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# Mobility Prediction for Mobile Agent-based Service Continuity in the Wireless Internet

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# Agenda

- Wireless Internet
- Middleware for service tailoring
- Mobility Prediction
  - RSSI based algorithm
  - Position based algorithm
- Experimental results

# Location dependent / aware services

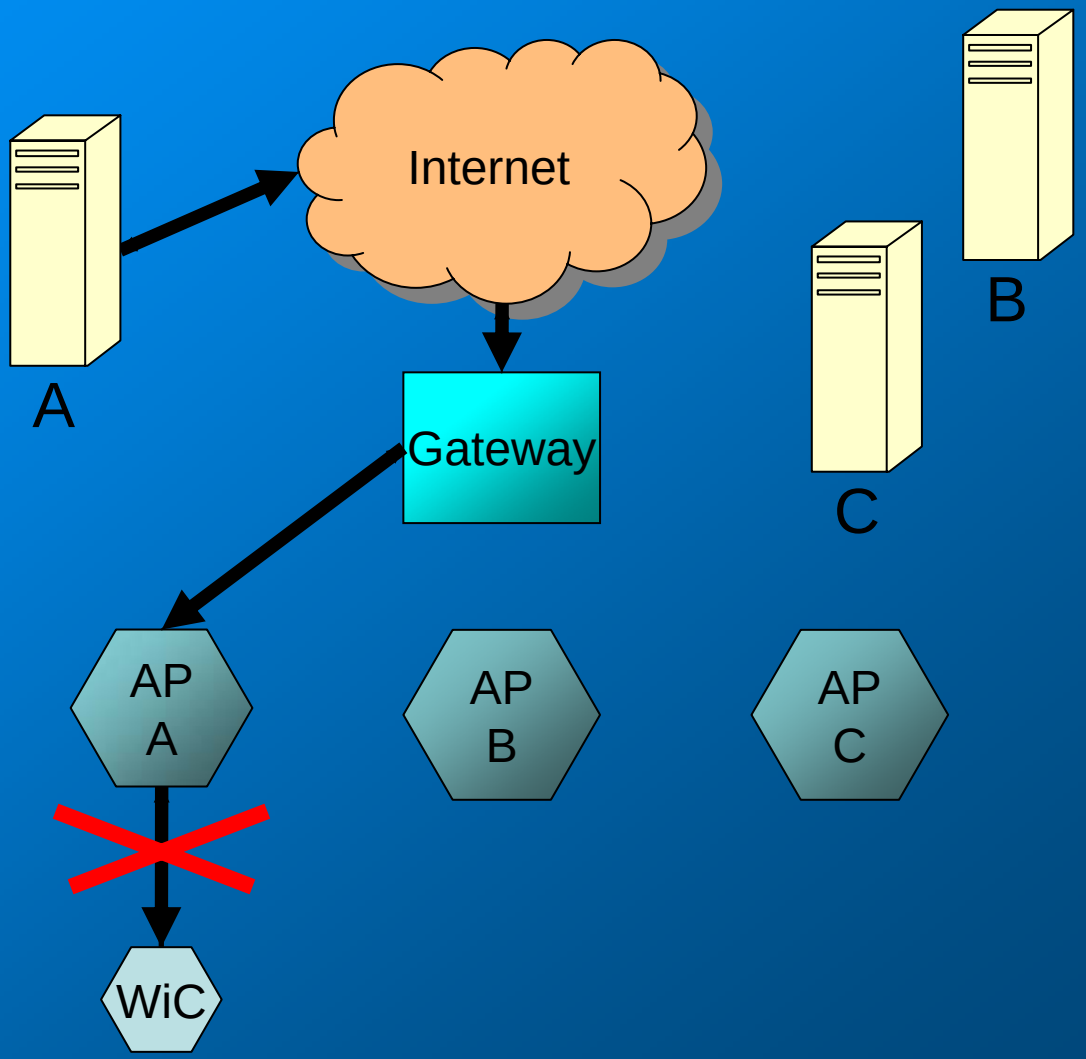
- Wireless technologies make possible to develop location dependent / aware services

