projekt c21

Kommunikation-MultiMedia-Wireless Internet

User location estimation by means of WLAN

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Contents

- **Location-aware applications**
- **Indoor positioning: IMST ipos**
  - Experimental testbed
  - Deterministic and probabilistic approach
  - Software design
- **Summary**
- **Outlook**

Location-aware Applications

- **Locate people and nearby resources**
  - Tracking
    Who/what is close?
  - Navigation
    How do I get there?
- **Product location information**
  - Example: Metro Future Store, Rheinberg

Experimental testbed

	IMST 1st floor
Standard	IEEE 802.11b
# of AP's	7
Dimensions	69 x 22 m
OS	Linux/Windows
Hardware	hp iPAQ
	Lucent ORiNOCO

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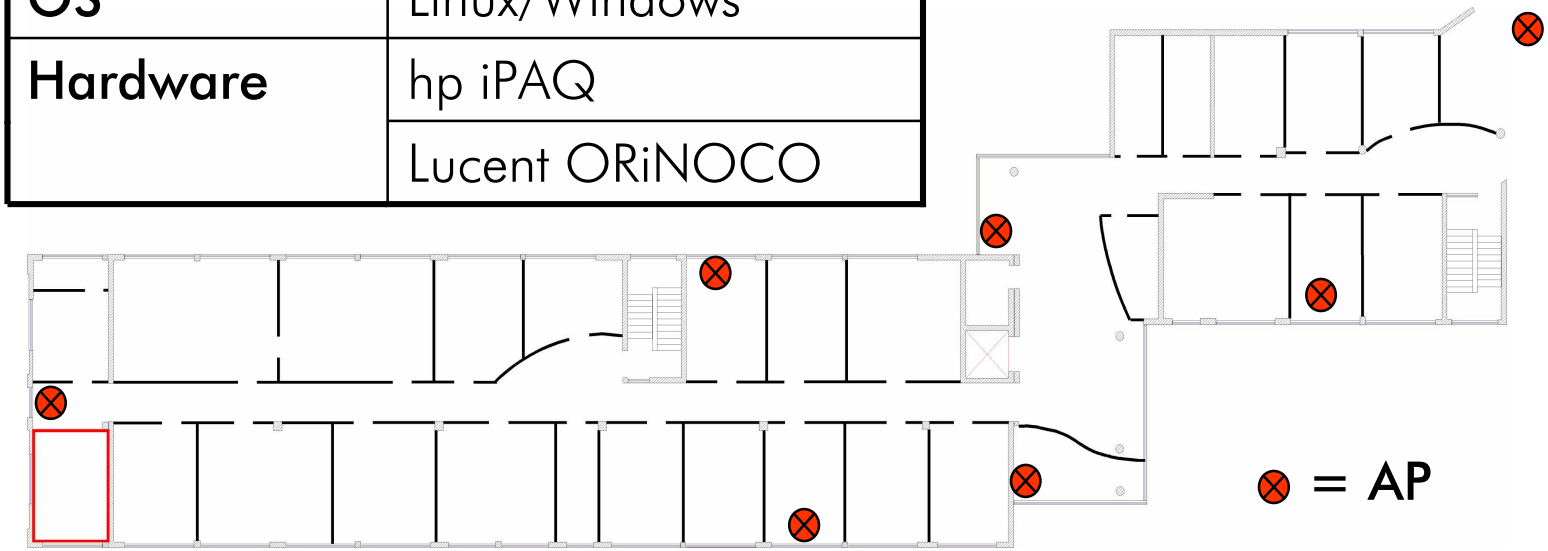

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User location estimation by means of WLAN / DV

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Experimental testbed (2)

