$

$$y(t) = x(t) * h(t) + \cancel{n(t)}_{\swarrow 0}$$

$$= \alpha\,x(t) + \alpha\,x(t-\Delta T)$$

$$= \alpha \sum a_k\, g(t-kT) + \alpha \underbrace{\sum a_k\, g(t-[k+1]T)}_{k+1=l}$$

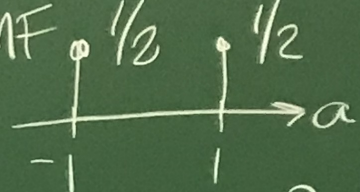
Assume $\Delta T = T$

$$\sum a_{l-1}\, g(t-lT) \qquad l=k$$

$$= \alpha \sum (a_{k-1}+a_k)\, g(t-kT)$$

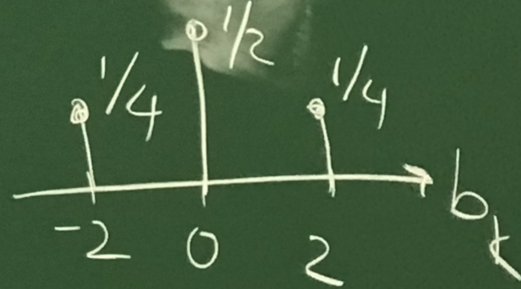
Assume a_k : iid Bernoulli rv
equally likely, ± 1

PMF



a_{k-1}	a_k	p	b_k
-1	-1	1/4	-2
1	-1	1/4	0
-1	1	1/4	0
1	1	1/4	2

$b_k = a_{k-1} + a_k$



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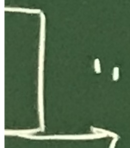

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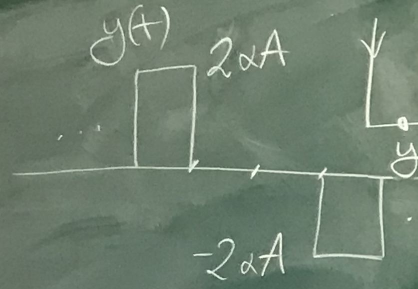
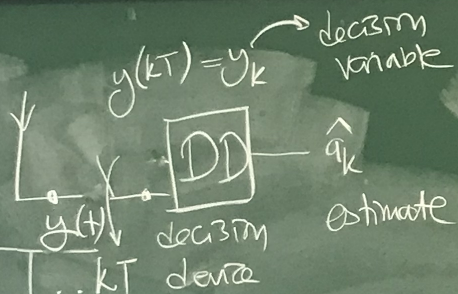




Symbol-by-symbol decision making

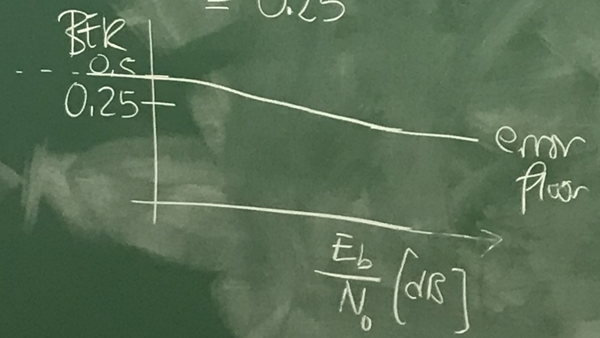
a_{k-1}	a_k	b_k	y_k	$\hat{a}_k$
−1	−1	−2	$-2\alpha A$	−1
1	−1	0	0	±1 } flip a coin?
−1	1	0	0	±1
1	1	2	$2\alpha A$	1

$$P_e = \cancel{P_{e|y_k=-2\alpha A}}^{\,0}\; P(y_k=-2\alpha A)$$

$$+ \overbrace{P_{e|y_k=0}}^{1/2}\; \overbrace{P(y_k=0)}^{1/2}$$

$$+ \cancel{P_{e|y_k=2\alpha A}}_{\,0}\; P(y_k=2\alpha A)$$

$$= 0.25$$



Q: Sequence estimator?

a_k : independent

b_k : non-independent

→ ch has MEMORY

When memory, sym-by-sym detection is suboptimal