Performance Evaluation of a DVB-T2 Mobile System Using a New Time-Variant FIR Channel

Jerker Björkqvist, Kristian Nybom
Åbo Akademi University
Jukka Rinne, Ali Hazmi
Tampere University of Technology

Åbo Akademi University

Presentation Outline

- Introduction
- Motivation
- Time-Variant FIR Channel Model
- Simulations
  - Setup
  - Results
- Conclusions

Introduction

- A FIR channel model for performance evaluation of mobile reception
- Based on the DVB-T2 Helsinki channel sounding in 2010
- Channel model is based on FIR filtering of the measured data
- Mimics the channel conditions experienced during the channel sounding

Motivation

- Common channel models are fixed representations of a multipath channel model
- For mobile reception, analysis in a time varying scenario is important
- Using the time variant FIR channel model presented here gives the possibility to
  - Analyze mobile performance
  - Analyze different system settings
  - Analyze the effect of adding additional interleaving depth by additional coding

Time-Variant FIR Channel Model

- A discrete multipath channel can be described as

$$y(t) = \sum_{k=1}^{K(t)} a_k(\tau_k, t) s(t - \tau_k(t))$$

whereas the general format for a FIR filter is

$$y[k] = \sum_{n=1}^{N} h_k[n] x[k-n]$$

and with Gaussian noise

$$y[k] = \sum_{n=1}^{N} h_k[n] x[k-n] + W_k$$

- At each time sample instant k, a new FIR filter h_k will be used
- With small filter kernel lengths (N<20), the simulation speed is increased

Time-Variant FIR Channel Model

- A data analysis of the measured data in Helsinki revealed that 8 multipath taps describe sufficiently the time-variant multipath behaviour of the channel
- Power delay profile

$$h(t,\tau) = \sum_{k=1}^{8} g(t,\tau_k)\delta(\tau - \tau_k)$$

Tap number, k	Excess delay, τ_k (μs)	Tap power gain, (dB)
1	0	-4.0
2	0.1094	-7.5
3	0.2188	-9.5
4	0.6094	-11
5	1.109	-15
6	2.109	-26
7	4.109	-30
8	8.109	-30