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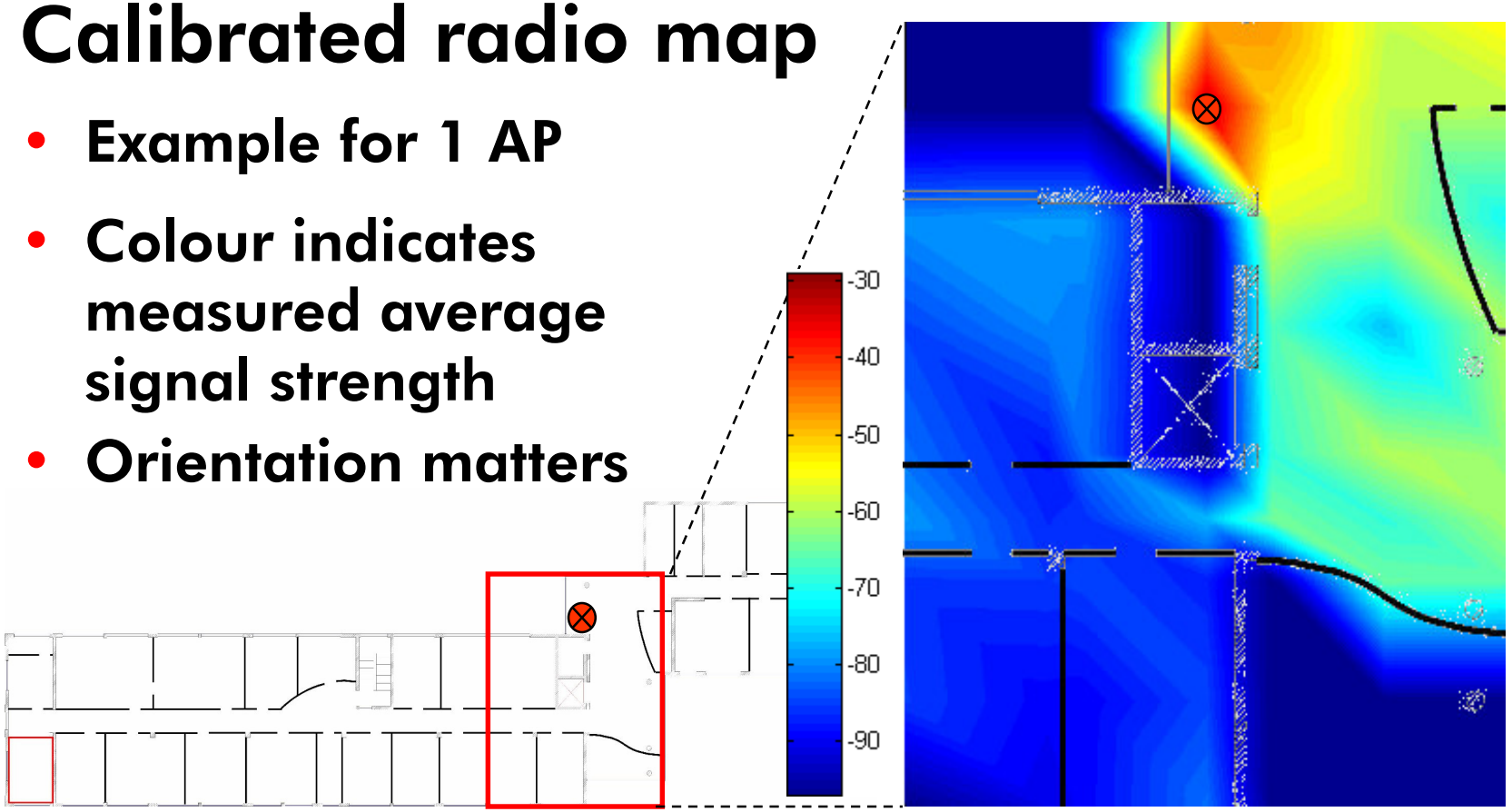
Calibrated radio map

- Example for 1 AP
- Colour indicates measured average signal strength
- Orientation matters