New challenges due to:

- necessity of additional information, i.e. wireless client position
- heavy hardware / software client heterogeneity

# The Wireless Internet

- limited bandwidth
- limited hardware
- limited battery life

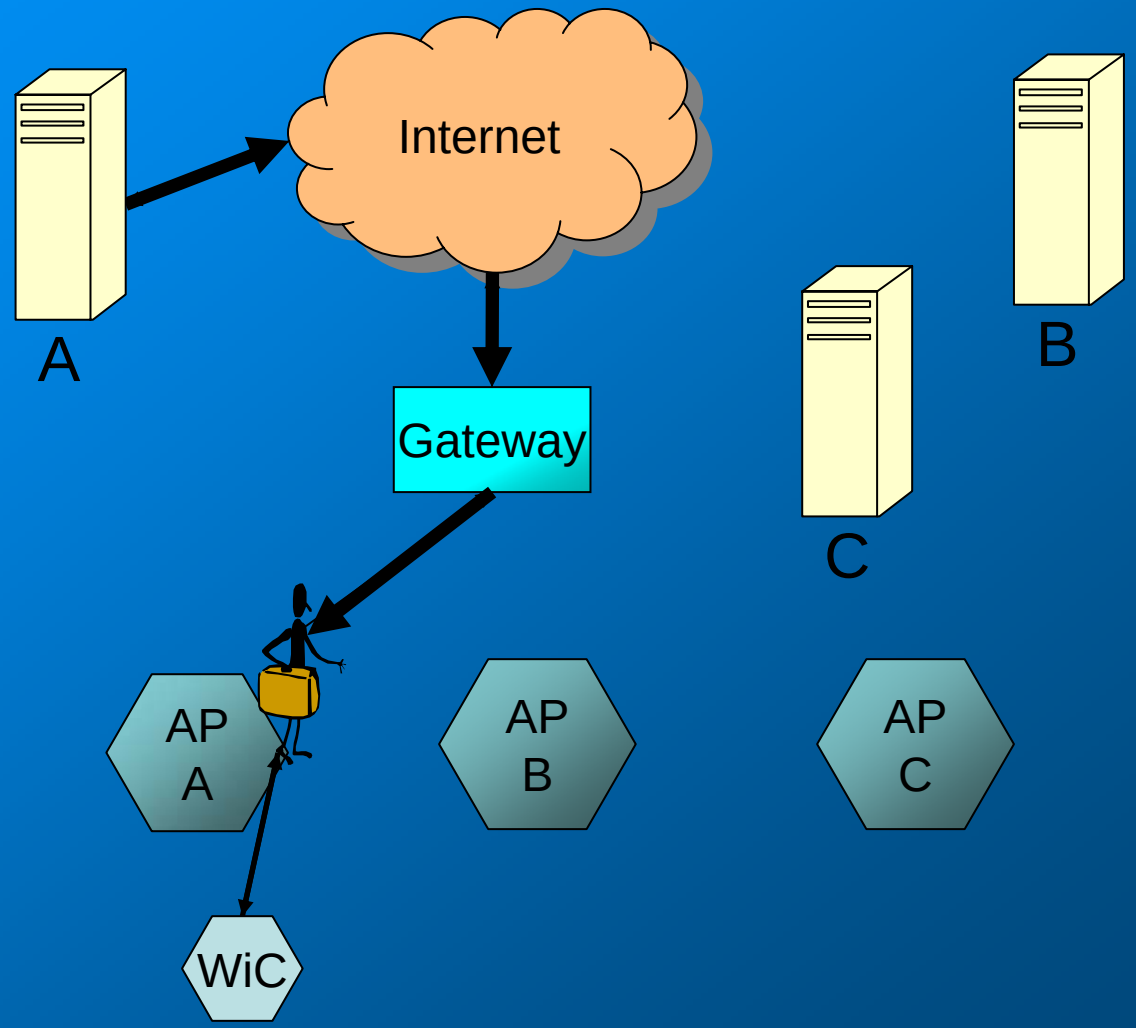


# A new layer

- Proxies tailor services to WiC software / hardware capabilities and bandwidth availability
- Service development complexity reduced by a middleware solution

