Slide 1

Performance Evaluation of
Single Carrier/Frequency Domain Equalization
and Carrier Interferometry/OFDM

COE Technical Presentation
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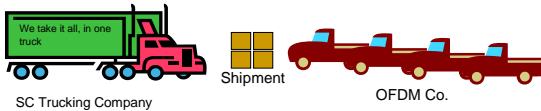**Wireless Communication Laboratory**

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Slide 2

Contents

- Introduction
  - Single Carrier/Frequency Domain Equalization (SC-FDE)
  - Carrier Interferometry/Orthogonal Frequency Digital Modulation (CI/OFDM)
- Research Directions
- Conclusion

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BACKGROUND: OFDM vs Single Carrier

We take it all, in one truck

SC Trucking Company

Shipment

OFDM Co.

- Both methods carry the same amount of data
- But in case of an accident, only ¼ data of the OFDM trucking will suffer
- Although both do the same thing, they respond differently to the interference

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Slide 4

Problem

- As OFDM uses many carriers, causes the high Power to Average Power Ratio (PAPR)
- Many researches has been done on the PAPR reduction technique (eg; CI/OFDM, SLM, dll)
- Finally there is an idea that Single carrier is simpler

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Slide 5

PAPR Definition

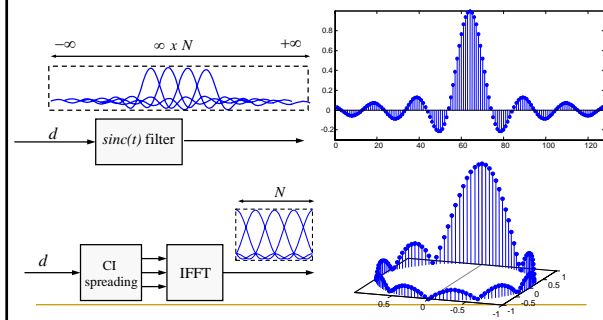$$PAPR = \frac{\max_{0<t<Ts} |s_i(t)|^2}{E_{0<t<Ts}[\frac{1}{N}\|s(t)\|^2]}$$

- $0<t<Ts$ is symbol period
- E is the averages of $s(t)2$
- N is the number of samples

Power

Time Samples (1 OFDM Symbol)

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Slide 6
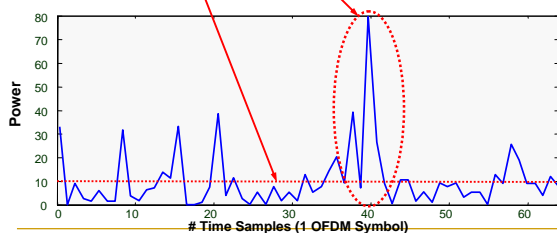
CI/OFDM and Single Carrier

Is CI/OFDM is Single Carrier?

$-\infty$ $\infty \, x \, N$ $+\infty$

d → sinc(t) filter →

d → CI spreading → IFFT →

N

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Research Objectives

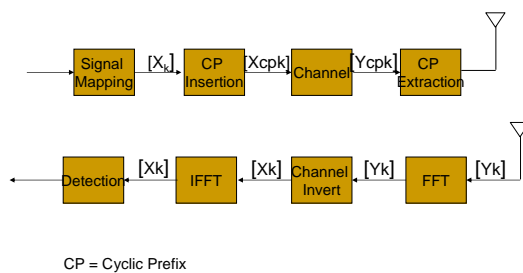- Investigate the bit error rate (BER) performance and computational complexity of SC/FDE and CI/OFDM

SC/FDE

- SC-FDE is an alternative equalization approach, which eliminates PAPR problem
- SC-FDE approach delivers performance similar to OFDM.
- Single carrier uses a single carrier so the PAPR is smaller.
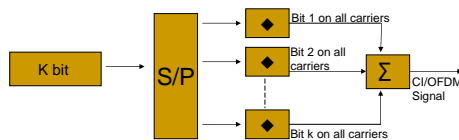
SC/FDE

CP = Cyclic Prefix

CI/OFDM

Carrier Interferometry

- Improve performance through full frequency diversity
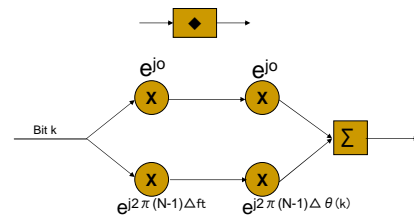- Besides that, eliminates the problem of high Peak-to- Average ratio introduced by OFDM

Concept of CI/OFDM

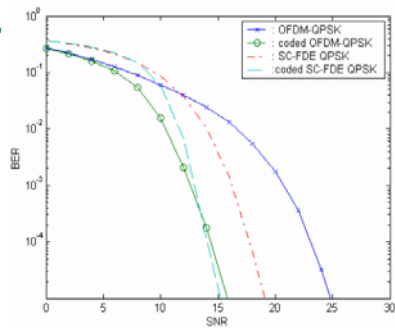Additional phase offset is applied to the sub carriers and each bit is transmitted across all the sub carriers

CI/OFDM Continue

$$s_k(t) = \frac{1}{\sqrt{N}} \sum_{i=0}^{K-1} a_k \cos(2\pi f_i t + i\Delta\theta k)$$
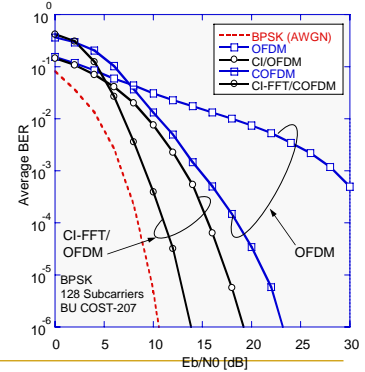
BER Performance of OFDM and SC-FDE

Taken from 2

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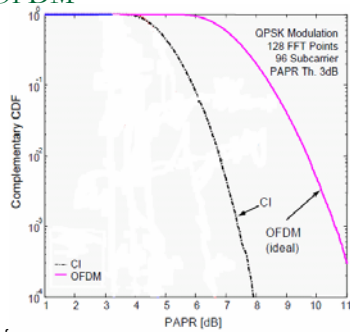## BER Performance Overview of OFDM and CI/OFDM

- CI/OFDM is outperform OFDM by about 15dB.

Taken from 1

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Overview of PAPR performance of CI/OFDM and OFDM

Taken from 1

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CONCLUSION

- The concept of SC/FDE and CI/OFDM is presented
- SC/FDE and CI/OFDM both reduce some of the disadvatages of the OFDM signals, especially the high PAPR

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REFERENCES

1. Khoirul Anwar et all,"Simplified Realization of Carrier Interferometry OFDM by FFT Algorithm", IEEE APWCS 2005, Hokkaido, pp.199-203, August 4-5,2005.
2. Marius Oltean et al,"Performance Evaluation of Single Carrier Broadband Transmission with Frequency Domain Equalization",Transactions on Electronics and Communications, Tom 49(63), Fascicola 1-2,2004
3. David Falconer et all, "Frequency Domain Equalization for Single Carrier Broadband Wireless Systems", Februari 15,2002
4. M. Huemer, L. Reindl, A. Springer, R. Weigel, "Implementation Aspects on Single Carrier Transmission with Frequency Domain Equalization," Proceedings of the 1st International OFDM-

   Workshop '99, Hamburg, Germany, pp. 18.1-18.4, 1999

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