Adaptive WCL – Improving Coarse Grained Localization

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Outline

- Introduction
- Motivation
- Algorithm
- Simulational Results
- Conclusion

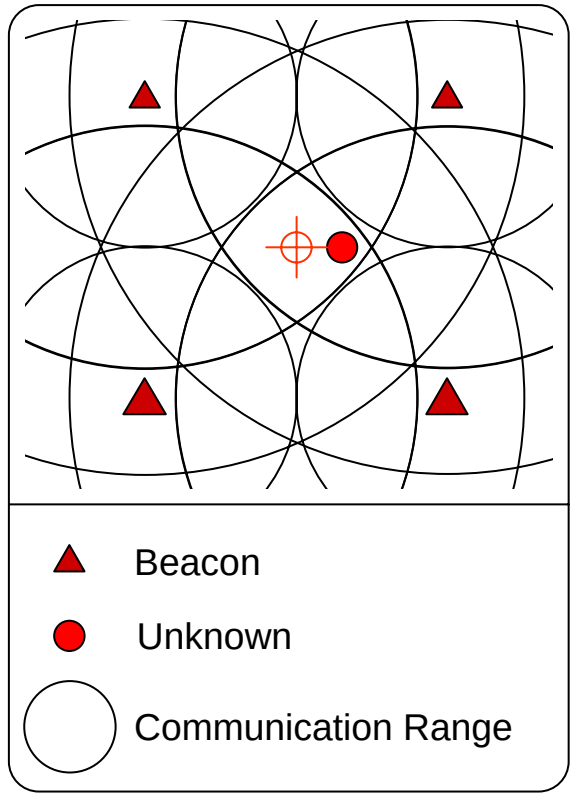
Introduction

Centroid Localisation (CL)

- Unknown calculates its position as centroid
- Simple equation:

$$P_i(x,y) = \frac{\sum_{j=1}^{m} B_j(x,y)}{m}$$

- Drawbacks
  - High dependency on communication range
  - Low accuracy



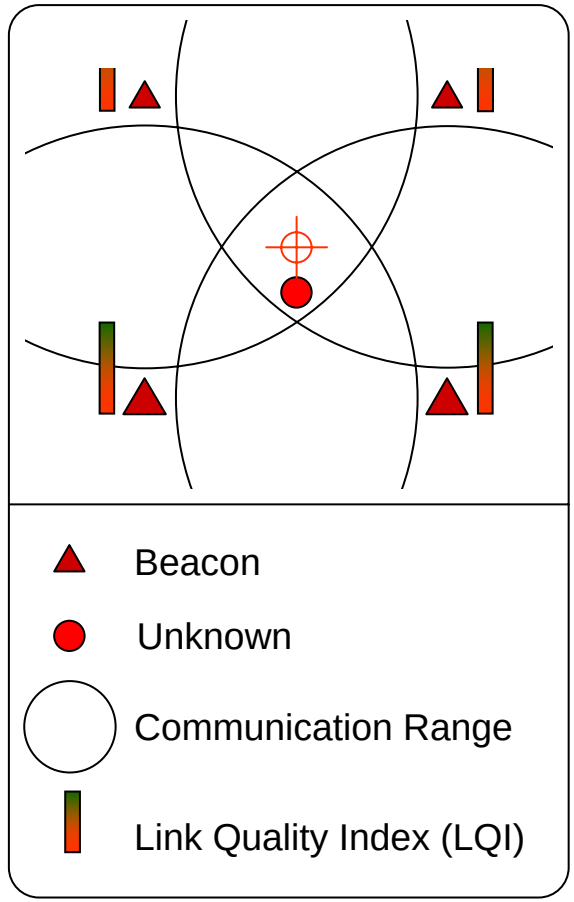
Introduction

Weighted CL (WCL)

- Use of Signal Strenght as quantifier
- Equation:

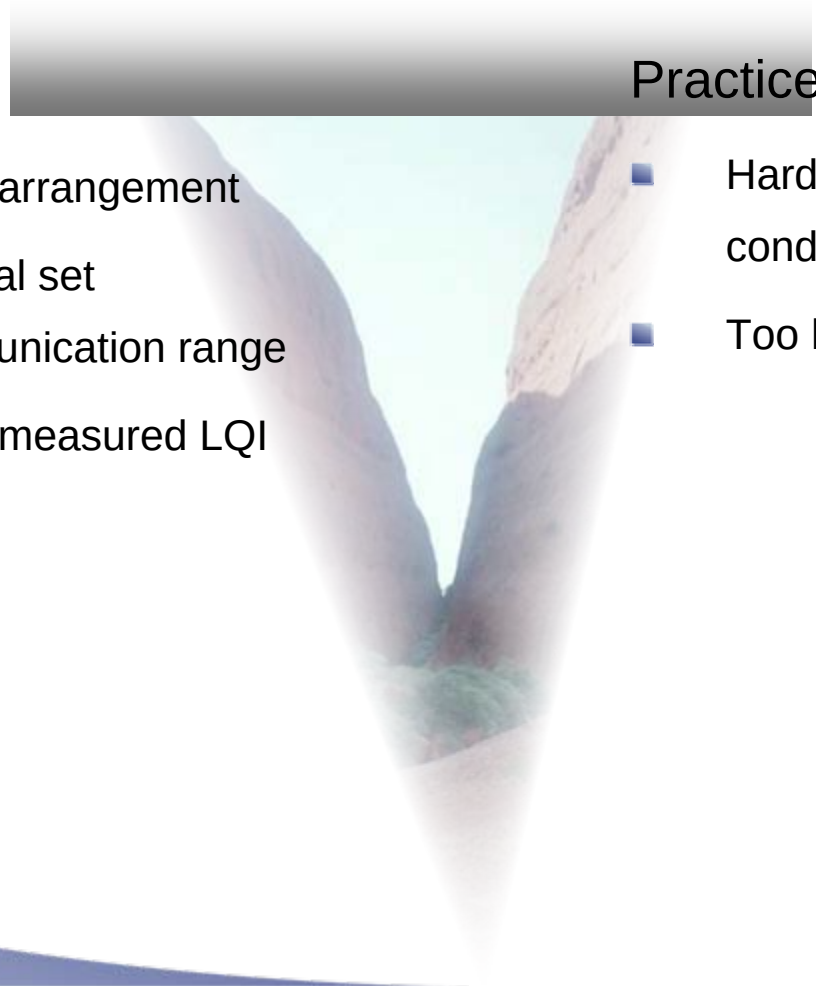
$$P_i(x,y) = \frac{\sum_{j=1}^{m} \left(LQI_{ij} \cdot B_j(x,y) \right)}{\sum_{j=1}^{m} LQI_{ij}}$$