Time-Variant FIR Channel Model

- Tap-wise Doppler spectra applied

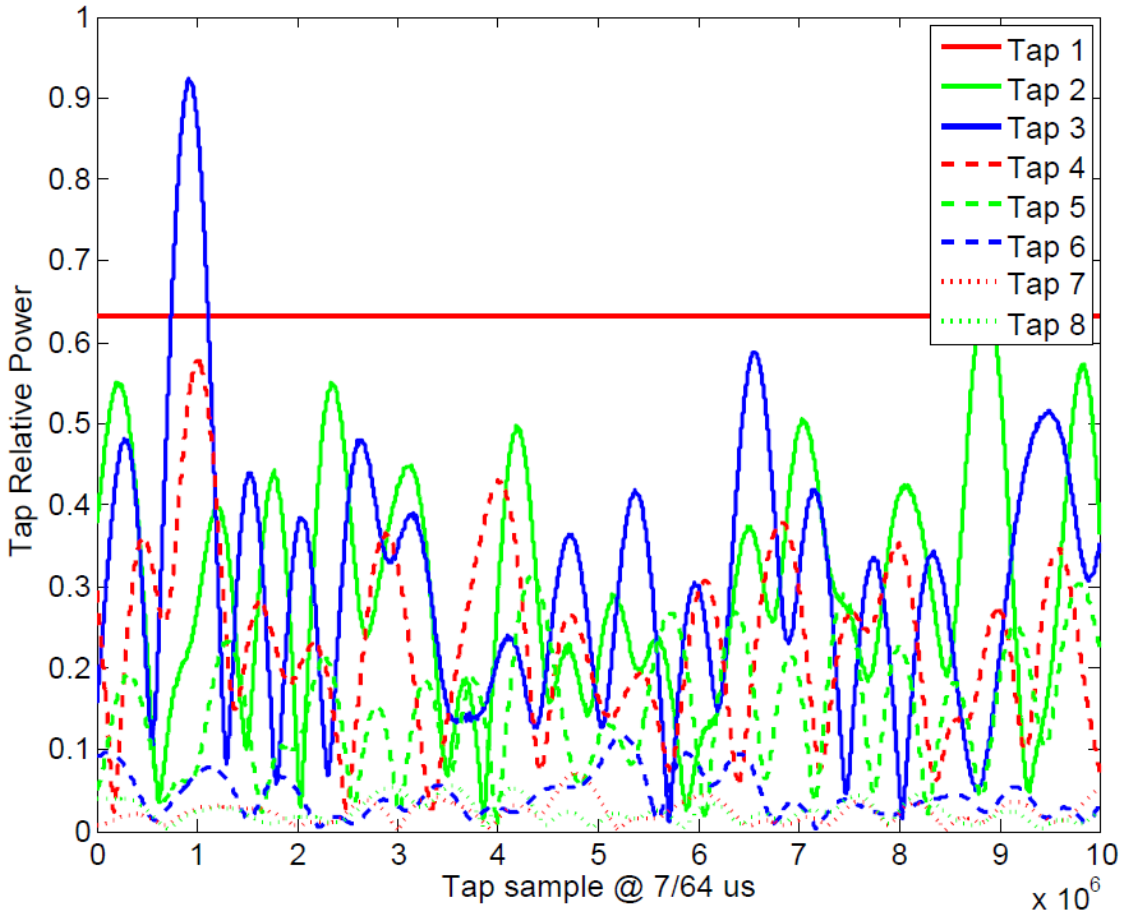
Tap number, k	Doppler spectrum
1	LOS only, no additional Doppler shift
$2 \ldots 3$	$S\left(f - \frac{3f_d}{4}, \frac{f_d}{4}\right)$
$4 \ldots 8$	$S\left(f + \frac{3f_d}{4}, \frac{f_d}{4}\right)$

where $$S(f, f_d) = \begin{cases} \frac{1}{\pi f_d \sqrt{1-(f/f_d)^2}}, \text{when} |f| < f_d \\ 0, \text{otherwise} \end{cases}$$