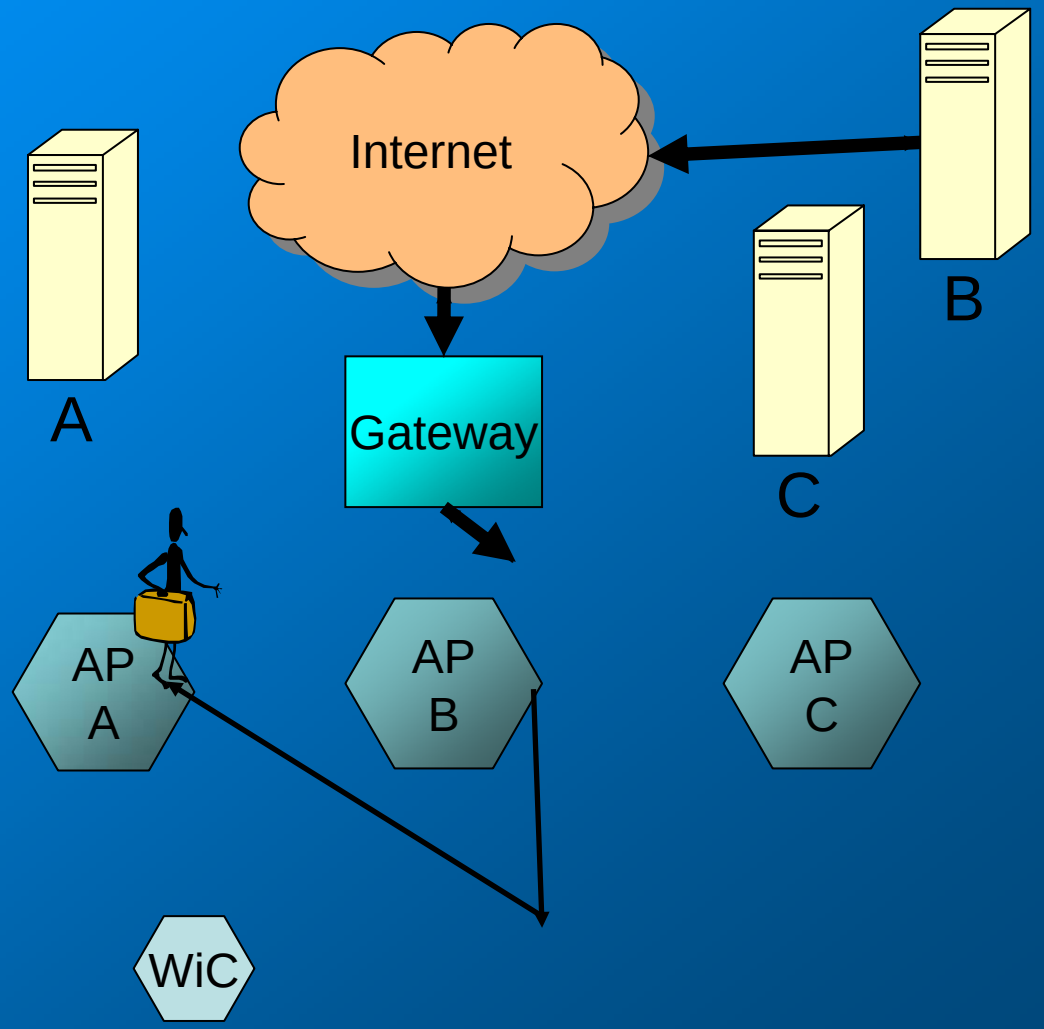
# The Wireless Internet + Proxy

- Mobile agent based proxy tailors services to WiC software / hardware capabilities and bandwidth availability