- Drawbacks
  - Depends on communication range



Motivation

- Gap between theory and practice



Theory

- Exact arrangement
- Optimal set communication range
- Exact measured LQI

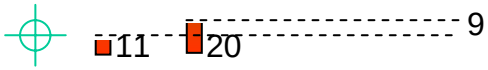
Practice

- Hard to achive best conditions
- Too high LQIs

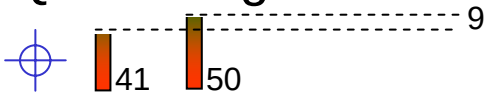
Motivation

Faulty cases

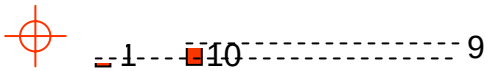
- Optimal conditions

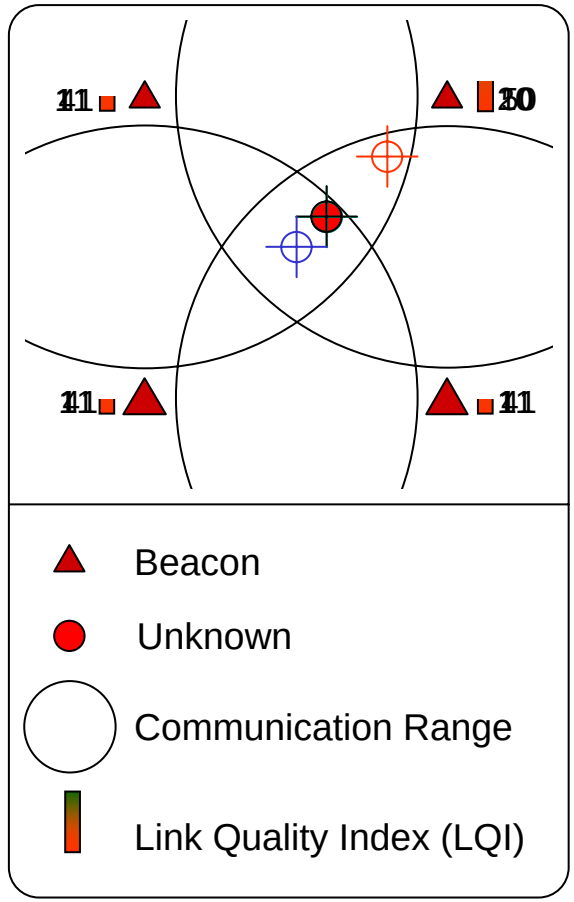


- LQIs too high



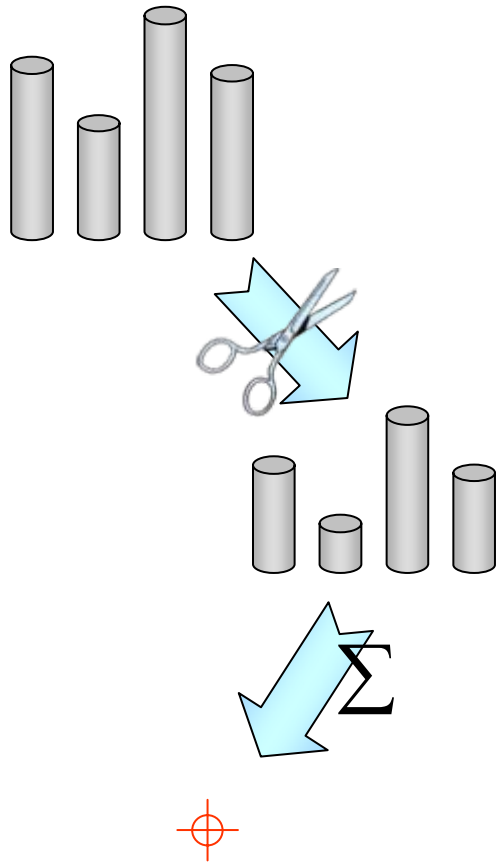
- LQIs too low





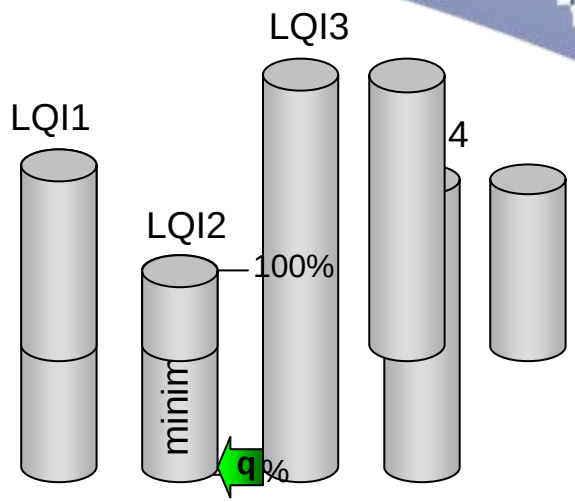
Algorithm

- 1. Phase
  - Collecting LQIs – as in WCL
- 2. Phase NEW
  - Do AWCL reduction
- 3. Phase
  - Calculate Position – as in WCL



Algorithm

- AWCL Reduction
  - Identify minimum LQI
  - Reduce all LQIs by a percentage of the minimum



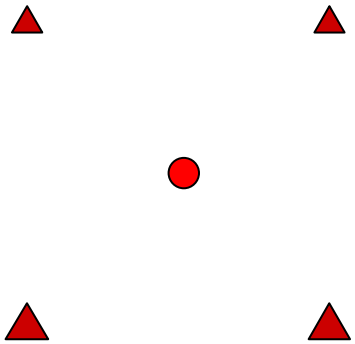
- Calculation

$$P_i(x,y) = \frac{\sum_{j=1}^{m} \left(\left(LQI_{ij} - q \cdot \min\left(LQI_{i,1..m} \right) \right) \cdot B_j(x,y) \right)}{\sum_{j=1}^{m} \left(LQI_{ij} - q \cdot \min\left(LQI_{i,1..m} \right) \right)}$$

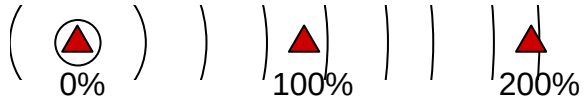
- Question
  - Reduction part q

Simulations

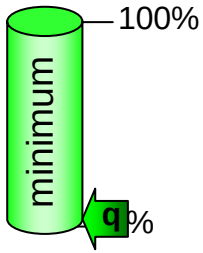
- Basic procedure:
  - 4 Beacons, 1 Unknown
  - Set Unknown to 100 X 100 Positions
  - Calculate failure as distance between real and estimated position
  - Calculate average and maximum



