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

Submission Title: Panasonic 802.15.7r1 Proposal

Date Submitted: January, 2016

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Abstract: Panasonic 802.15.7r1 Proposal

Purpose: Call for Proposals Response

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Requirements

• Flicker free:
  average luminance must be constant

• Of-Off modulation:
  signal must be modulated with monochrome On
  and Off state of luminance (Off state may not be
  zero luminance) so as to use most of LED devices
  as transmitters
Purposes of Communications

• ID broadcast
• Unidirectional data transfer
Modes

Mode 1
for ID broadcast mode

Mode 2
for ID broadcast mode
for low luminance mode

Mode 3
for unidirectional data transfer mode
Mode 1

Modulation [us]
\[(P_1, P_2, P_3, P_4) = (100, 90, 90, 100)\]
\[D_{Ri} = 120 + 20 \times w_i \ (i \in 1 \sim 4, w_i \in 0 \sim 15)\]
\[D_{Li} = 120 + 20 \times (15 - w_i)\]

A transmitter can send either or both of Data R and L
Mode 2

Modulation [us]

\[(P_1, P_2, P_3) = (160, 180, 160)\]

\[D_i = 180 + 20 \times w_i \text{ (i } \in 1\sim4, w_i \in 0\sim15)\]

Pulse width < 10
Mode 3

Modulation [us]

\[(P_1, P_2, P_3, P_4) = (50, 60, 60, 50)\]

\[D_{2i} + D_{2i+1} = 100 + 15 \times x_i\]

\[(i \in 1 \sim N, x_i \in 0 \sim 15, D_{2i} > 50, D_{2i+1} > 50)\]
Packet Modulation for ID Broadcast
Packet Modulation

<table>
<thead>
<tr>
<th>bit 1</th>
<th>bit 2</th>
<th>bit 3</th>
<th>bit 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>( w_1 ) = ( ( P_1 ), ( D_{a1} ), ( S ), ( D_{b1} ) )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( w_2 ) = ( ( P_2 ), ( D_{a2} ), ( A_1 ), ( D_{b2} ) )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( w_3 ) = ( ( P_3 ), ( D_{a3} ), ( A_2 / D_{a6} ), ( D_{b3} ) )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( w_4 ) = ( ( P_4 ), ( D_{a4} ), ( A_2 / D_{a5} ), ( A_3 / D_{b4} ) )</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| A : Address | 1-4 bit |
| D : Data    | 4-6 + 3-4 bit |
| P : Parity  | 4 bit   |
| S : Stop bit| 1 bit   |
Packet Division (1, 2)

**Division (1)**

![Diagram of Packet Division (1)]

- **Data 7**
  - **Da (1)**: 4
  - **Db (1)**: 3

- **Packet 1**
  - **S**: 1
  - **A**: 4 0000
  - **D_a (1)**: 6
  - **D_b (1)**: 4

**Division (2)**

![Diagram of Packet Division (2)]

- **Parity 1**
- **Data 16**
  - **D_a (1)**: 6
  - **D_a (2)**: 4
  - **D_b (1)**: 4
  - **D_b (2)**: 3

- **Packet 1**
  - **S**: 1
  - **A**: 1
  - **D_a (1)**: 6
  - **D_b (1)**: 4

- **Packet 2**
  - **S**: 1
  - **A**: 4 1000
  - **D_a (2)**: 4
  - **D_b (2)**: 3
Packet Division (3, 4)

Division (3)

\[
\begin{array}{c|c|c}
\text{Data} & 16 \\
\hline
\text{Data}_a & 9 \\
\text{Data}_b & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c}
\text{Data}_a & 9 \\
\hline
\text{Data}_b & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c}
\text{Parity} & 5 \\
\hline
\text{Data}_a & 9 \\
\text{Data}_b & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c}
\text{Data}_a & 9 \\
\hline
\text{Data}_b & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c|c}
\text{CRC} & \\
\hline
\text{Data}_a & 9 \\
\text{Data}_b & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c|c}
\text{CRC} & \\
\hline
\text{Data}_a & 9 \\
\text{Data}_b & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c|c}
\text{Parity} & 5 \\
\hline
\text{Data}_a & 9 \\
\text{Data}_b & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c|c}
\text{Parity} & 4 \\
\hline
\text{Data}_a & 9 \\
\text{Data}_b & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c|c}
\text{CRC} & \\
\hline
\text{Data}_a & 9 \\
\text{Data}_b & 7 \\
\end{array}
\]

\[
\begin{array}{c|c|c|c}
\text{CRC} & \\
\hline
\text{Data}_a & 9 \\
\text{Data}_b & 7 \\
\end{array}
\]

