Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Self Spatial Filtering for PAC: Device Discovery Scheme in Visible Range
Date Submitted: March 12, 2014
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Re: TG8 PAC Call for Contributions (CFC), 15-14-0087-00-0008, Jan. 23, 2014.

Abstract: Technical proposal of Self Spatial Filterinig scheme for device discovery in visible range.

Purpose: To discuss the merits of the proposed scheme, which is to be harmonized with other proposals for approval.

Self Spatial Filtering for PAC
Device Discovery Scheme in Visible Range

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Spatial Filtering: Benefits and Requirements

- Benefits
  - Minimize signaling overhead
  - Minimize interference
  - Faster discovery
  - Improved user experience
- Spatial filtering scheme should
  - have good spatial resolution
  - minimize the harmful influence of sidelobes
  - be independent of the RSS or SNR (i.e., distance)
- H/W requirement
  - Transmitter: array antenna
  - Receiver: single antenna

Transmission

a sequence of symbols

random beampatterns
choosen from
K pre-defined beampatterns
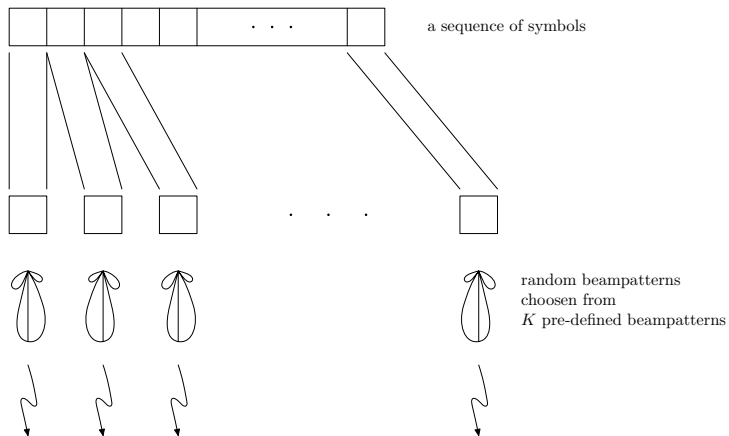
Received Signals

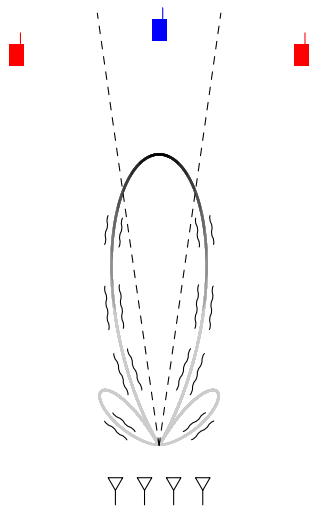
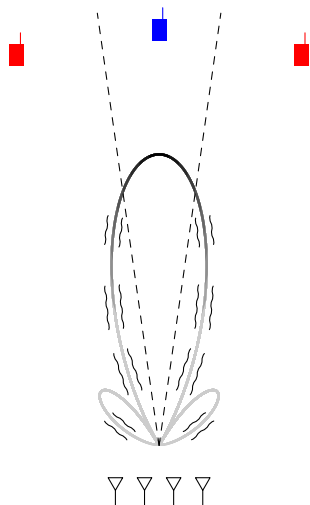The received symbols in the look direction

The received symbols not in the look direction

The Effect

"It is a terrible thing
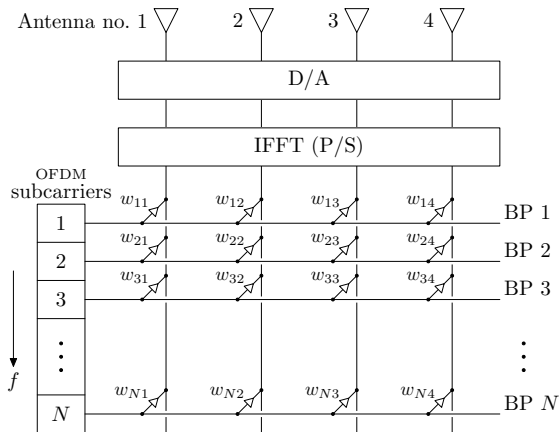to see and have no vision."
– Helen Keller

The Effect

"It is a terrible thing
to see and have no vision."
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"It is a terrible thing
to see and have no vision."
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Transmitter Structure

OFDM transmitter structure for RJBF (4 antenna case)

Same structure as a single stream MIMO-OFDM transmitter

Reception of RJBF Signals

- No special hardware required
  (an omni-directional single antenna suffices)
- Receiver calculates ρ

$$\rho = \frac{<\vec{x}, \vec{r}>}{\sqrt{<\vec{x}, \vec{x}> \cdot <\vec{r}, \vec{r}>}} \quad \gtrless \quad \text{threshold}$$

where $\vec{x}$: (known) transmitted sequence
$\vec{r}$: received sequence

- $0 \leq \rho \leq 1$: $\rho \approx 1 \Rightarrow$ I'm the target! :-)
  $\rho \ll 1 \Rightarrow$ I'm not the target. :-(

- ρ: function of θ only, independent of SNR, and immune to sidelobes

Reception of RJBF Signals

- No special hardware required
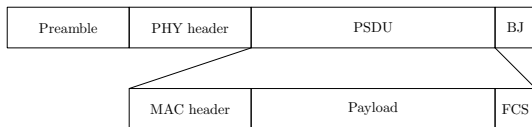 (an omni-directional single antenna suffices)
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$$\rho = \frac{< \vec{x}, \vec{r} >}{\sqrt{< \vec{x}, \vec{x} > \cdot < \vec{r}, \vec{r} >}} \quad \gtrless \quad \text{threshold}$$

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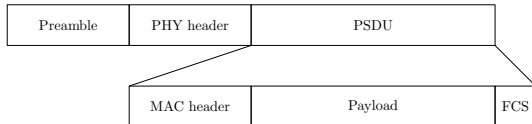
Device Discovery with Spatial Filtering

- ▶ Discovery query message

Preamble	PHY header	PSDU	BJ

MAC header	Payload	FCS

  - ▶ MAC header: message type
  - ▶ Payload: threshold (1 octet)
  - ▶ BJ field: a single OFDM symbol
  - ▶ Transmitted in discovery slot using random access

- ▶ Discovery response message

Preamble	PHY header	PSDU

MAC header	Payload	FCS

  - ▶ MAC header: message type
  - ▶ Payload: ρ, available service info (application ID, etc)
  - ▶ Transmitted in discovery slot using random access

Bibliography

[1] "Fully Distributed Contention Based MAC Proposal for PAC," IEEE 802.15-14-0131-00-0008, March 2014.

[2] "Collision Detection based PHY Proposal for PAC," IEEE 802.15-14-0132-00-0008, March 2014.

Thank You!