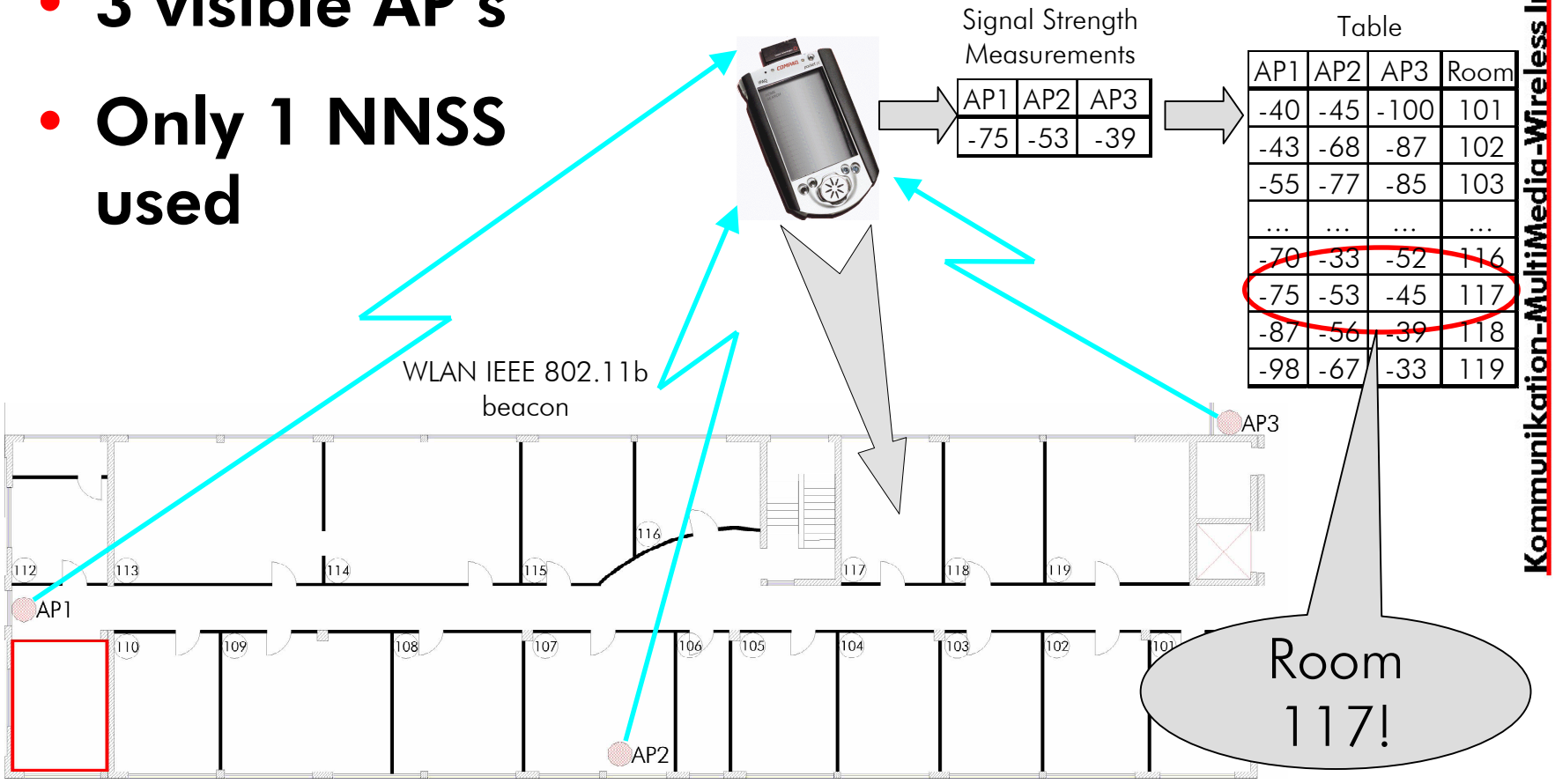


ipos WLAN overview

- **Determine signal strength from beacons received from „visible“ access points**
- **Average of *k* Nearest Neighbours in Signal Space (*k*-NNSS)**
- **Deterministic**
  - Data base contains averaged signal strength values
  - Determine smallest Euclidean distance
- **Probabilistic**
  - Data base contains histograms of signal strengths
  - Determine largest joint probability
- **Postprocessing (averaging, etc)**

Simplified example

- 3 visible AP's
- Only 1 NNSS used



Deterministic approach

- Data base with measured average values for each calibrated location: ss_1, ss_2,... ss_n
- Mobile station with real time signal strength measurements from *n* Access Points: ss_1',... ss_n'
- Nearest neighbours are calibrated values with minimal Euclidean distance in signal space:

$$d = \sqrt{\sum_{i=1}^{n} \left(ss_i - ss_i' \right)^2}$$

- Average *k* NN to obtain location estimation

Probabilistic approach

- **Data base with histograms instead of averages**
- **Estimated joint probability:**