is the classical Jakes Doppler spectrum

- 40 Hz Doppler when the frequency is 800 MHz

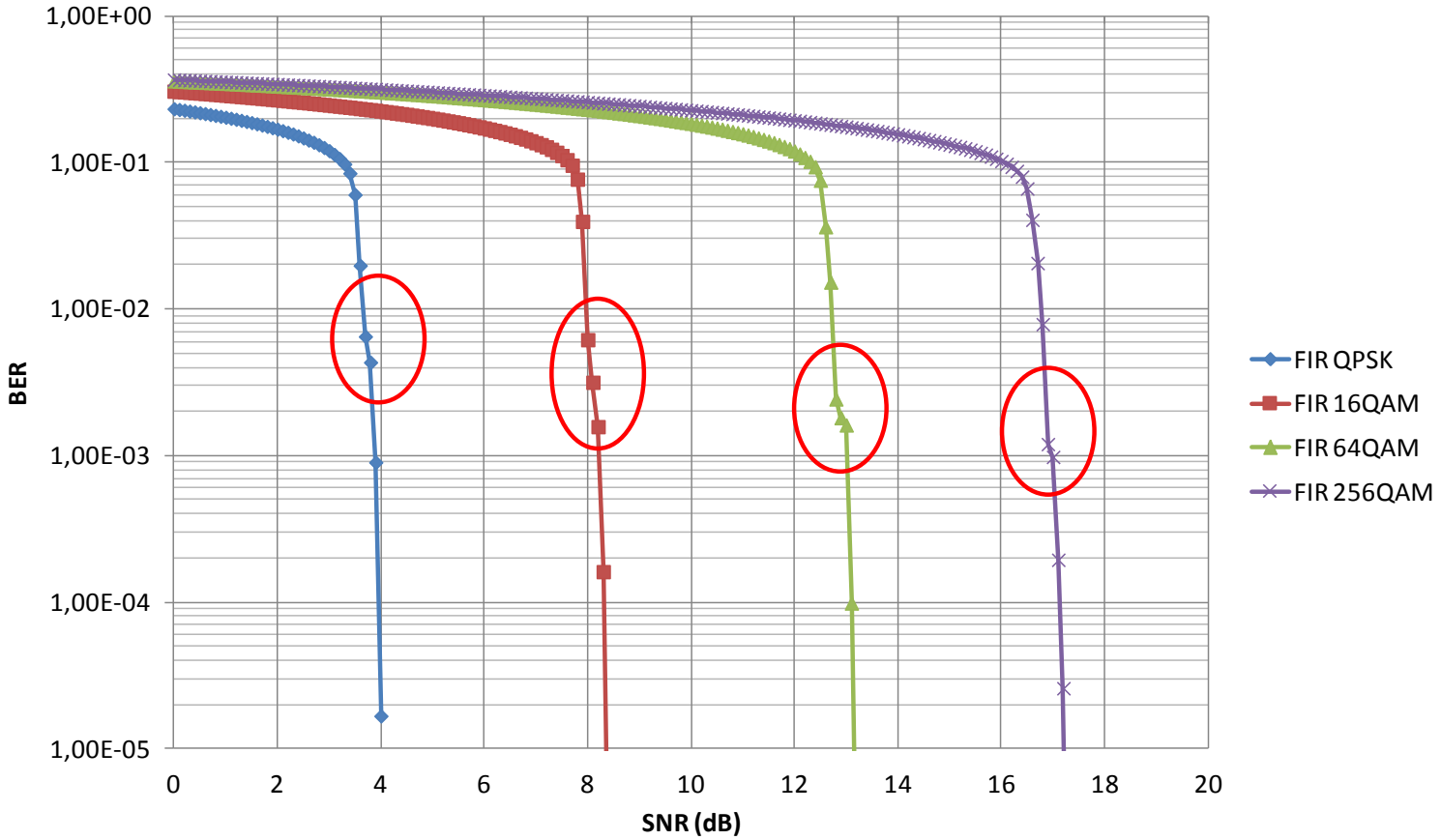
Time-Variant FIR Channel Model



Simulation Setup

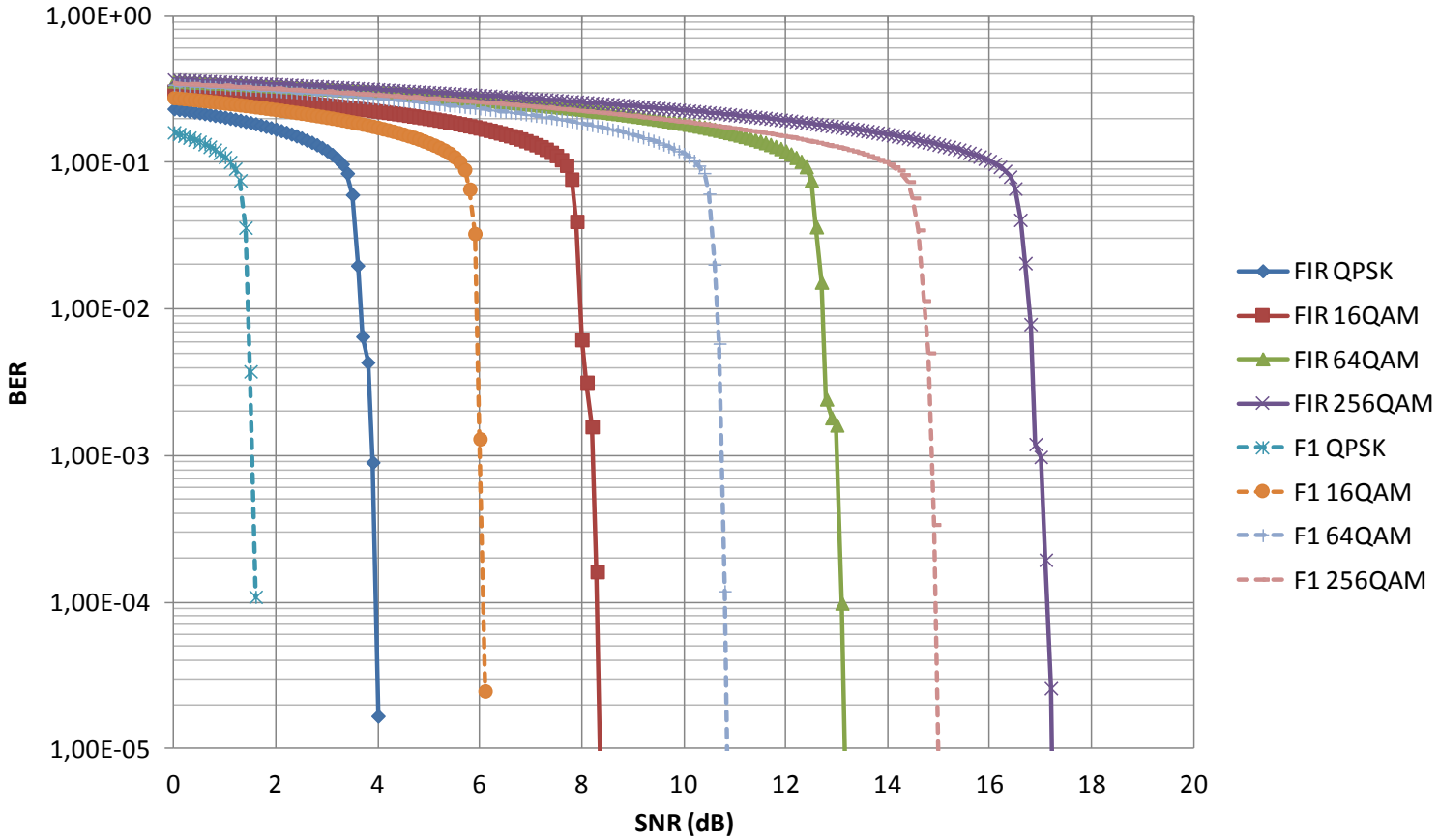
- A single PLP with:
  - 64800 bits FEC, rate ½
  - All supported QAM modulations
  - Maximum time interleaving
  - FFT size 8k
  - Guard interval 1/8
- Stopping criterion for simulations:
  - 20 erroneous FEC frames had been accumulated or
  - 2000 FEC frames had been decoded without errors