- Varying Parameters
  - Communication range

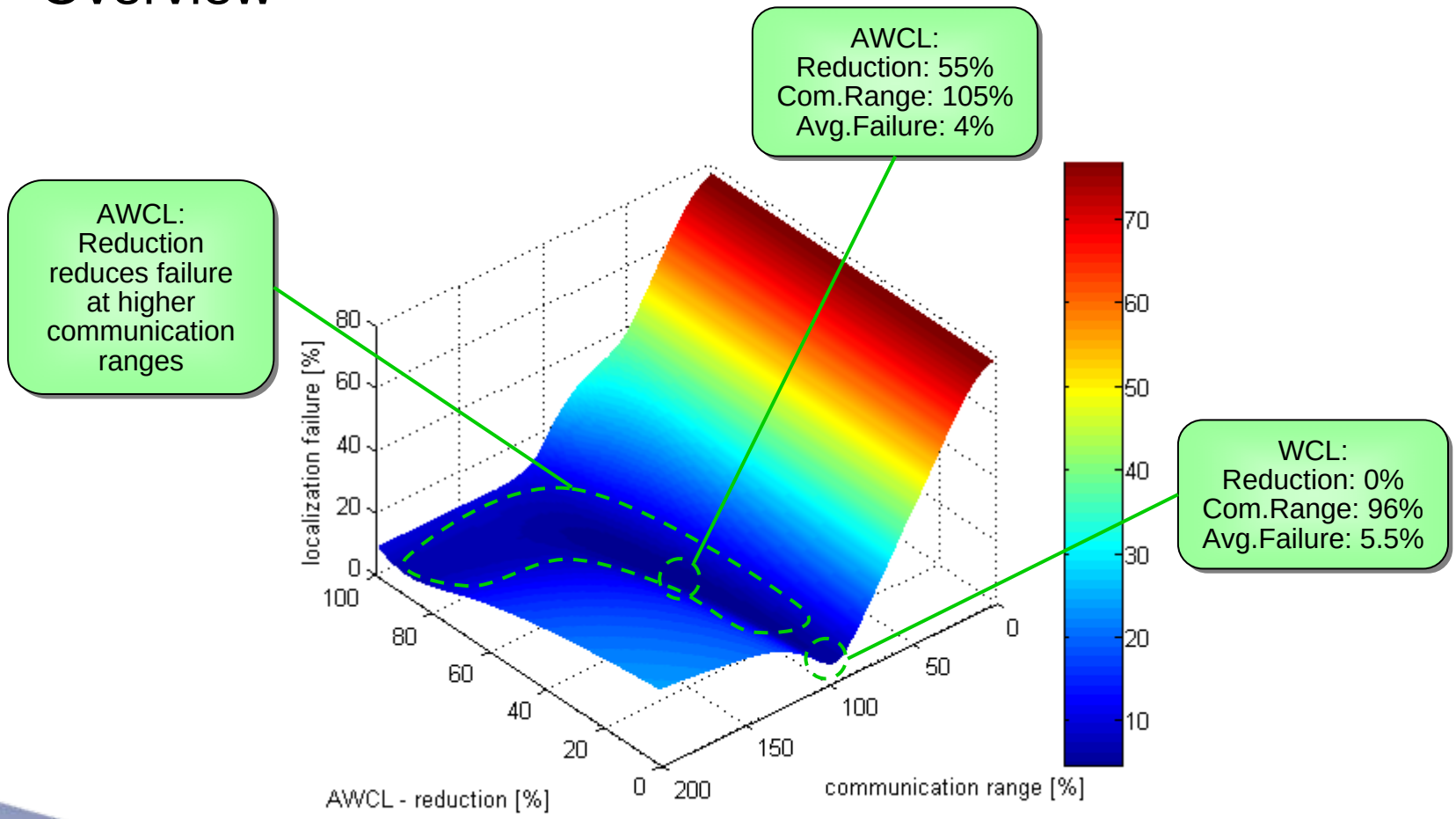


  - Reduction part



Simulations

- Overview



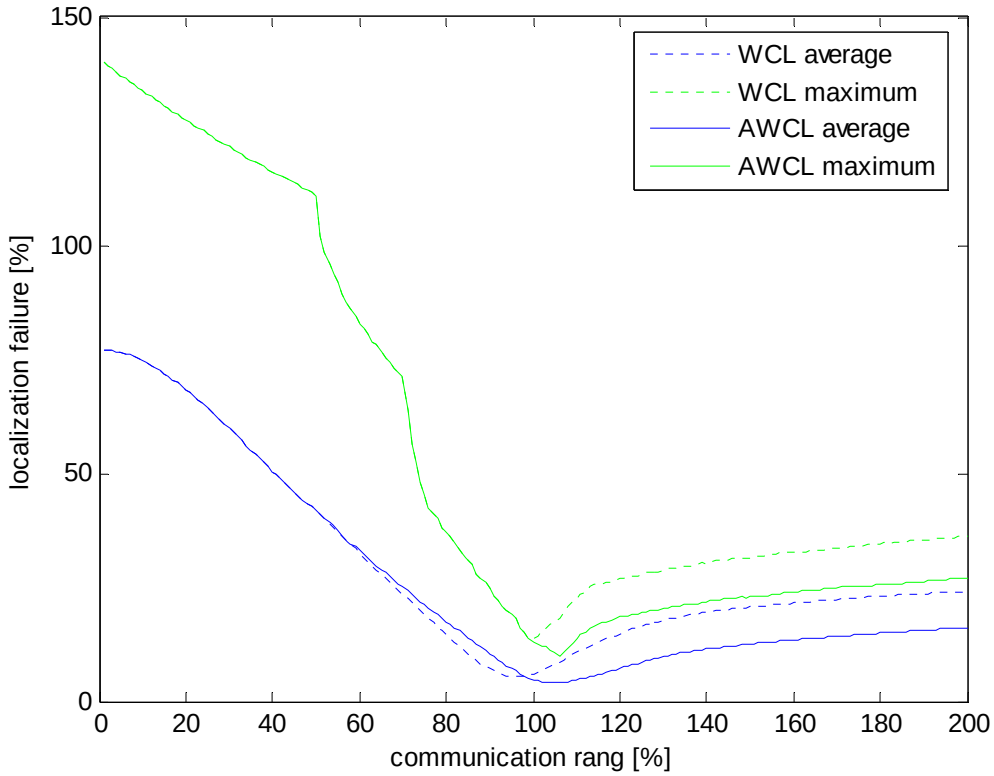
Simulations

- Best conditions

WCL:

Com.Range: 96%

Avg.Failure: 5.5%
Max.Failure: 18%



AWCL:

Com.Range: 105%
Reduction: 55%

Avg.Failure: 4%
Max.Failure: 10.7%

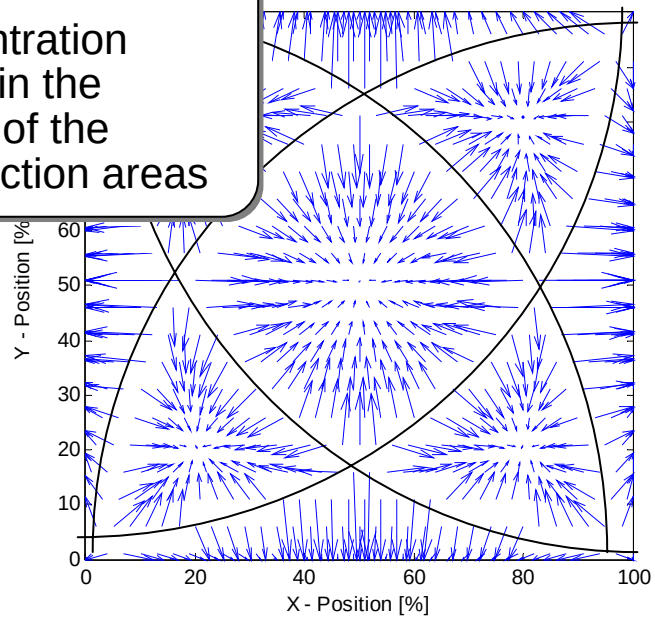
Simulations

- Best conditions – Failure distribution

WCL:

Com.Range: 96%

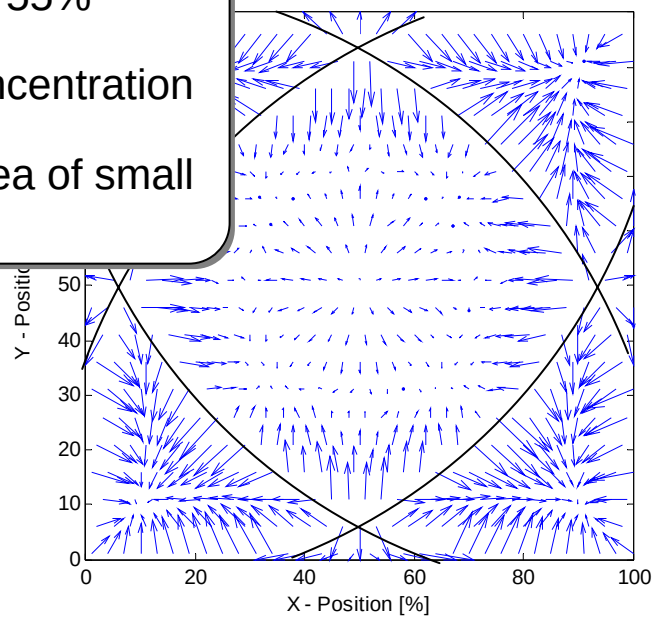
- concentration points in the centre of the intersection areas



AWCL:

Com.Range: 105%
Reduction: 55%

- More concentration points
- Large area of small failure



Simulations

- Best conditions – Failure distribution

WCL:

Com.

- con
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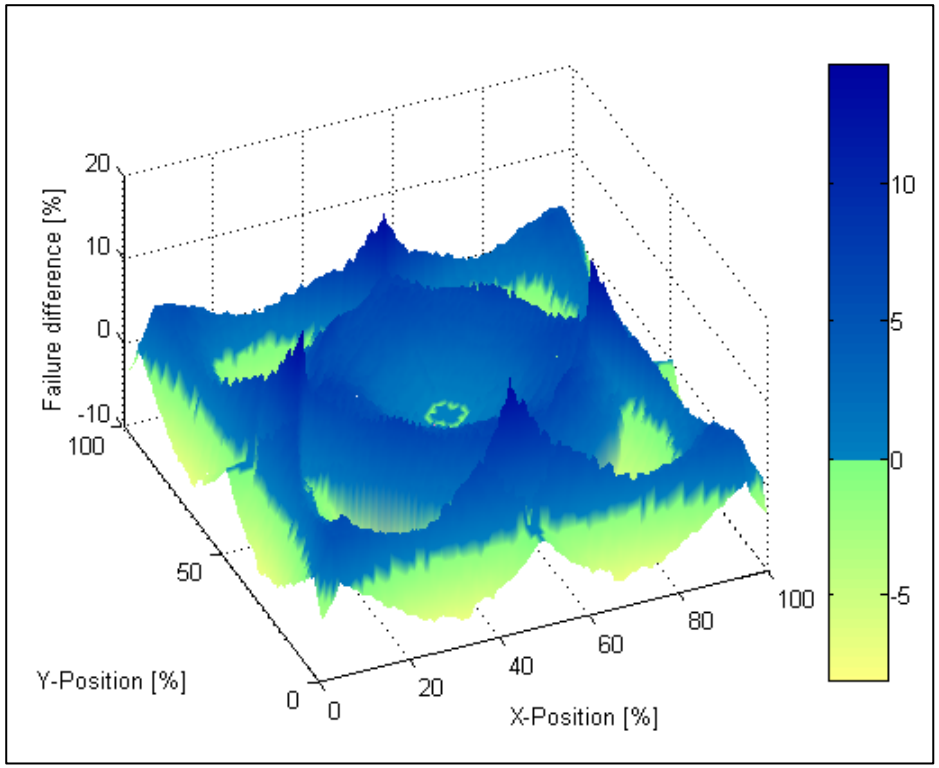
Failure difference