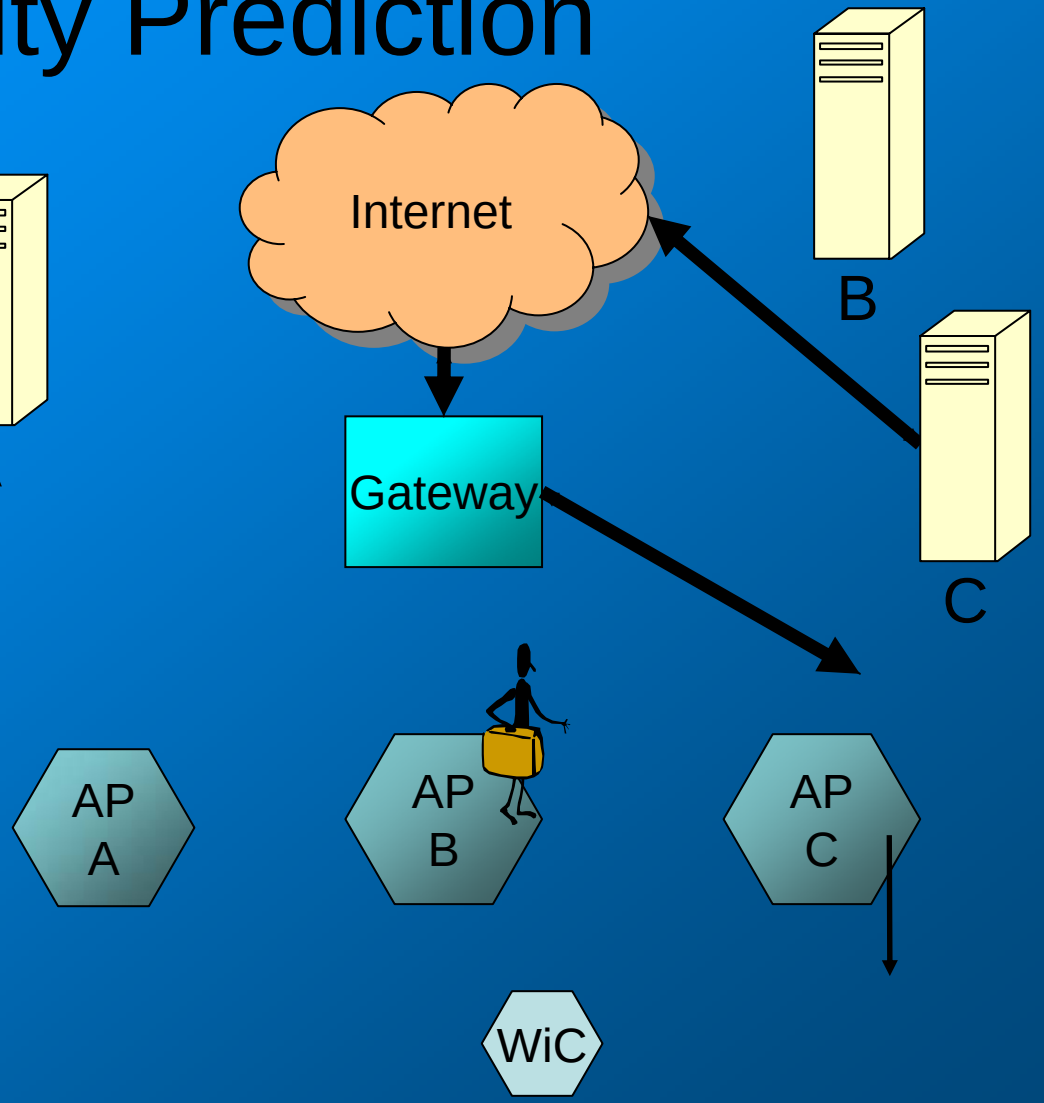
# WiC handover

1) WiC handovers
2) WiC triggers proxy migration
3) Proxy prepares WiC service
4) Proxy supplies service to WiC



# The Wireless Internet + Proxy + Mobility Prediction

- To provide a faster response, proxy must prepare service before WiC handover
- Mobility prediction!