T2 Performance on the FIR channel model

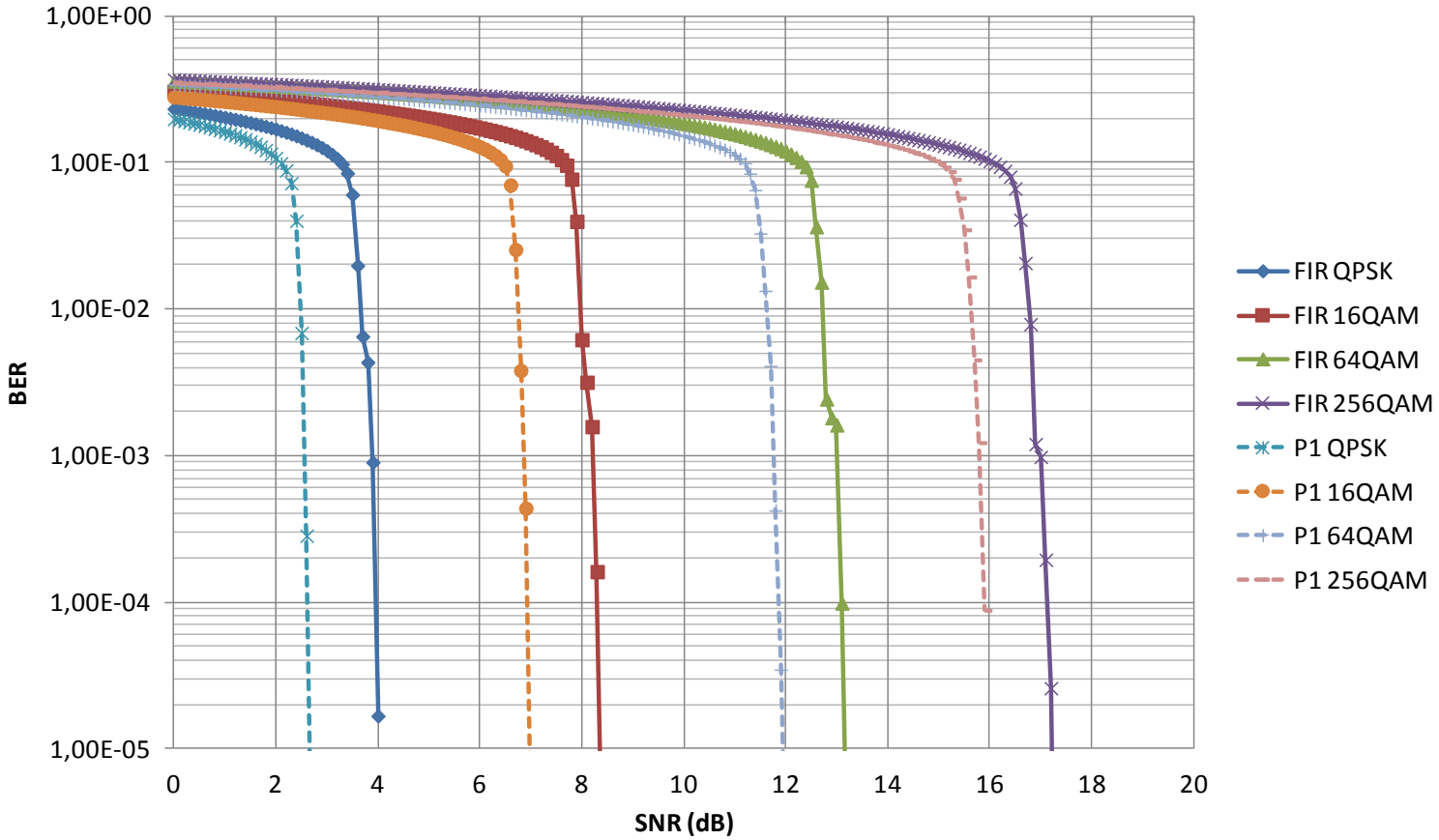


Small error floors visible in the middle of the waterfall regions

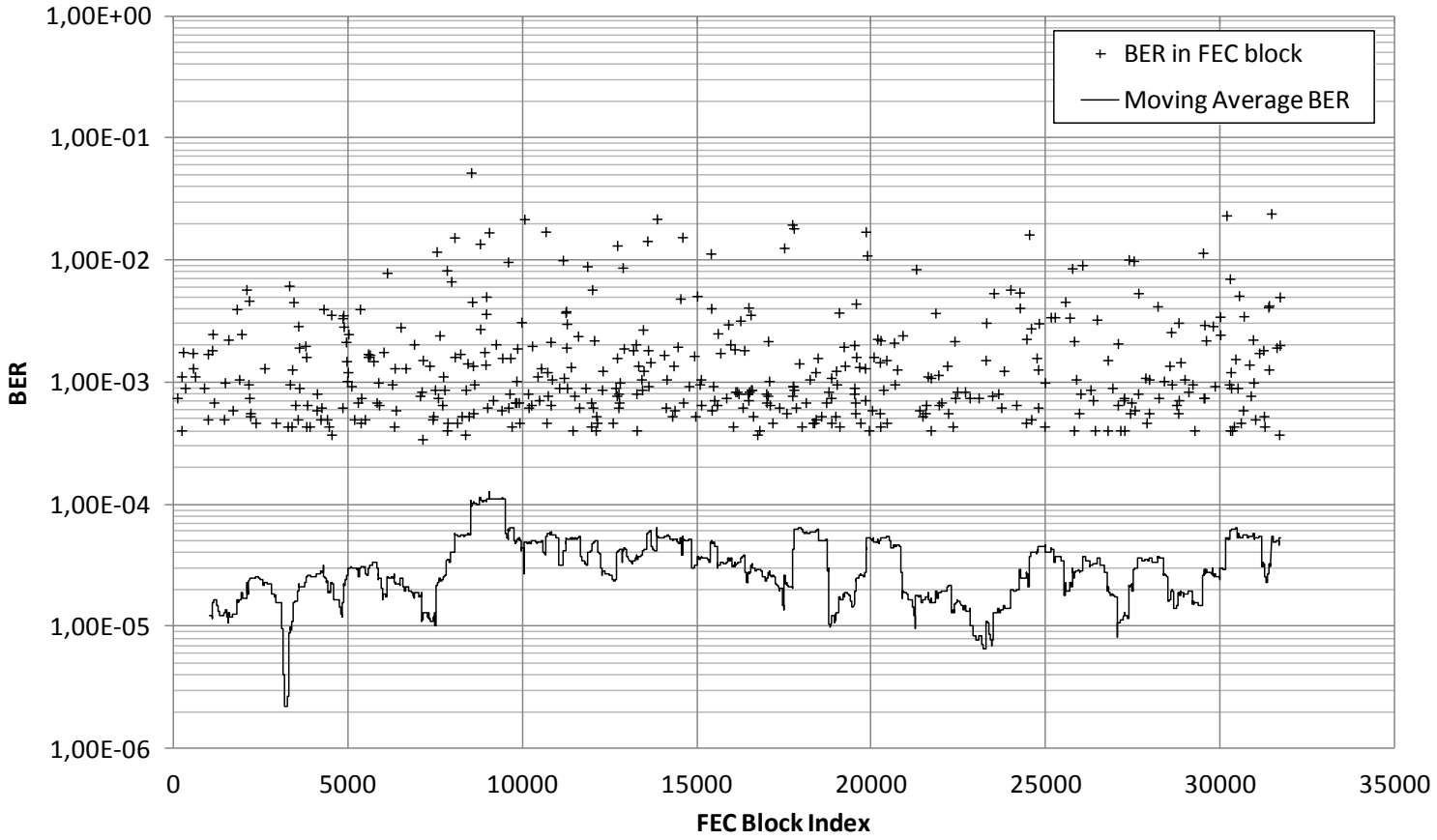
FIR vs F1


1,00E+00
1,00E-01
1,00E-02
1,00E-03
1,00E-04
1,00E-05
BER
0
2
4
6
8
10
12
14
16
18
20
SNR (dB)
FIR QPSK
FIR 16QAM
FIR 64QAM
FIR 256QAM
F1 QPSK
F1 16QAM
F1 64QAM
F1 256QAM

FIR vs P1


1,00E+00
1,00E-01
1,00E-02
1,00E-03
1,00E-04
1,00E-05
BER
0
2
4
6
8
10
12
14
16
18
20
SNR (dB)
FIR QPSK
FIR 16QAM
FIR 64QAM
FIR 256QAM
P1 QPSK
P1 16QAM
P1 64QAM
P1 256QAM

QPSK @ SNR 4 dB



The 1000-point moving average shows time variance

Conclusions

- The time variant FIR channel model shows worse performance than those obtained from static channel models
  - The FIR channel results in varying FEC block error ratios for any given SNR
- The gain of the strongest tap was normalized
  - Future work includes using varying gains for all taps
  - Will give more information on how the time interleaving in DVB-T2 works in mobile scenarios
  - Future studies also includes analysis of the MIMO case