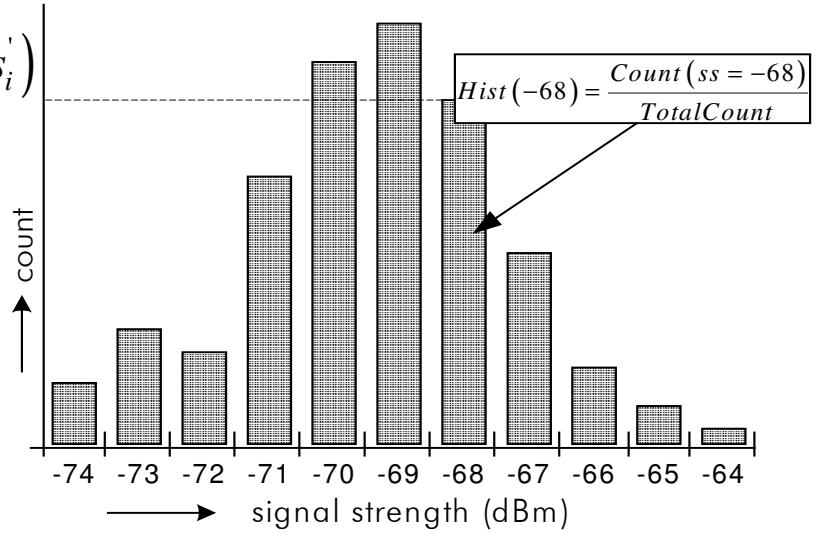
$$P\left(ss_1 = ss_1^{'},\ldots,ss_n = ss_n^{'}\right) = \frac{Count\left(ss_1,\ldots,ss_n\right)}{TotalCount}$$

- **Assume AP's are independent:**

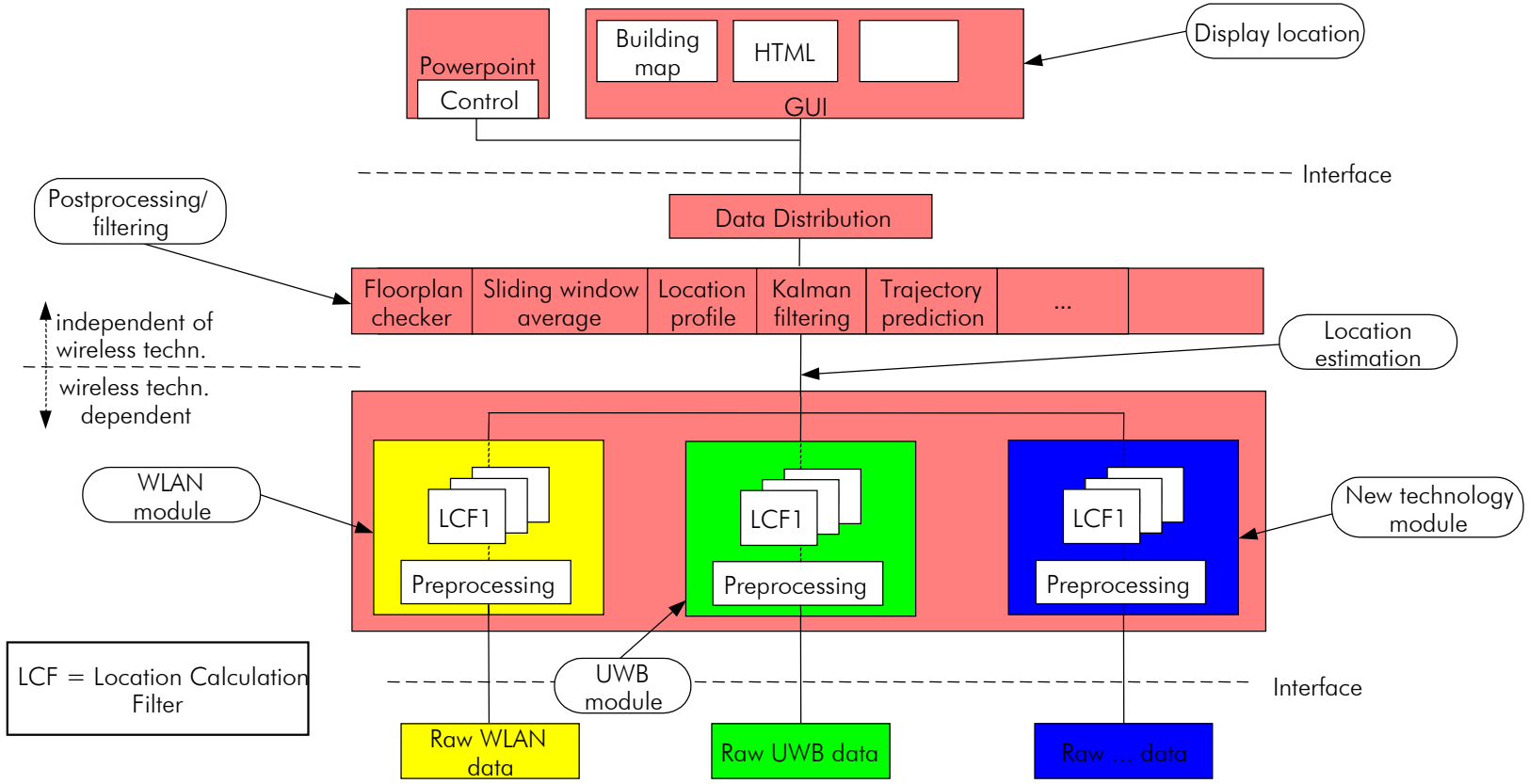
$$P\left(ss_1 = ss_1^{'},\ldots,ss_n = ss_n^{'}\right) = \prod_{i=1}^{n} P\left(ss_i = ss_i^{'}\right)$$