Blue = Improvement

Green = Impairment

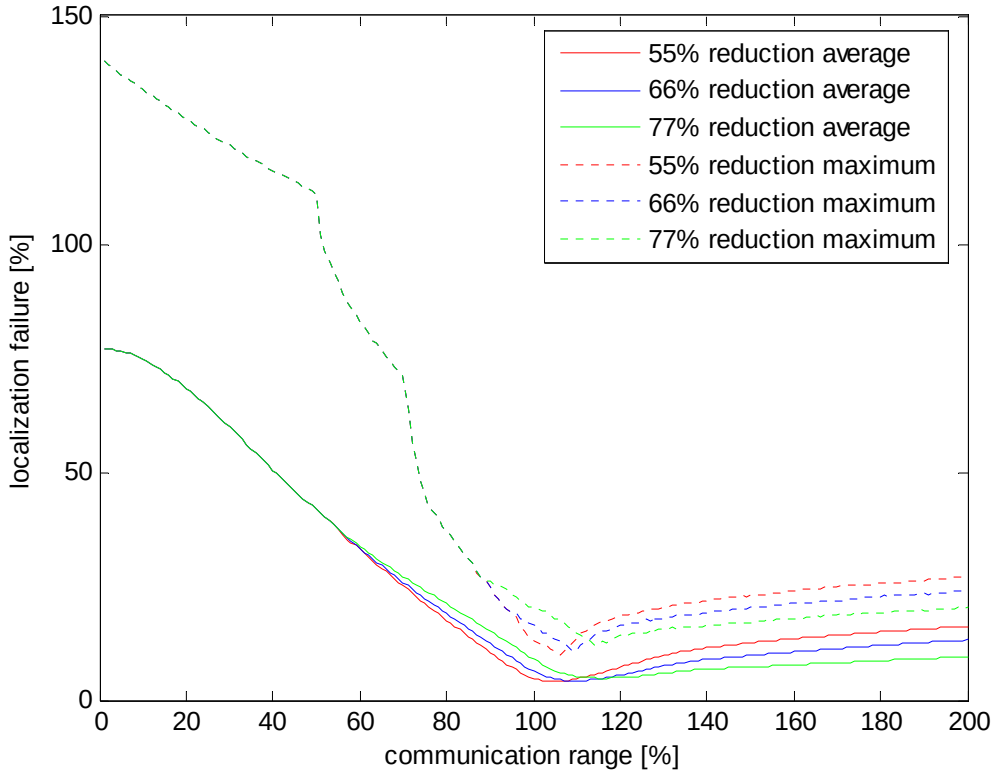
Improvement outwights impairement!



Simulations

- General purpose conditions
  - An reduction part, performing good for various communication ranges

- 3 reduction examples
- Tradeoff: Communication range
- Good reduction part: 66%



Simulation

- General purpose conditions

Failure difference

WCL

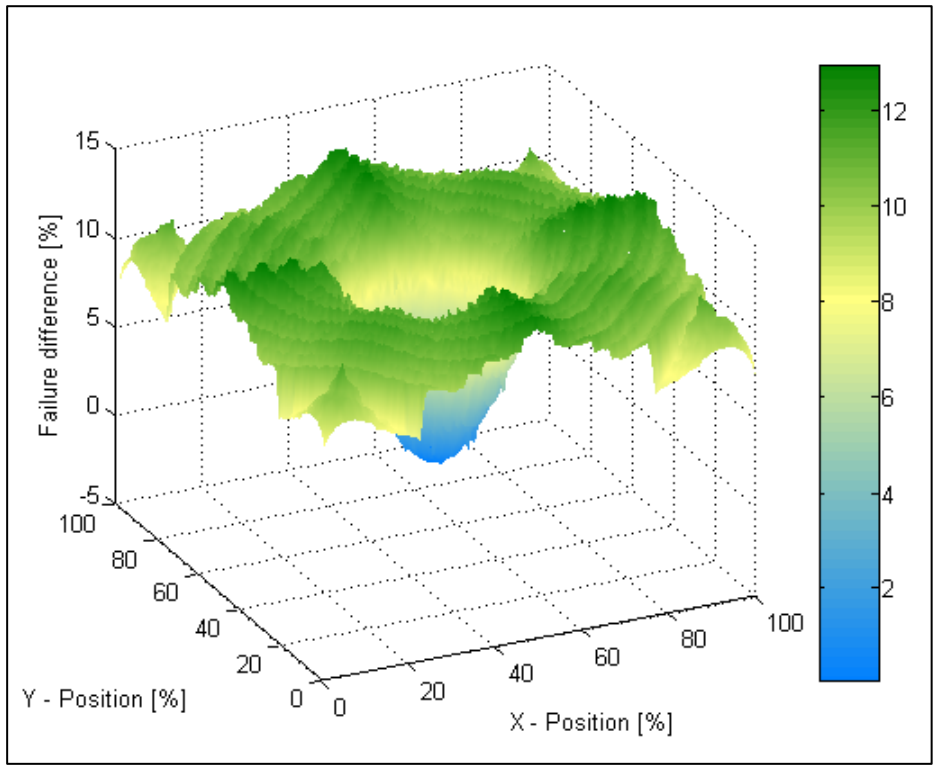
vs.

