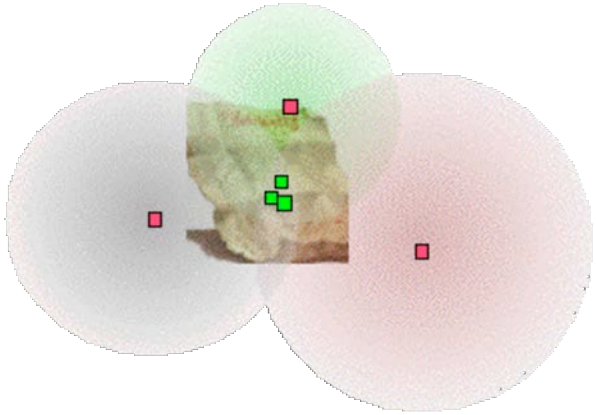


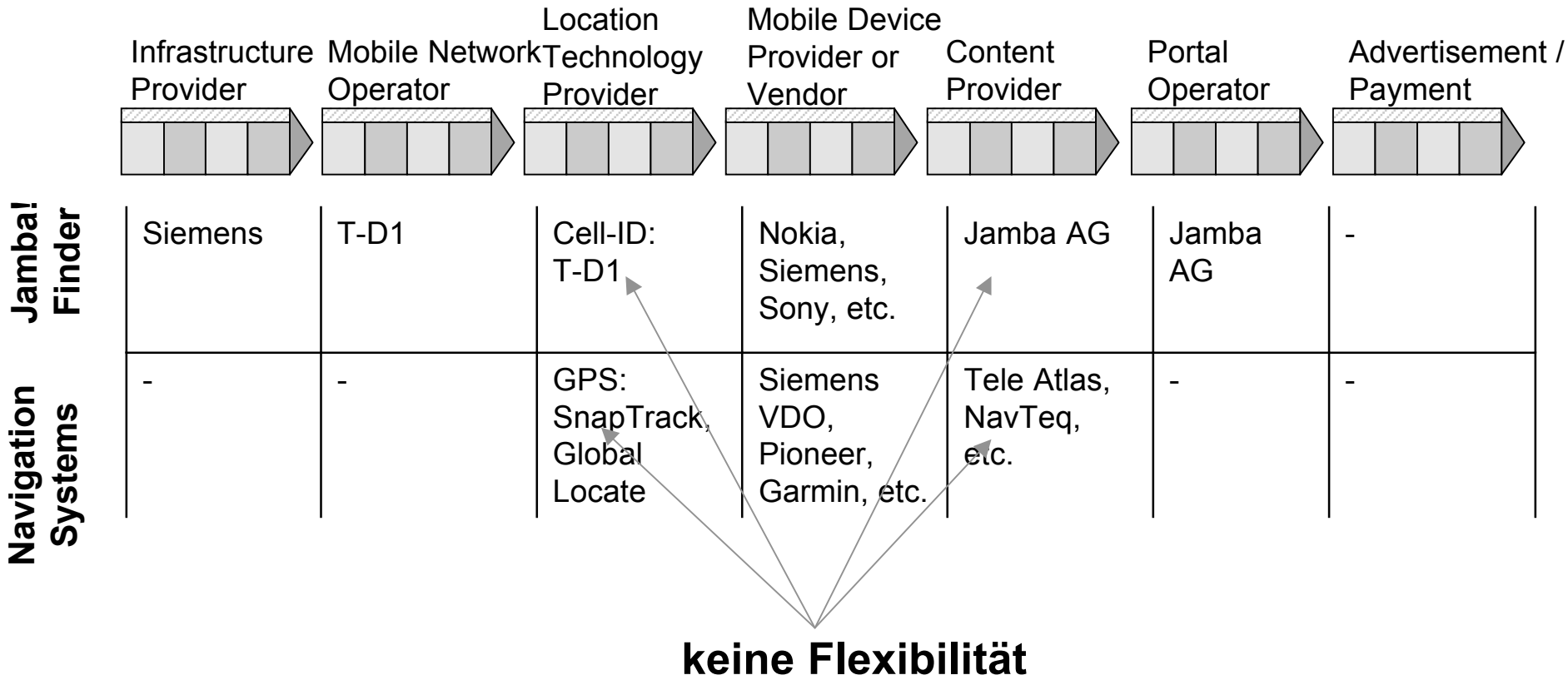
MagicMap – Kooperative Positionsbestimmung über WLAN

Peter Ibach
Humboldt-Universität
Institut für Informatik
Lehrstuhl für Rechnerorganisation und Kommunikation

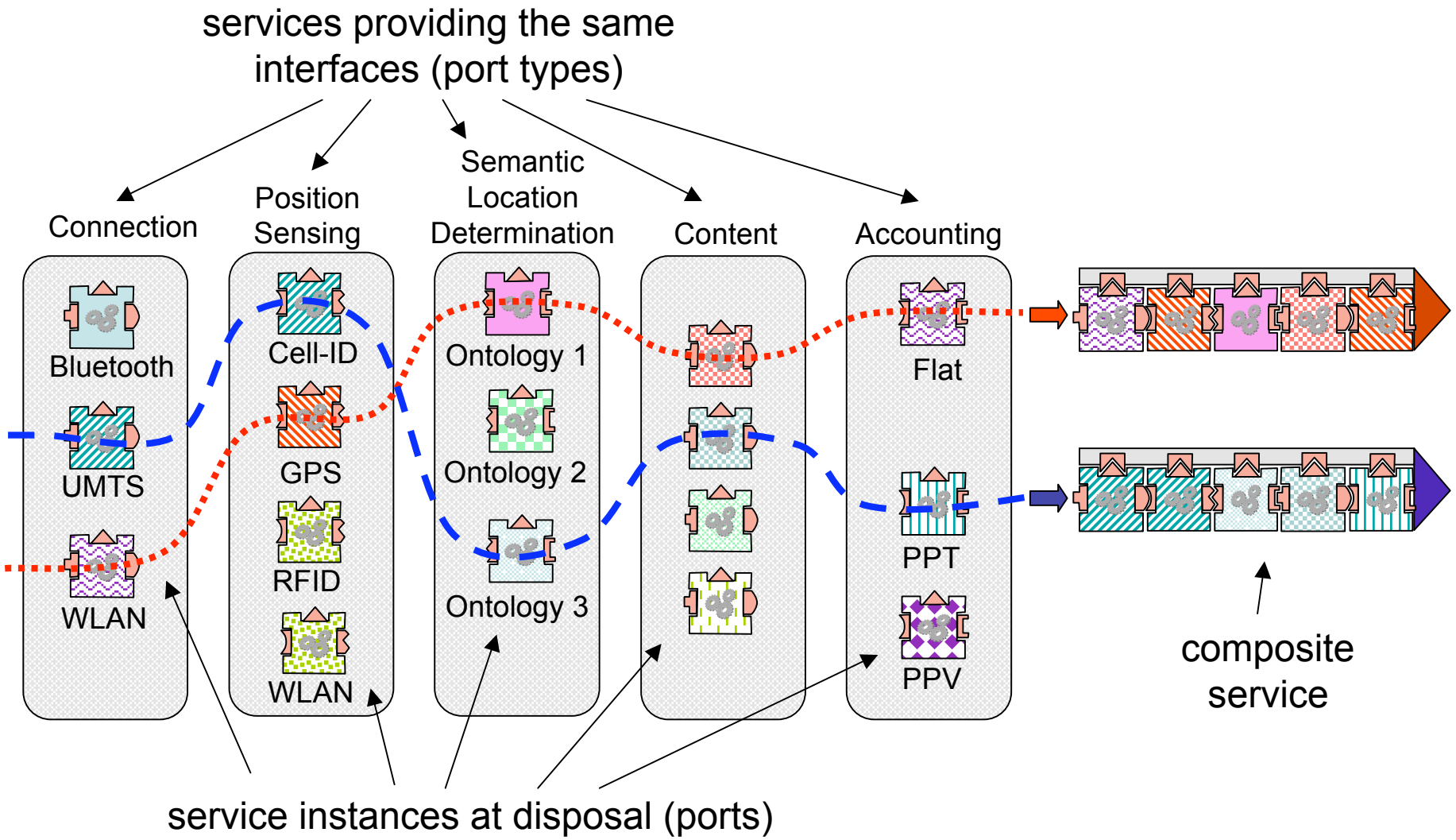
Inhalt

- Location Based Services – Heute und Morgen
- Voraussetzung: Positionsbestimmung
  - Ortungsverfahren
  - Signalstärke-basierte Ortung über WLAN
  - MagicMap