with

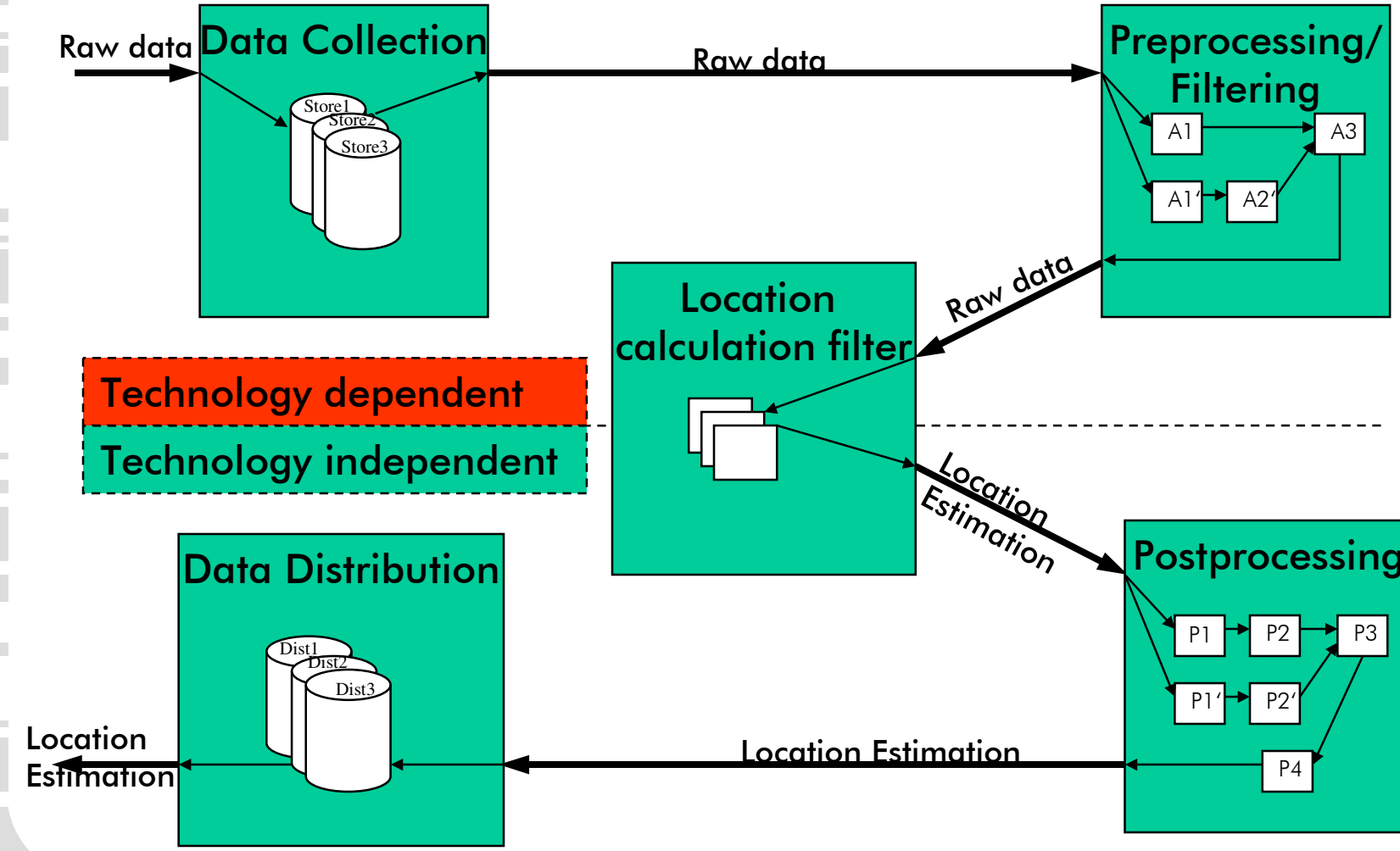
$$P\left(ss_i = ss_i^{'}\right) = Hist\left(ss_i^{'}\right)$$