AWCL

Com.Range: 125%

Reduction: 66%

Only Improvements!



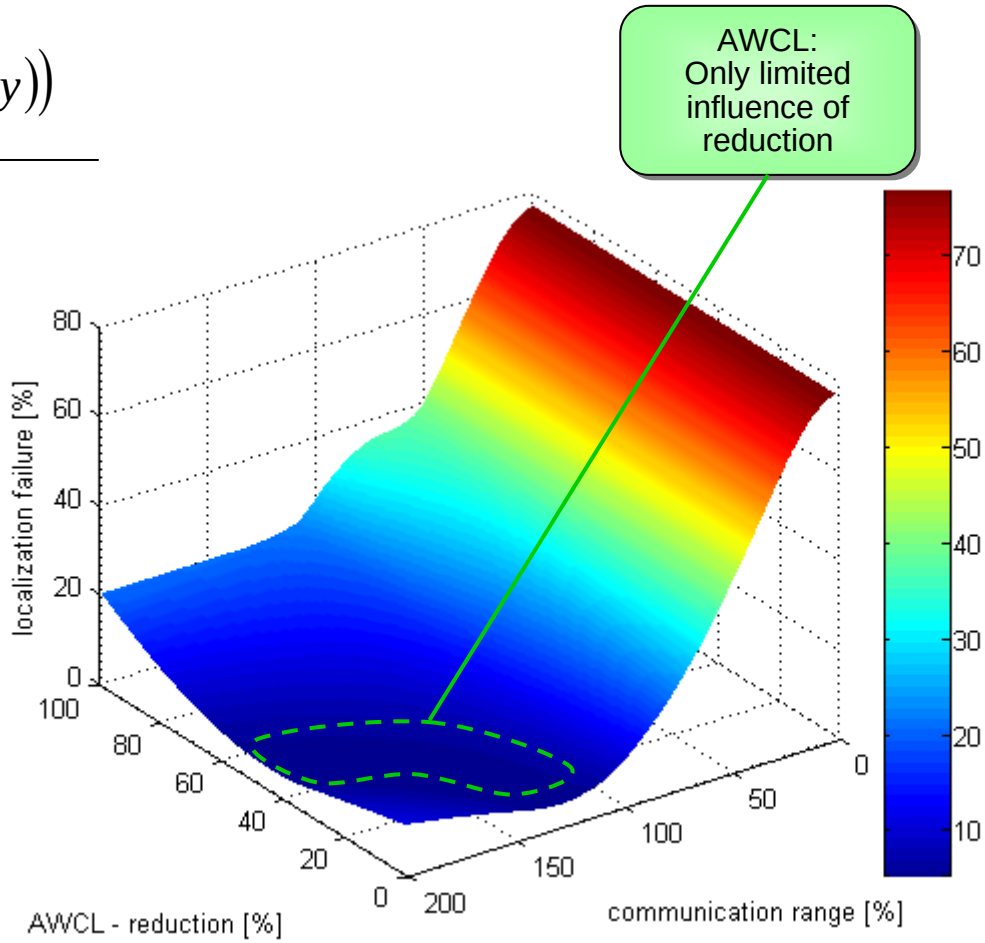
Simulations

- About quadratic quantification

$$P_i(x,y) = \frac{\sum_{j=1}^{m} \left(LQI_{ij}^{2} \cdot B_j(x,y) \right)}{\sum_{j=1}^{m} LQI_{ij}^{2}}$$

