Power Spectral Density Approach to Optimal Lattice OFDM Design for Time-Frequency Dispersive Wireless Channels
Cycle Prefix

A cyclic prefix is a copy of the last part of the OFDM symbol, which is prepended to the transmitted symbol.
OFDM

Orthogonal Frequency-Division Multiplexing

Wireless Networks

December 04, 2003
Continuous-time OFDM
Discrete-time OFDM
The transmission functions of an OFDM system consist of translations and modulations of a single pulse shape $\varphi$, i.e.,

$$
\varphi_{kl}(t) = \varphi(t - kT) e^{2\pi i l F t}
$$

$l = 0, \ldots, N - 1$
OFDM Signal

\[ s(t) = \sum_{k, l} x_{k, l} \varphi_{k, l} \]

\[ r(t) = (s * h)(t) + \varepsilon(t) = \int_{-\infty}^{+\infty} h(t, \tau) s(t - \tau) d\tau + \varepsilon(t) \]

\[ \tilde{y}_{k, l} = \langle \tilde{y}_{k, l}, \tilde{x}_{k, l} \rangle \]

\[ \tilde{y}_{k, l} = \langle r, \psi_{k, l} \rangle \]
How the transmitted data are recovered

\[
\tilde{y}_k, l = \langle r, \psi_k, l \rangle
\]

\[
\tilde{y}_{k,l} = \langle [(s * h)(t)] \psi_{k,l} + \langle \varepsilon, \psi_{k,l} \rangle
\]

\[
= \sum_{k', l'} x_{k', l'} \langle \phi_{k', l'}, \psi_{k, l} \rangle + \langle \varepsilon, \psi_{k, l} \rangle
\]
Lattice OFDM

\[ \varphi_{kl}(t) = \varphi(t - kT) e^{2\pi i l F t} \]

Wireless Networks

December 04, 2003
What we want

- The time-frequency localization of $\Psi$,
- The distance between adjacent time-frequency lattice points, and
- $TF = 1$, i.e., maximal spectral efficiency.
Optimal OFDM

\[ L_1 = \begin{bmatrix} x_{11} & y_{12} \\ 0 & z_{22} \end{bmatrix}, \quad L_2 = \begin{bmatrix} x'_{11} & y'_{12} \\ 0 & z'_{22} \end{bmatrix} \]

\[ \alpha = \frac{z_{22}}{z_{22}}, \quad \beta = -\frac{y_{12}}{z_{22}} + \frac{y_{12}}{z_{22}} \frac{z_{22}}{z_{22}} \]

\[ \varphi_2 = FD \alpha^{-1} C - \beta \alpha^2 F^{-1} \varphi_1 \]

\[ D_{\alpha} f(t) = \sqrt{\alpha} f(\alpha t) \]

\[ C_{\beta} f(t) = f(t) e^{-\pi i \beta t^2} \]
Power Spectral Density

\[
(P\phi_{k,l})(t, f) = \int \phi_{k,l}(\tau)\dot{\phi}_{k,l}(\tau - t)e^{-j2\pi ft}d\tau
\]
Simulation

SLPR is 8.62% and 6.25%

Wireless Networks

December 04, 2003
Concerns

1. PAPR
2. Synchronous

Wireless Networks  
December 04, 2003
Wireless Networks

Discussion

- Provides robustness of the OFDM systems
- Improvement of approximately 1dB-2dB Signal-to Noise-plus Interface Ratio (SNIR)
Thank You

Wireless Networks

December 04, 2003