# Mobility prediction: RSSI vs. Position

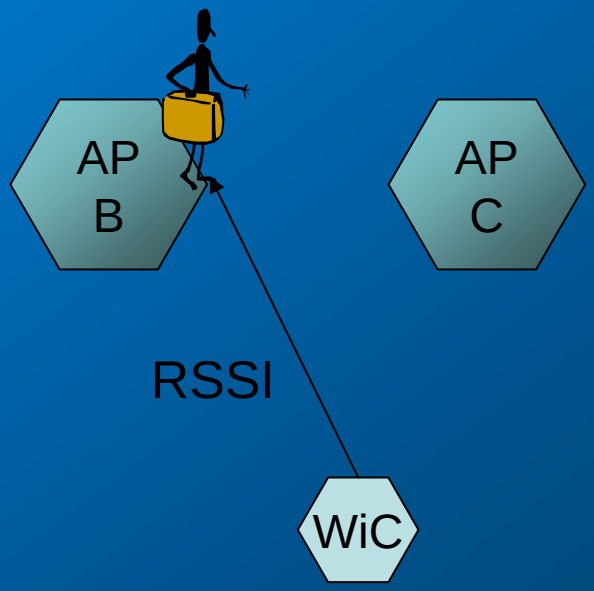
We want to predict when a client change AP and which is its next AP:

- visible AP RSSI monitoring / prediction
- client position estimation / prediction and knowledge of AP deployment and coverage area

# RSSI – Grey Model

$$pr(i) = \left( r_1(1) - \frac{u}{a} \right) e^{-ak} + \frac{u}{a}$$

1. a client stub achieves visible AP RSSI
2. client stub sends data to proxy
3. proxy exploits RSSI-GM to predict visible AP RSSI
4. proxy performs mobility prediction

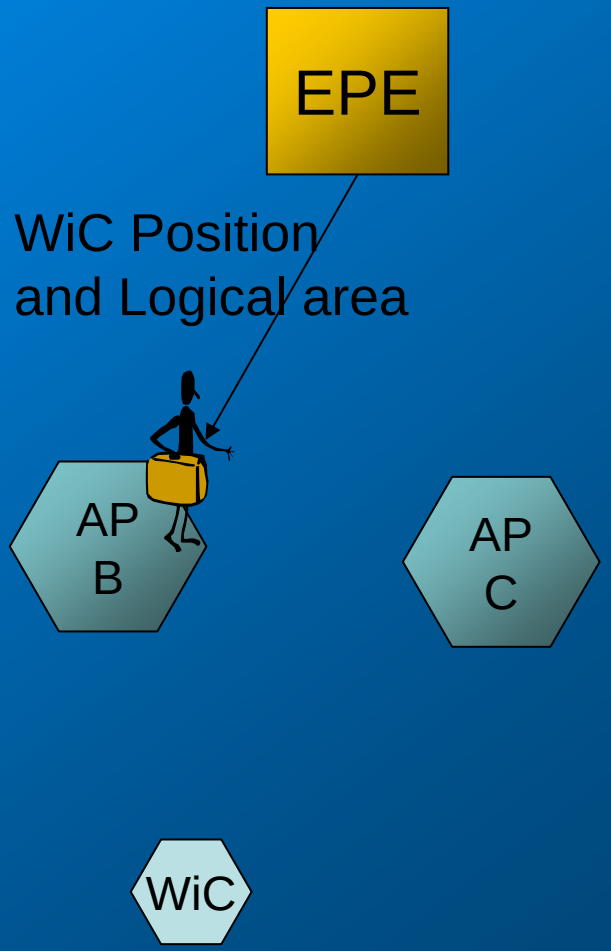


# Ekahau Positioning Engine (EPE)

- WiC position estimation through EPE
- EPE performs positioning comparing actual and pre-recorded RSSI
- Monitored area eventually divided on configurable logical areas
- For each tracked client, EPE supplies position estimation and probabilities WiC is located in logical areas