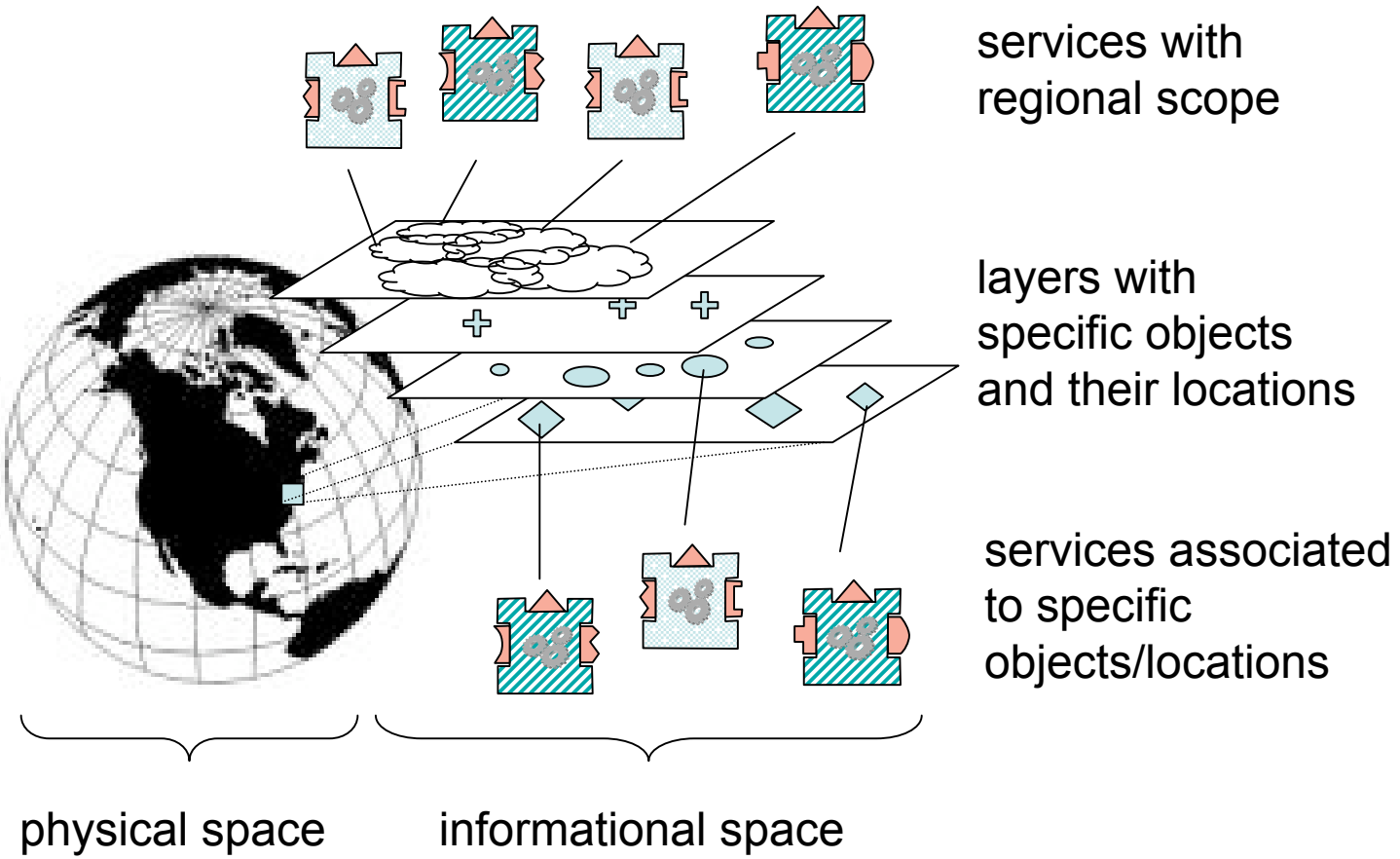
Location Based Services – Heute



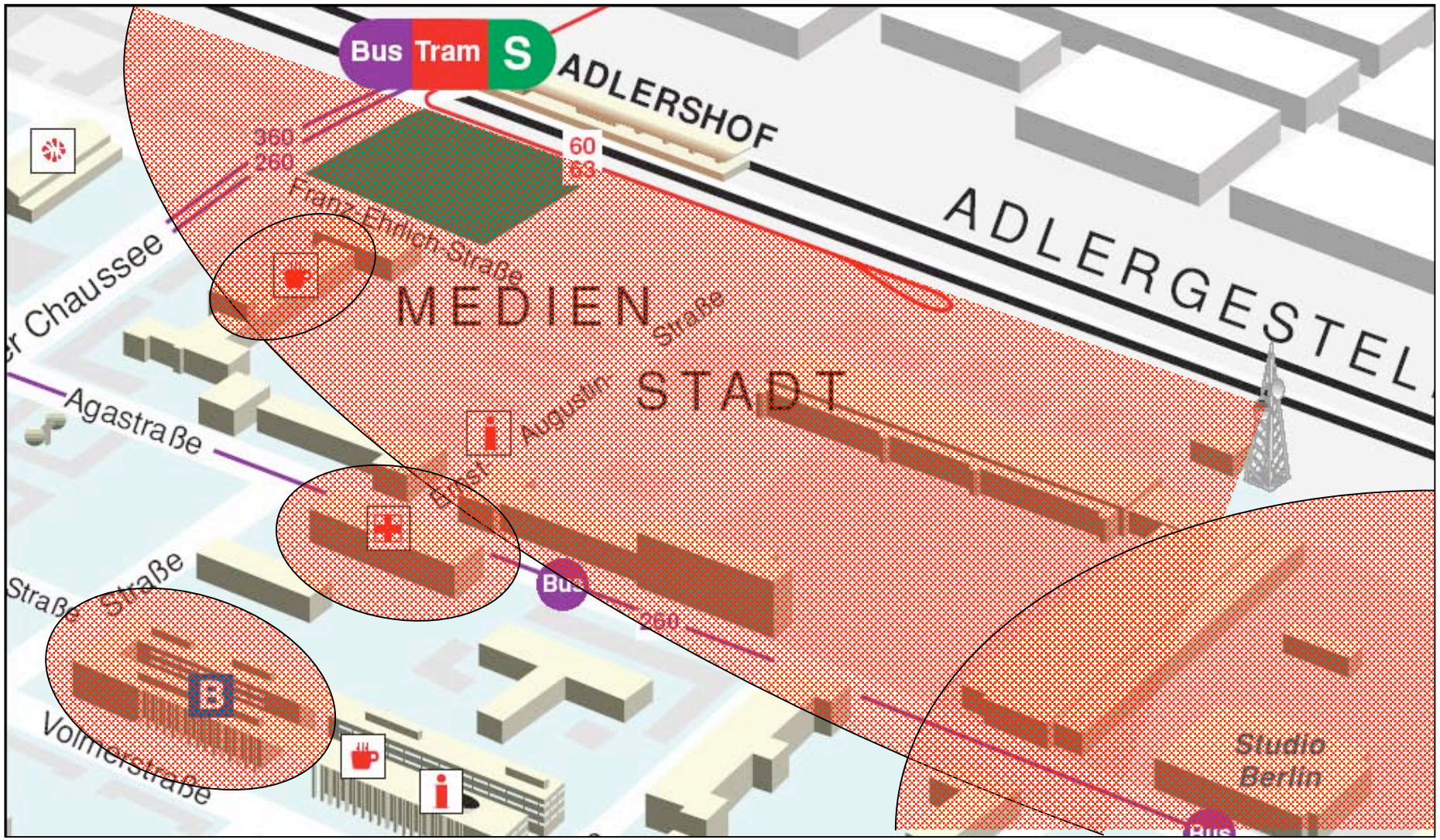
Location Based Services – Morgen