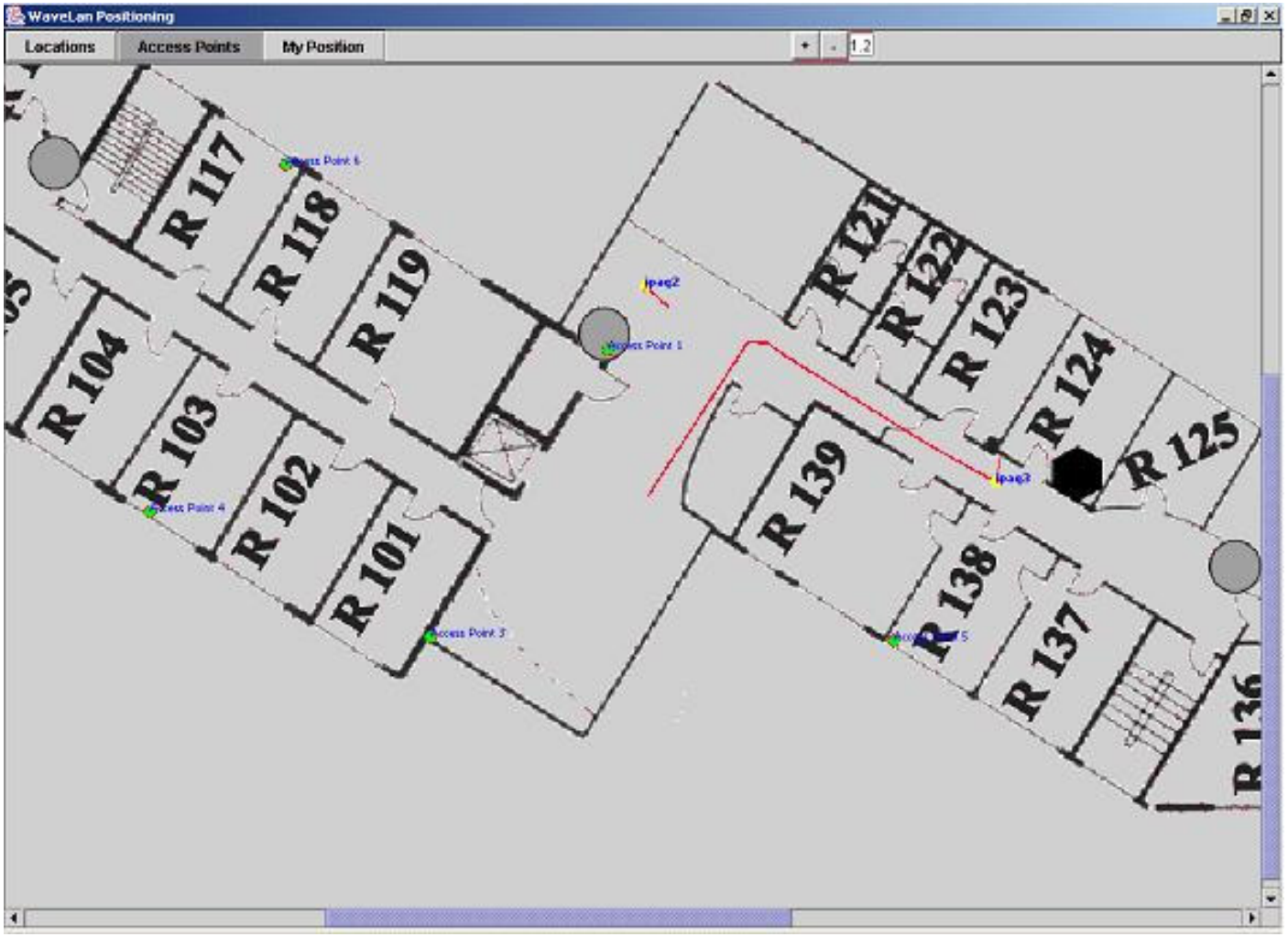
ipos system design



ipos data processing



Example: user tracking



User location estimation by means of WLAN / DV

Summary

- Use existing WLAN infrastructure
- Find best match of AP beacons' signal strength measurements to a calibrated radio map
- Realtime positioning with average error of 1-3 meter in testbed

Outlook

- **Identify and resolve error sources**
  - Influence of environmental changes (number of persons, etc)
  - Differences between WLAN hardware
- **Design and implement ipos-software**
- **Research into new data sources and calculation algorithms**

Questions?

Thank you for your attention!

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