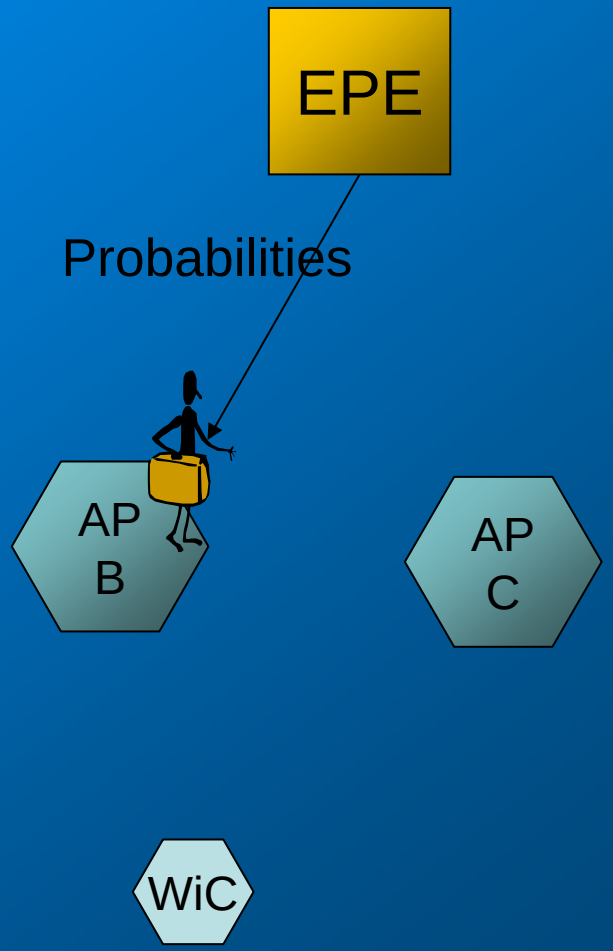
# Ekahau Distance – Grey Model

1) proxy obtains from EPE WiC position and logical area map
2) proxy exploits ED-GM to predict distance between WiC and logical areas
3) proxy performs mobility prediction



# Ekahau Cell Probability – Grey Model

1) proxy obtains from EPE WiC probabilities for each AP
2) proxy exploits ECP-GM to predict probability for each AP
3) proxy performs mobility prediction



# Performance indicators

- effectiveness *E1%* = $\left(1-\frac{NFSP}{NR}\right)*100$

  *NFSP* number of time proxy is not yet ready after a WiC handover
  *NR* number of WiC handovers