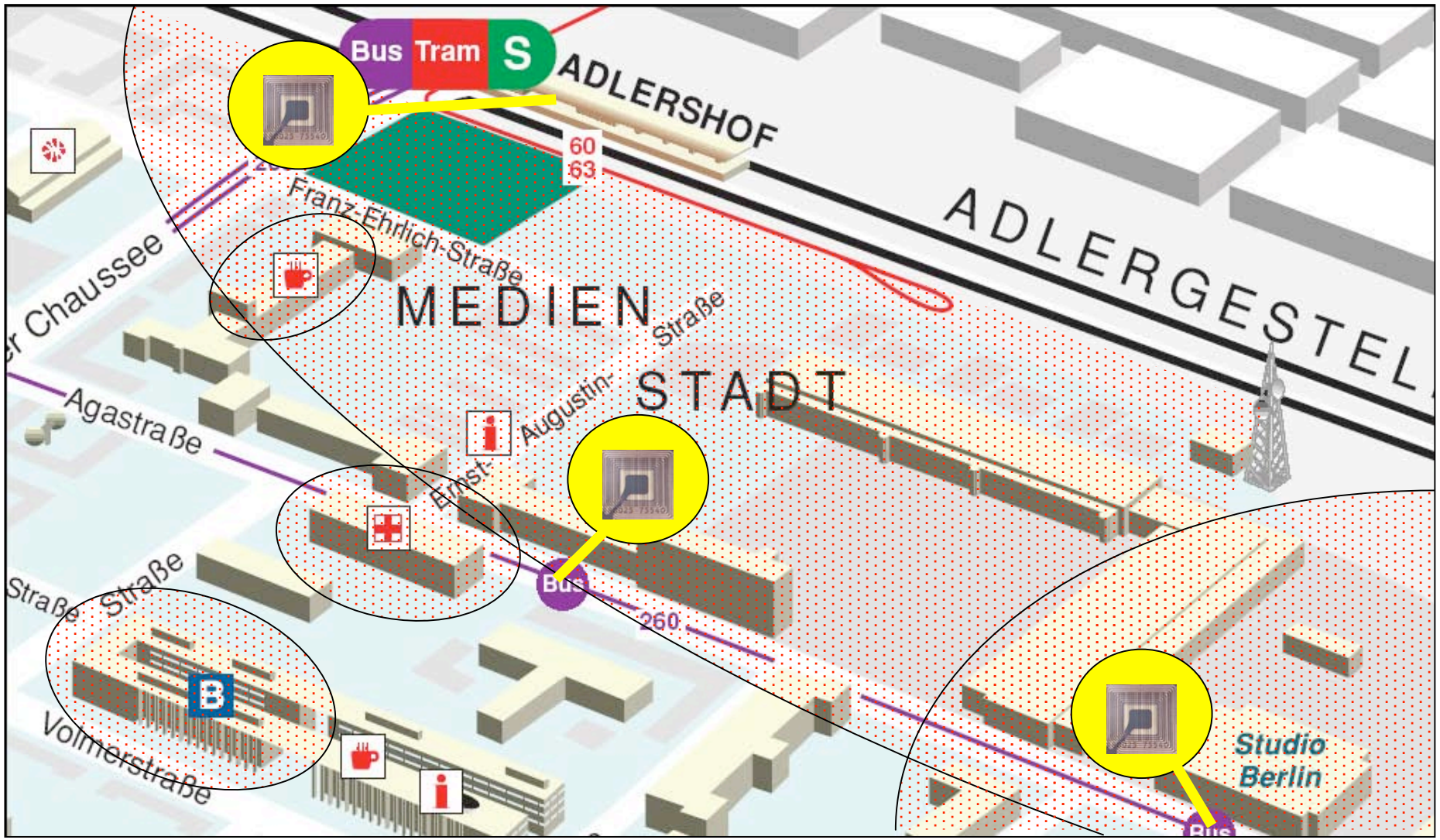
Vision: Konvergenz von Realität und Virtualität



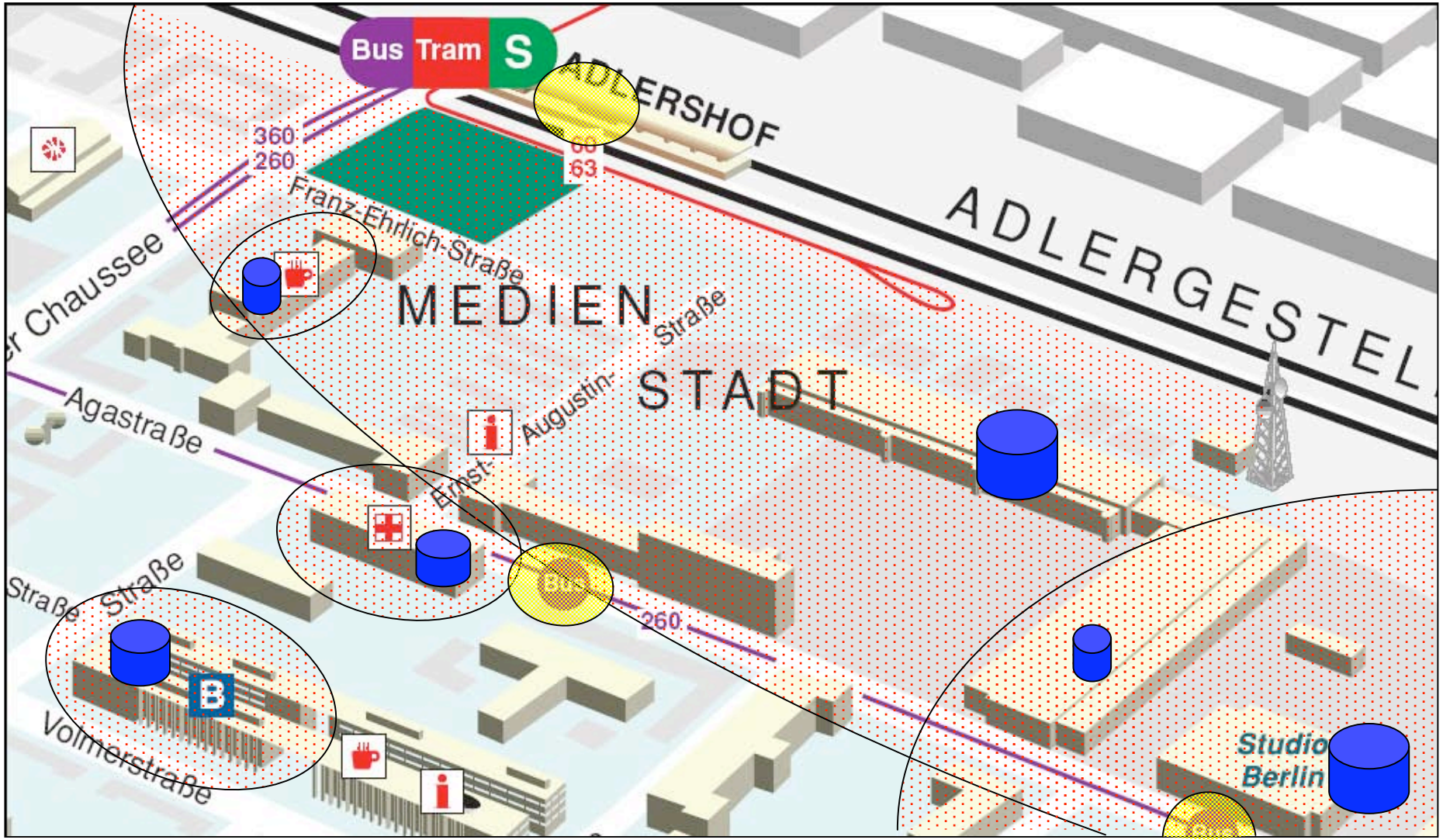
Verfügbare WLAN-Netze:



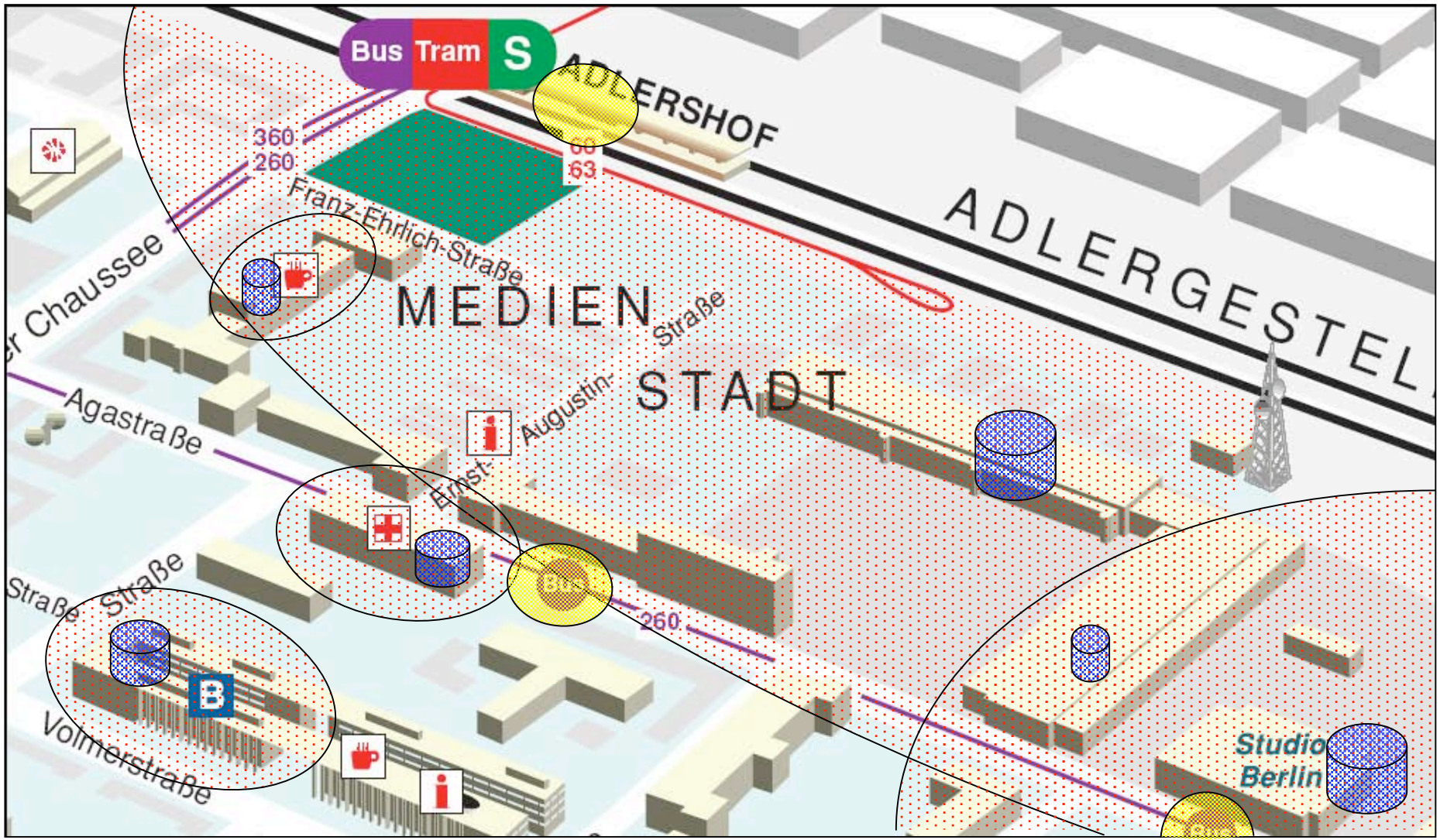
Installierte RFID-Chips:



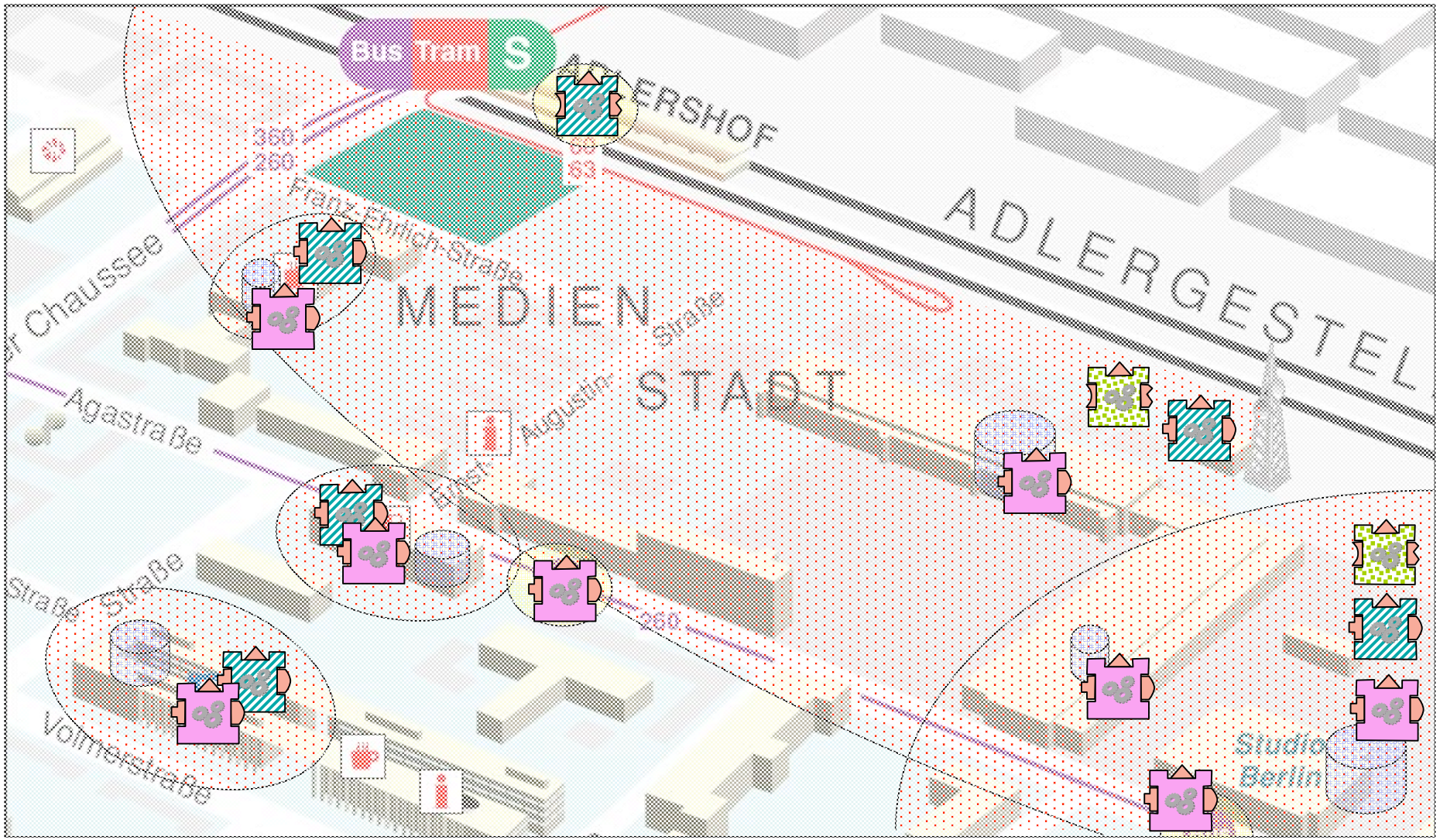
Informationsanbieter (Content):



GPS-Satelliten:

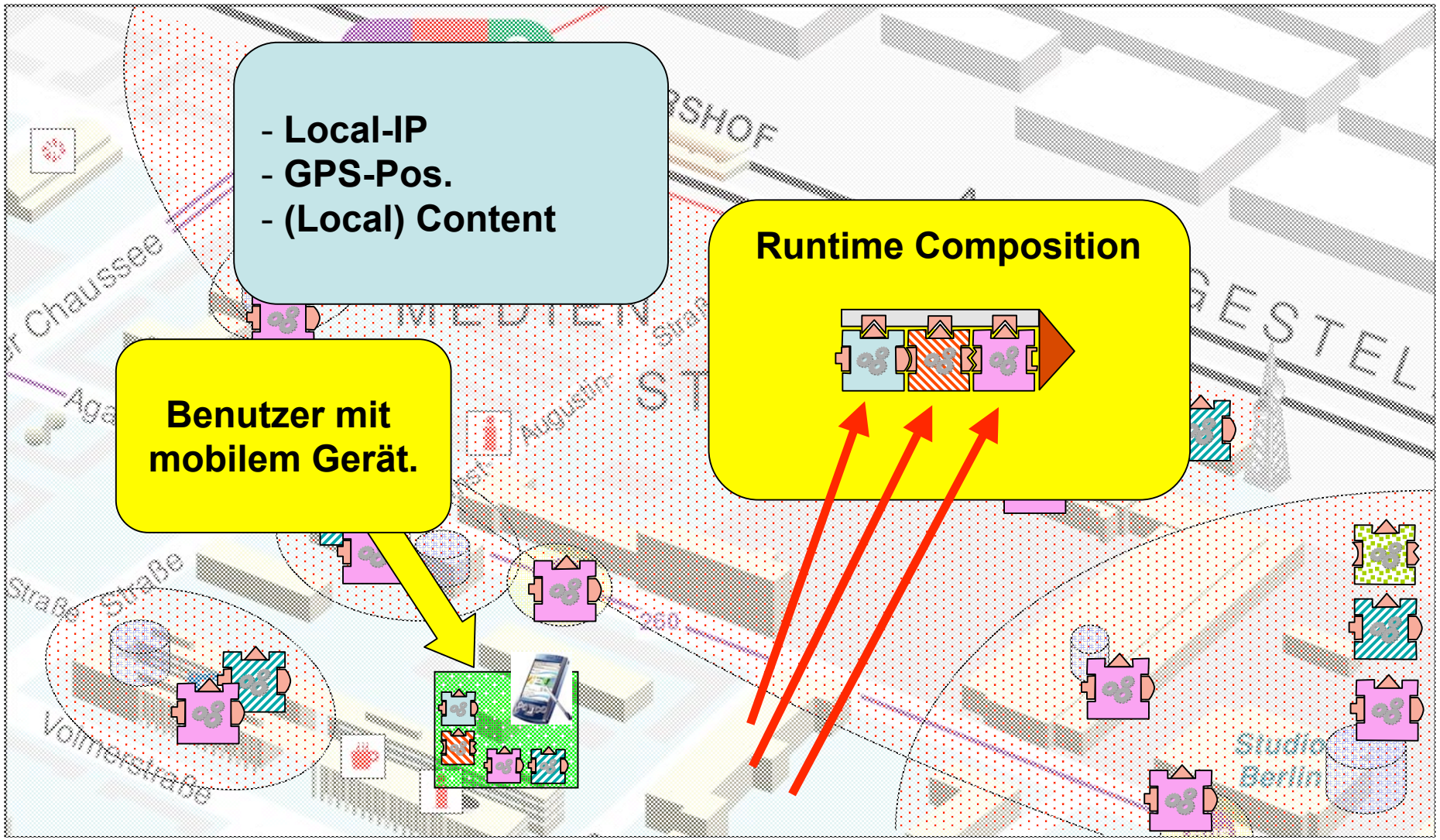


Services auf reale Objekte gemapped



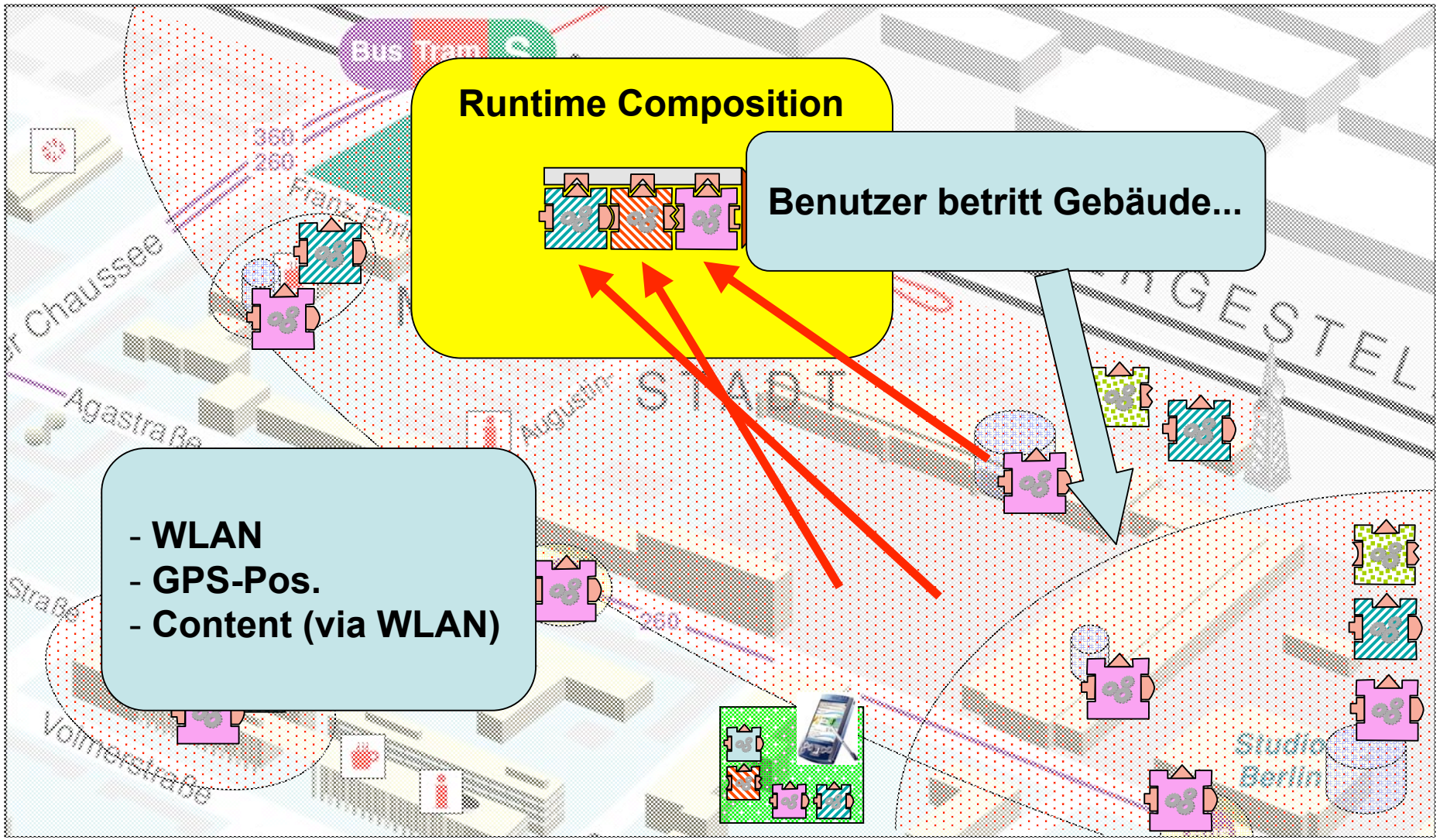
WLAN: Local-IP: GPS-Pos: WLAN-Pos: RFID-Pos: Content:

Dynamic Runtime Composition



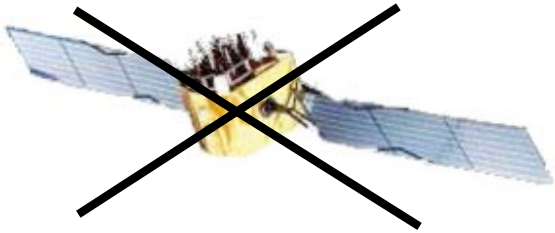
WLAN: Local-IP: GPS-Pos: WLAN-Pos: RFID-Pos: Content:

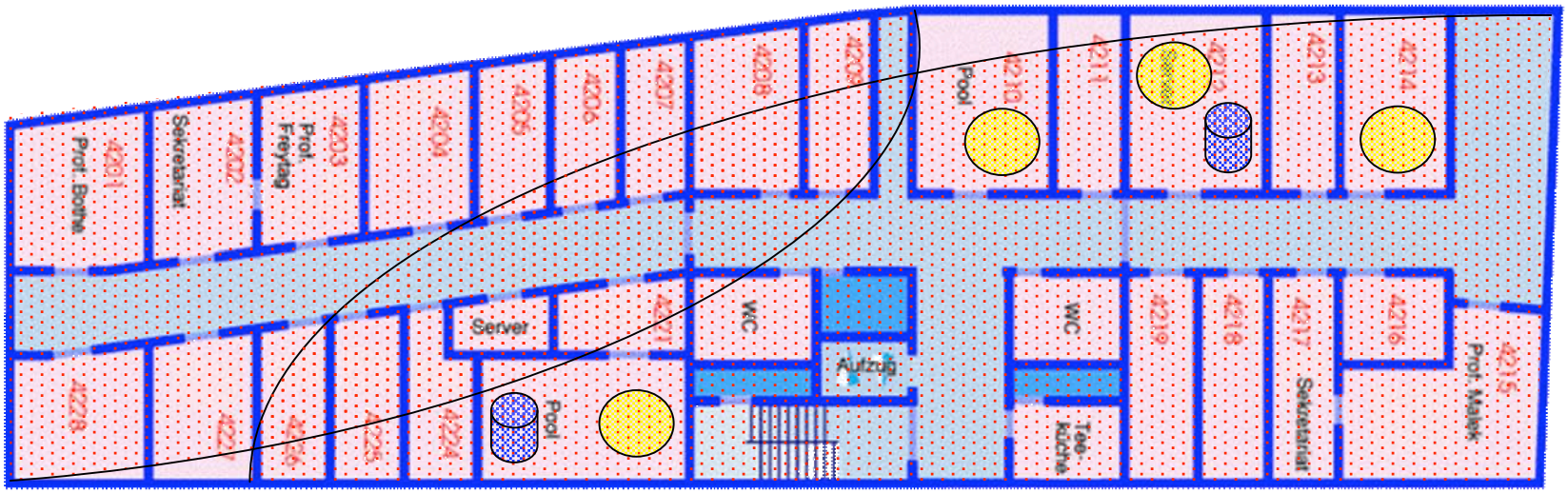
Dynamic Runtime Composition



WLAN: Local-IP: GPS-Pos: WLAN-Pos: RFID-Pos: Content:

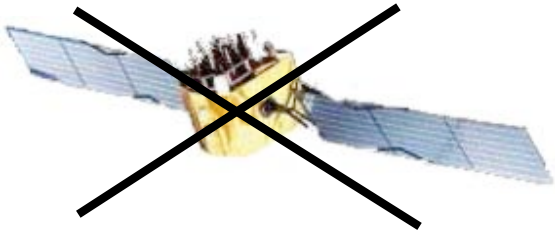
In einem Gebäude:

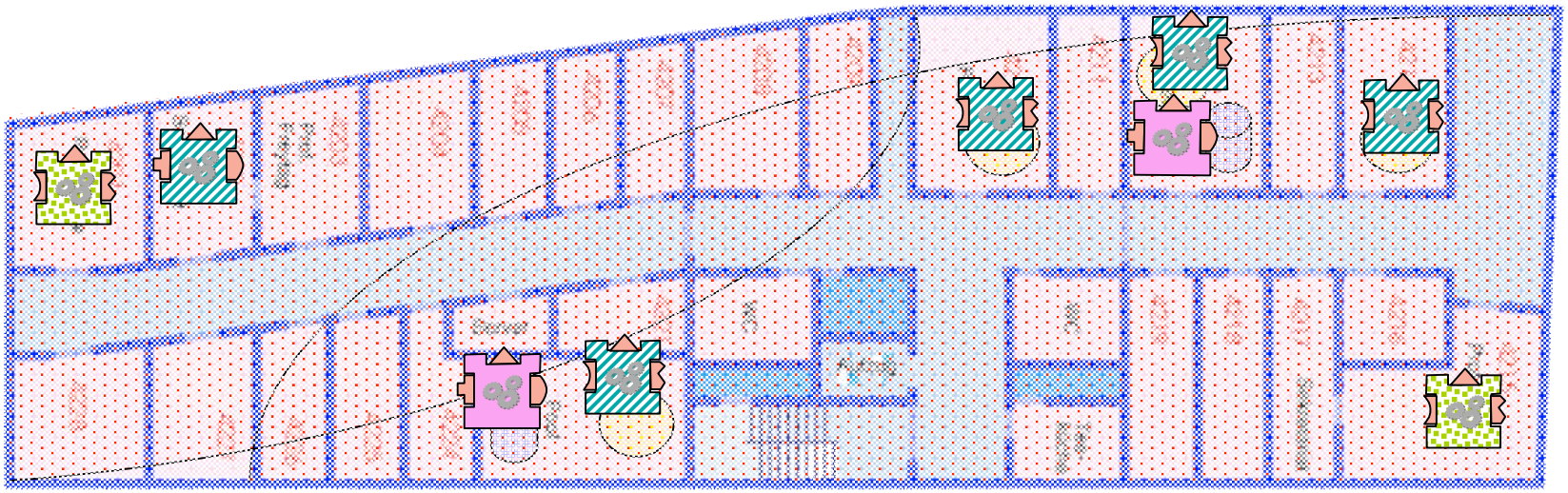




WLAN: **RFID:** **Content:** **GPS:**

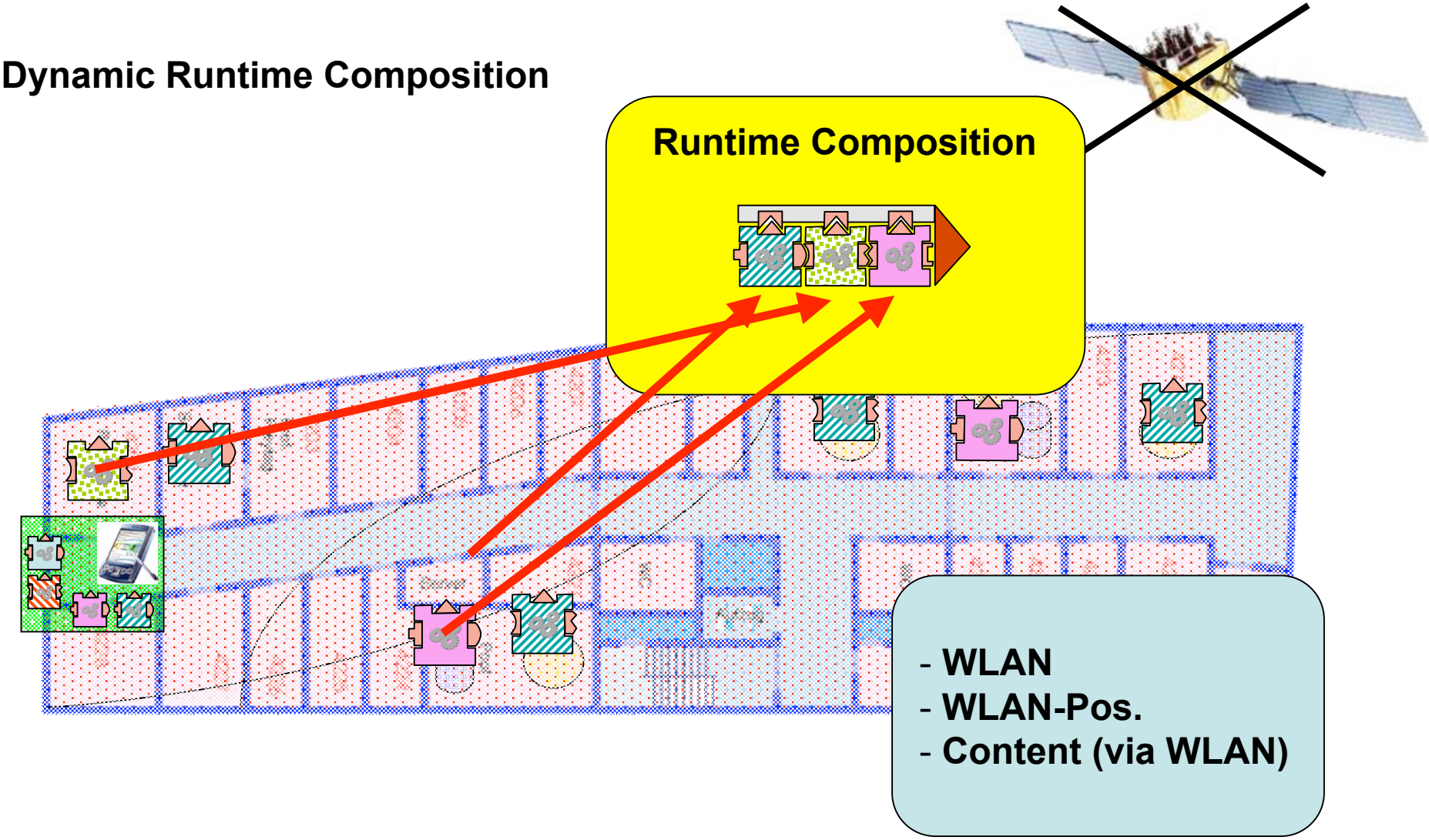
Services im Gebäude





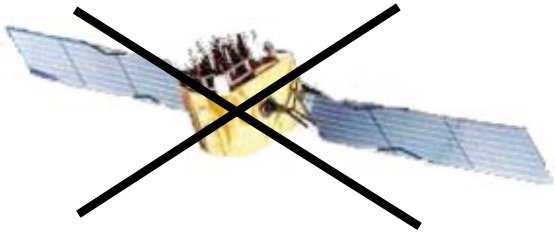
WLAN: Local-IP: WLAN-Pos: RFID-Pos: Content:

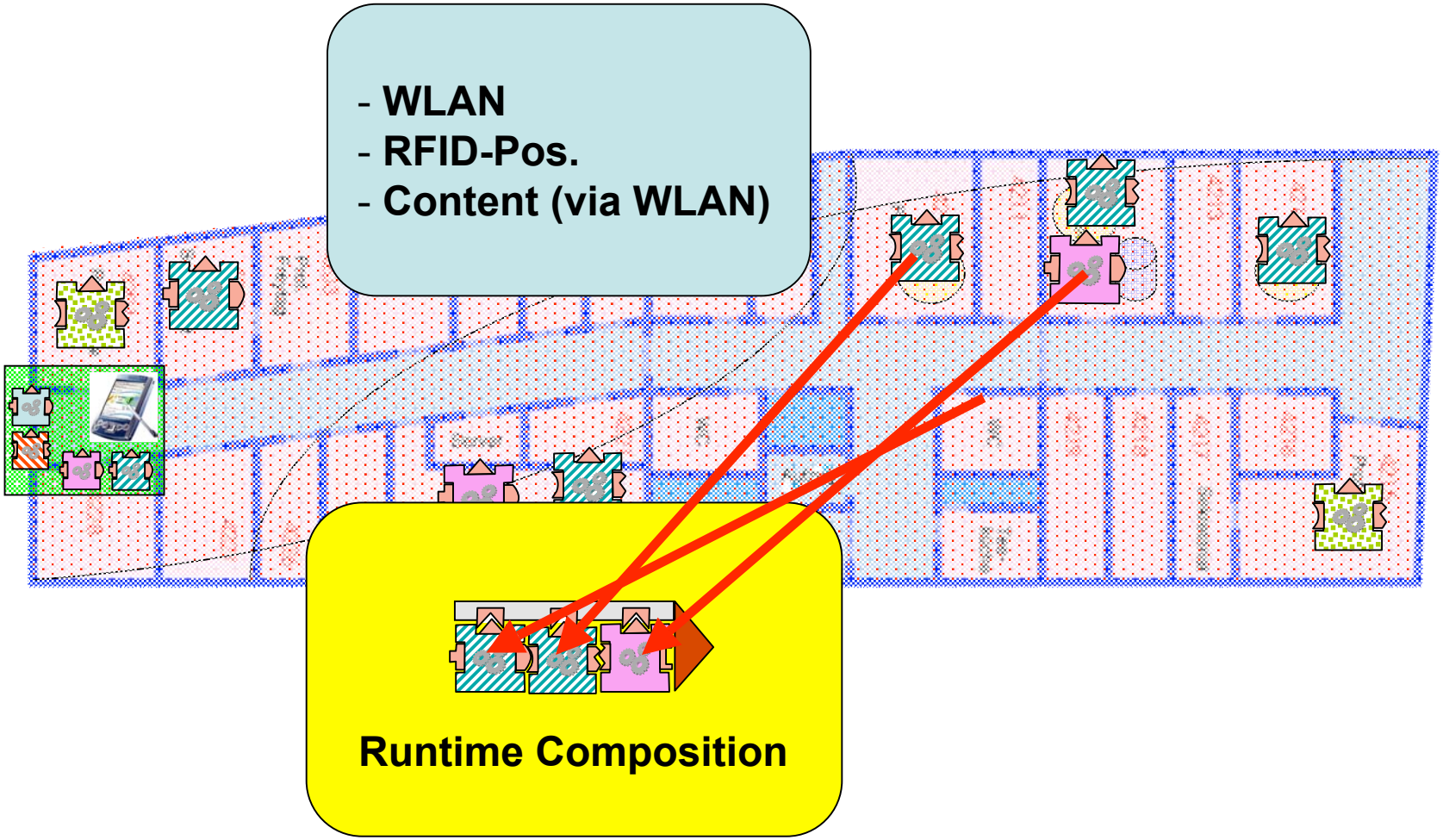
Dynamic Runtime Composition



WLAN: Local-IP: WLAN-Pos: RFID-Pos: Content:

Dynamic Runtime Composition





WLAN: Local-IP: WLAN-Pos: RFID-Pos: Content:

Ortungsverfahren

Verfahren

- Angle of arrival (AOA)
- Time difference of arrival (TDOA)
- **Signal strength (RSS)**

