Practical testbed demonstration of REM enabled transmitter localization in indoor environments

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◊ Radio Environmental Maps – General Considerations

- Rich hierarchical database or knowledge base that stores various kinds of radio environmental information
- Powerful enabler and/or facilitator of:
  - Dynamic Spectrum Access (DSA)
  - Improved environmental awareness and spectral efficiency of wireless networks

◊ REM Architecture [1]

- Measurement Capable Devices (MCDs) – all network devices capable of performing spectrum measurements
- REM Storage and Acquisition unit (REM SA) – main REM storage entity capable of storing raw and processed data (both static and dynamic)
- REM Manager – responsible for requesting measurements and extracting and processing the data stored in the REM SA
- REM Users

◊ REM Architecture [1] (Diagram)

◊ Transmitter Localization Background

- Appropriate model for the Received Signal Strength (RSS) should be adopted:
  - The model should be parameterized w.r.t. the unknown position(s) of the transmitter(s)
  - The localization technique should estimate the unknown position(s) of the transmitter(s) using the observed RSS values and the adopted RSS model

◊ Transmitter Localization Toolbox

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<th>REM Manager: Localization Toolbox</th>
<th>Single Transmitter Localization</th>
<th>Multiple Transmitters Localization</th>
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<td>Full Search</td>
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| Assumptions                      | - Simplified path loss model in log-normal shadowing | - Simplified path loss model in log-normal shadowing | - Simplified path loss model in log-normal shadowing | - Simplified path loss model under log-
|       | - Simplified path loss model     | - Simplified path loss model      | - Simplified path loss model      | normal shadowing                   |
| Operation                        | - Maximizes the log-likelihood of the RSS observation vector | - Minimizes the squared difference between the observed and predicted RSS values | - Searches through grid of points and chooses the point that maximizes the likelihood function | Estimates the parameters of the GMM by employing iterative Expectation Maximization (EM) approach |
| Remarks                          | - Requires prior channel knowledge | - Non-convex problem | - Best Linear Unbiased Estimator | - Complexity increases with the grid size Simultaneously estimates the propagation model parameters |
|                                  |                                  |                                  | - Circumvents the non-convexity problem & susceptibility to the hostile propagation environment | - Simultaneously estimates the propagation model parameters |
|                                  |                                  |                                  | - Complexity increases with the grid size Simultaneously estimates the propagation model parameters | Assumes a dominant transmitter per sensor and achieves complexity that increases linearly with number of sources Very susceptible to the hostile propagation environment |

◊ Experimental and Simulation Results

- Skopje experimental setup
- DySPAN 2011 experimental setup

- Highest deviation between simulation/experimental performances experienced in the DySPAN scenarios due to the heterogeneity of the used equipment.
  - The Least Squares-Grid algorithm proves to be a viable solution

◊ References