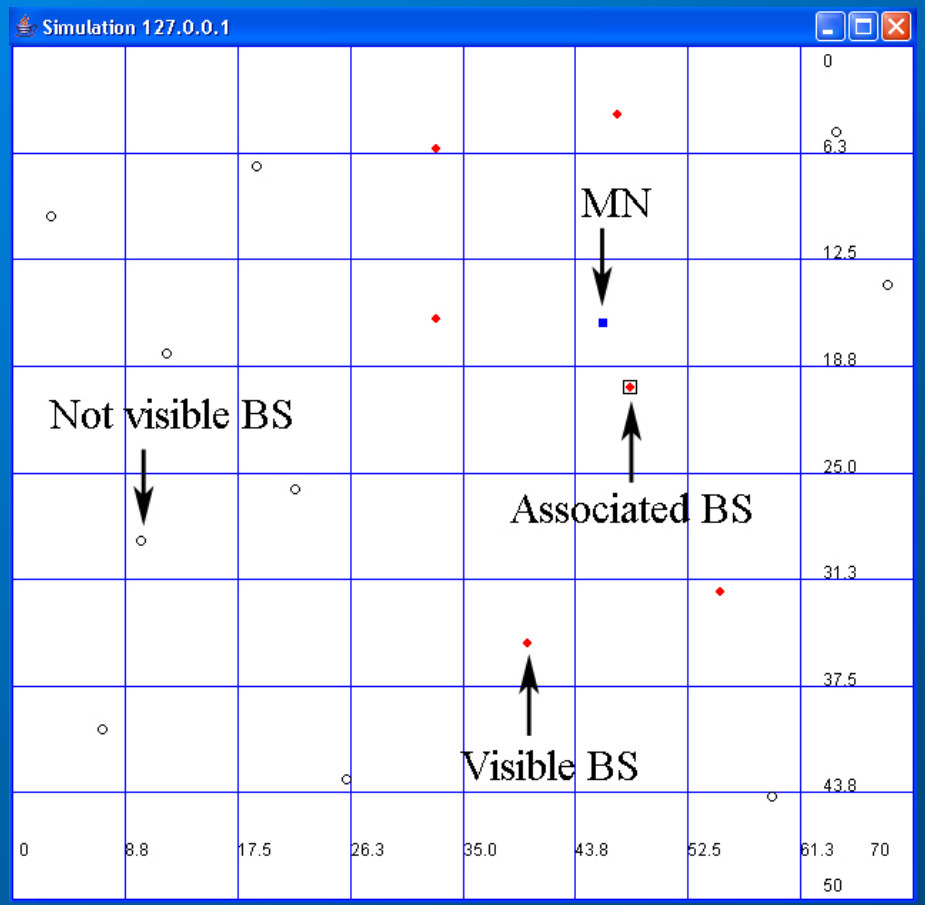
- efficiency *E2%* = $\left(\frac{USP}{NM}\right)*100$

  *USP* number of proxies eventually used by the WiCs
  *NM* number of migrated proxies

- advance time *AT*

# Simulated environment

- WiC speed between 0.2 and 2.5 m/s
- Handover hysteresis threshold at 0, 1, and 2 dB



# Experimental results (1)

- Straight path trajectory
- RSSI-GM outperforms both EPE predictors

| | Effectiveness | | | Efficiency | | | Advance Time (s) | | |
|---|---|---|---|---|---|---|---|---|---|
| Threshold (db) | 0 | 1 | 2 | 0 | 1 | 2 | 0 | 1 | 2 |
| RSSI-GM | 79 | 91 | 94 | 80 | 74 | 74 | 2.9 | 4.3 | 5.3 |
| ECP-GM | 9 | 14 | 19 | 30 | 33 | 37 | --- | --- | --- |
| ED-GM | 21 | 34 | 43 | 40 | 43 | 47 | --- | 0.7 | 2.5 |

# Experimental results (2)

- Gaussian random trajectory
- RSSI-GM outperforms both EPE predictors

| | Effectiveness | | | Efficiency | | | Advance Time (s) | | |
|---|---|---|---|---|---|---|---|---|---|
| Threshold (db) | 0 | 1 | 2 | 0 | 1 | 2 | 0 | 1 | 2 |
| RSSI-GM | 75 | 91 | 93 | 78 | 76 | 72 | 2.8 | 4.1 | 4.8 |
| ECP-GM | 10 | 13 | 20 | 34 | 34 | 38 | --- | --- | --- |
| ED-GM | 22 | 33 | 37 | 40 | 44 | 43 | --- | 0.8 | 1.9 |

# Conclusions & Ongoing work

- Supporting provisioning of personalized services without interruptions in case of handovers ❾
  - proactive migration of middleware components
- Our proposed solution RSSI-GM implies
  - limited overhead
  - simple lightweight solutions better perform than complex approaches
- Service continuity for the dynamic tailoring of Video-on-Demand streams ❾
  - adaptive buffering

# Any question?

Software and documents about proposed predictors are available on the Web:
http://lia.deis.unibo.it/Research/SOMA/MobilityPrediction/