S 1 2 5 4
A 0 0 1 0
D_a (1) D_a (2) D_a (3)
D_b (1) D_b (2) D_b (3)

Packet 1

Packet 2

Packet 3

Division (4)
Same manner as Division (3)
Packet Division (5-7)

Division (5)

```
<table>
<thead>
<tr>
<th>S</th>
<th>A</th>
<th>D_a (1)</th>
<th>D_a (2)</th>
<th>D_a (3)</th>
<th>D_a (4)</th>
<th>D_a (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Packet 1
```

```
<table>
<thead>
<tr>
<th>Parity</th>
<th>Data_a</th>
<th>Data_b</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>16</td>
<td>15</td>
</tr>
</tbody>
</table>

```

```
<table>
<thead>
<tr>
<th>D_a (1)</th>
<th>D_a (2)</th>
<th>D_a (3)</th>
<th>D_a (4)</th>
<th>D_a (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

CRC
```

```
<table>
<thead>
<tr>
<th>Parity</th>
<th>Data_b</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>15</td>
</tr>
</tbody>
</table>

```

```
<table>
<thead>
<tr>
<th>D_b (1)</th>
<th>D_b (2)</th>
<th>D_b (3)</th>
<th>D_b (4)</th>
<th>D_b (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

CRC
```

```
<table>
<thead>
<tr>
<th>S</th>
<th>A</th>
<th>D_a (4)</th>
<th>D_b (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>110</td>
<td></td>
</tr>
</tbody>
</table>

Packet 4
```

Division (6, 7)

Same manner as Division (5)
Packet Division (8)

Division (8)

Reed-Solomon

Parity 16

Data 47

Padding 1

<table>
<thead>
<tr>
<th>Label</th>
<th>Bit Size</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Packet 1</th>
<th>Packet 7</th>
<th>Packet 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>S 1 A 3 D_a D_b (1) 8</td>
<td>S 1 A 3 D_a D_b (7) 8</td>
<td>S 1 A 4 D_a D_b (8) 7</td>
</tr>
<tr>
<td>0 000</td>
<td>0 011</td>
<td>1 110</td>
</tr>
</tbody>
</table>
Packet Division (9-16)

Division (N = 9-16)

Reed-Solomon

Parity
14

Data
7 * (N – 2)

\( D_a D_b (1) \)
7

\( D_a D_b (N-1) \)
7

\( D_a D_b (N) \)
7

Packet 1

Packet N-1

Packet N

S 1 0 0000
A 4

S 1 0 xxxx
A

S 1 1 xxxx
A

D_a D_b (1)
7

D_a D_b (N-1)
7

D_a D_b (N)
7

label
bit size
value
# ID Size

<table>
<thead>
<tr>
<th>Packet Division</th>
<th>Data Size [bit]</th>
<th>Full mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short mode</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>5</td>
<td>16</td>
<td>31</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>39</td>
</tr>
<tr>
<td>7</td>
<td>24</td>
<td>47</td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td>47</td>
</tr>
<tr>
<td>9</td>
<td>-</td>
<td>49</td>
</tr>
<tr>
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<td>-</td>
<td>56</td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td>63</td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td>70</td>
</tr>
<tr>
<td>13</td>
<td>-</td>
<td>77</td>
</tr>
<tr>
<td>14</td>
<td>-</td>
<td>84</td>
</tr>
<tr>
<td>15</td>
<td>-</td>
<td>91</td>
</tr>
<tr>
<td>16</td>
<td>-</td>
<td>98</td>
</tr>
</tbody>
</table>