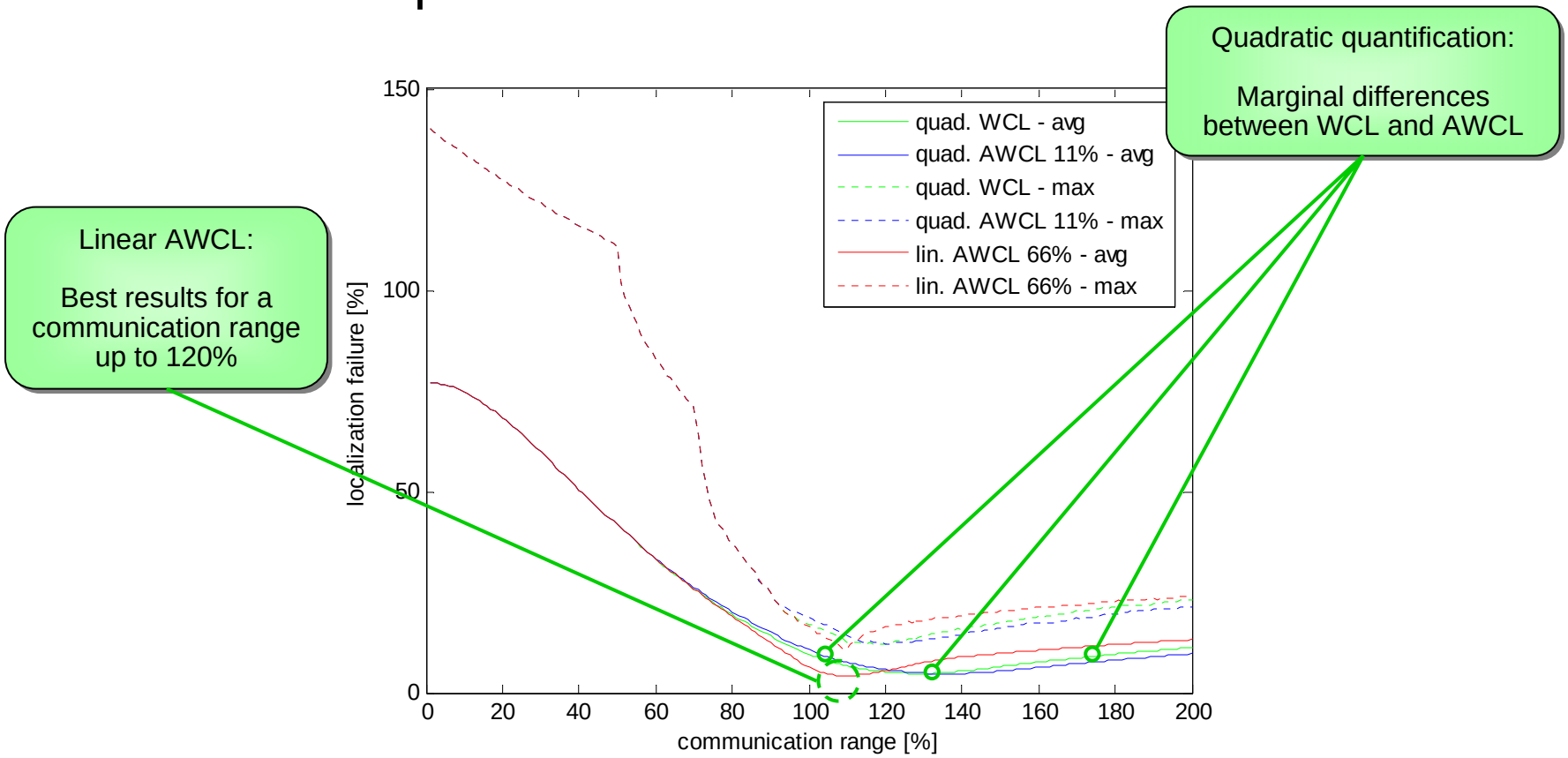
WCL - linear vs. Quadratic:

- Computational cost: Higher
- Localization: Better
- Optimal com.range: 129%



Simulations

- AWCL vs. quadratic WCL

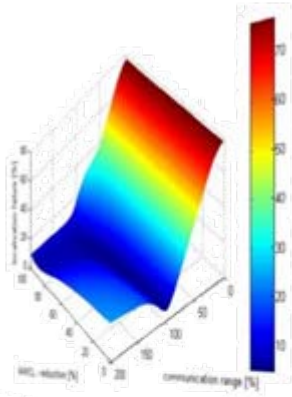


Simulations

Comparison

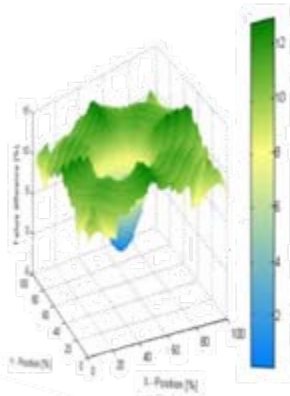
	CL	WCL linear	AWCL linear	WCL quadratic	AWCL quadratic
Communication range [%]	87	96	105	129	136
Reduction part [%]	-	-	55	-	11
Average failure [%]	18	5.5	4	4.76	4.72
Maximum failure [%]	45	18	10.7	13.72	13.87

Conlusion



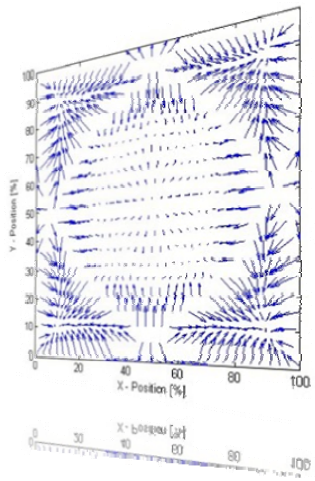
Benefit:

- Better Localization
- Less complex computation
- Quadratic localization with linear complexity
- Useful communication range > 100%
- Reduced dependence on communication range
- Smaller numbers
- No need to square



Cost:

- Find least LQI
- Reduce all LQIs



Conclusion

Future work

- Simulations with more than 4 Beacons
- Alternative reduction strategies
  - Fixed reduction
  - Fixed remain
  - Adaptive percentage
- Real life experiments

Thanks for your attention