RFID Technologies are often used in critical domains or into harsh environments where the on-line detection of RFID system defects is a must.

**Objectives**

- New on-line monitoring approach detecting reader, RF coupling or tag defects
- Non-intrusive approach: all the information are available from classical RFID system operations

**Case Study**

- 900MHz UHF RFID System
- EPC Class 1 Gen 2 tags
- Fixed number of tags per pallet: 111 tags
- Configuration detecting almost all the tags:
  - Optimized reader protocol parameters
  - Optimized tag location and direction on boxes
  - Optimized antenna reader types, location and direction

**RFID Systems Monitoring**

**Classical approaches**

- Remote monitoring:
  - Only detects catastrophic errors: disconnected or power down readers
- Performances monitoring:
  - \( \text{Average Tag Traffic Volume} \) (ATTV)
  - Requires a learning phase to create a reference
  - \( \text{Global « Read Errors to Total Reads » (RETR)} \)
  - Does not detect local soft errors
  - No localization of defects

**New approach**

- Characterization of a statistical parameter, the tag Read Rate Profile, individually involving each tag
- Learning phase: Each inventory leads to a specific inventory profile, the Read Rate Profile, which is the ordered read rate curve of the entire population
- Limit profile definition: this limit is computed using the average and the standard deviation of each ordered tags (assuming a Normal distribution)

**Experimental Validation & Conclusion**

**Hardware fault injection**

- The following faults have been randomly injected:
  - 5 tags rotated by 90°
  - 5-15-21 tags misplaced on boxes
  - Pallet rotation stopped during 15s-20s

**Software fault injection**

- The following faults have been randomly injected:
  - 5% RETR on 5 tags
  - 10% RETR on 20 tags

**Fault detection**

<table>
<thead>
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<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
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<tbody>
<tr>
<td>#Tags detected</td>
<td>108</td>
<td>108</td>
<td>109</td>
<td>107</td>
<td>109</td>
<td>109</td>
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<tr>
<td>RETR (%)</td>
<td>34.9</td>
<td>35.4</td>
<td>37.5</td>
<td>37.3</td>
<td>36.4</td>
<td>38</td>
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<tr>
<td>ATTV monitoring</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>RETR monitoring</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Profile monitoring</td>
<td>✗</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

✓: Fault detection  ✗: No fault detection

**Complementarities of the 3 monitoring methods**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>ATTV monitoring</td>
<td>10%</td>
<td>8%</td>
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<tr>
<td>RETR monitoring</td>
<td>7%</td>
<td>7%</td>
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<tr>
<td>Profile monitoring</td>
<td>69%</td>
<td>97%</td>
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Conclusion: ATTV and Profile monitoring methods must be concurrently used to detect the maximum number of faults.