- Infrastructure based
- Client based

- Triangulation
- Profiling
  - static
  - dynamic
- Propagation

- Deterministic
- Probabilistic

Beispiele

IMSI Catcher

Siemens/WhereNet/
Aeroscout

Ekahau

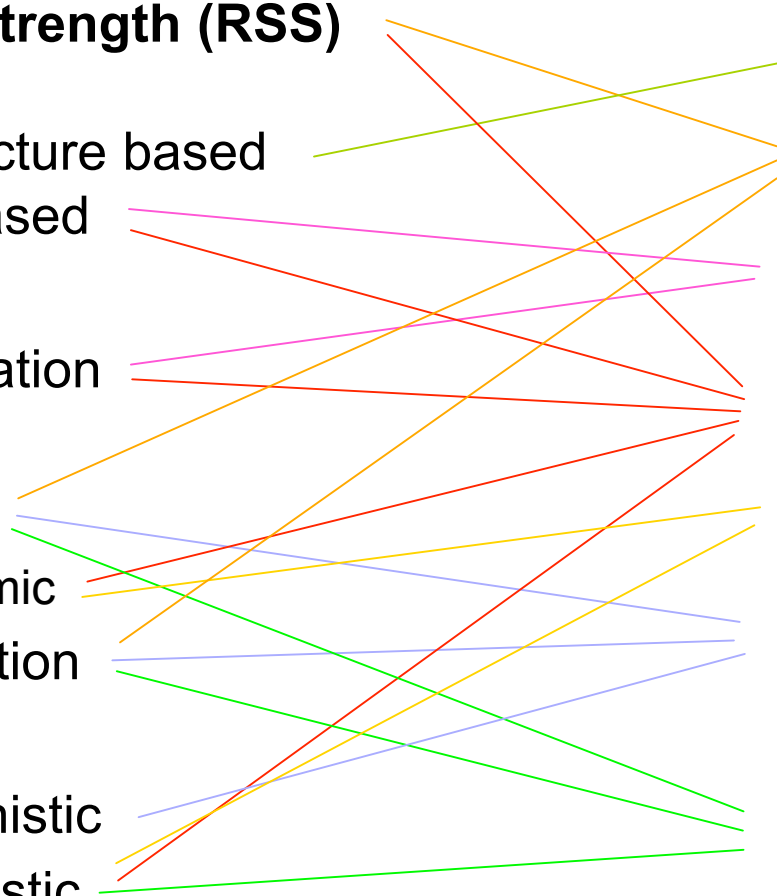
PlaceLab, Intel/UC Berkeley

MagicMap, HU-Berlin

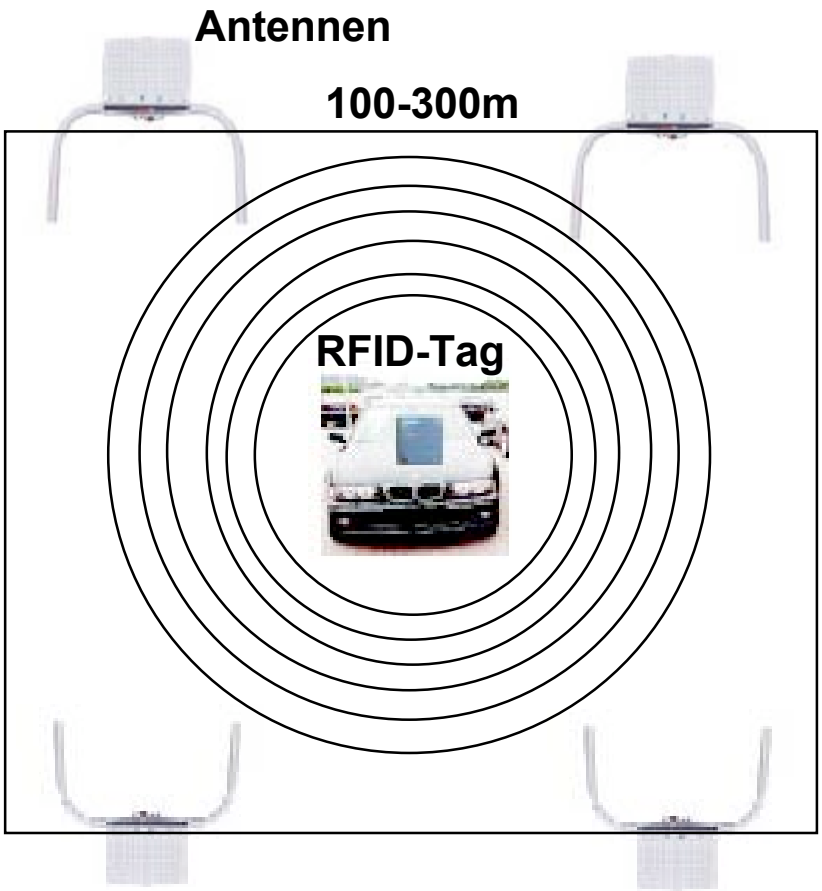
LEASE, Avaya Labs Research

RADAR, Microsoft Research

HORUS, Uni Maryland

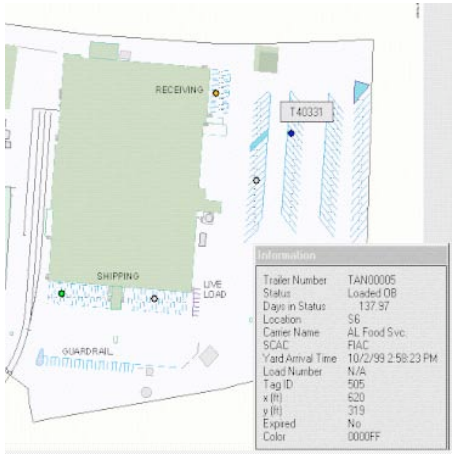


Beispiel: System Moby-R von Siemens/WhereNet



Trigger (Durchfahrtssensor)

Call Button



Wireless AccessPoint

Ortungs-Server

ualisierungs-Clients

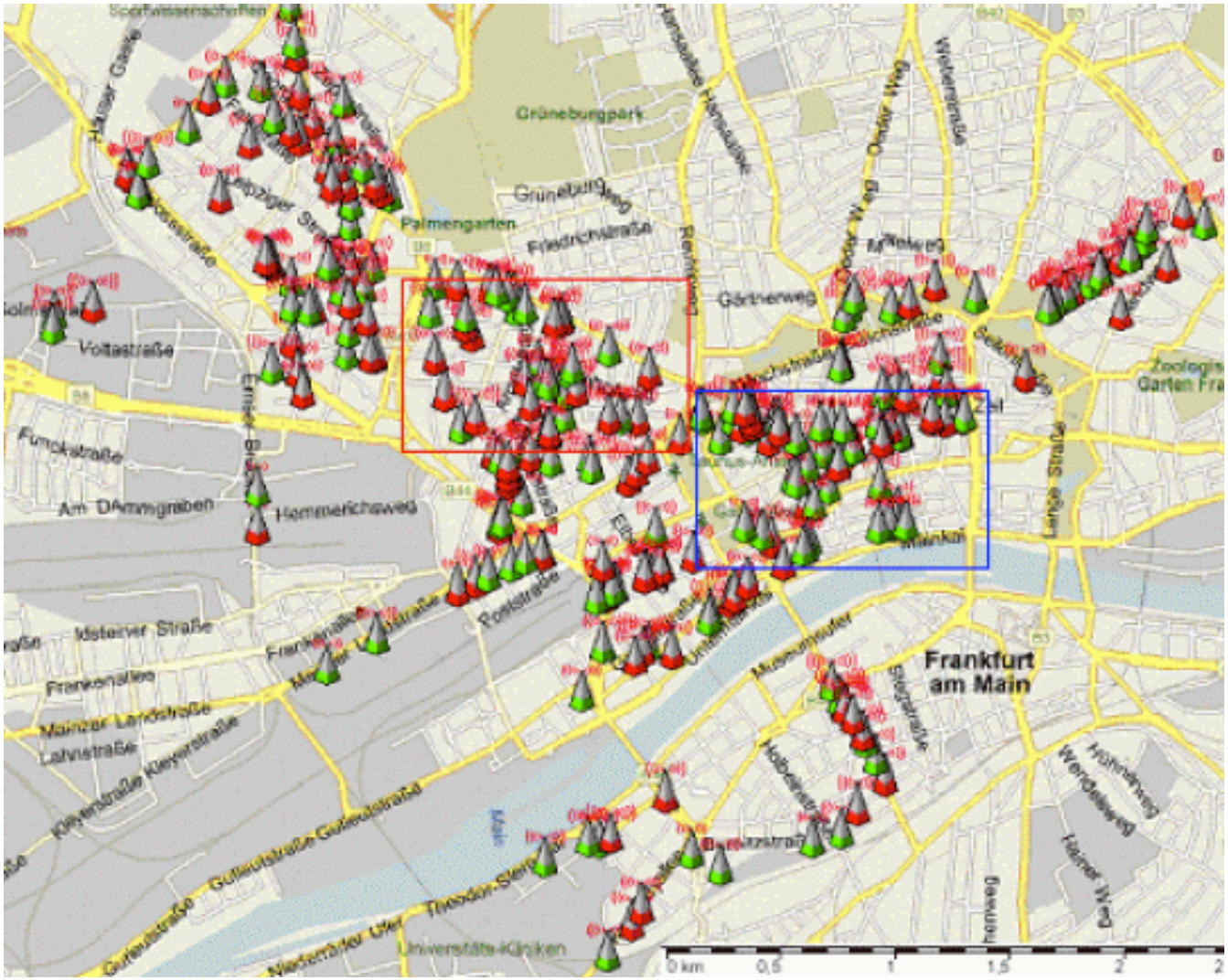
- RFID-Tag sendet periodisch eine ID aus (2,4 GHz, Air Interface Protocol, INCITS 371.1)
- Jede Antenne gibt empfangener ID Zeitstempel und sendet dies zum Server
- Ortungs-Server berechnet den Ort durch Zeitdifferenzen-Triangulierung
- Der Ortungs-Server aktualisiert Ort und den Status des Tags in der Datenbank

Anforderungen

- Outdoor- und Indoor-Ortung
- Geringe Kosten
- Hohe Genauigkeit
- Problemlose Interoperabilität
- Universelle Einsatzfähigkeit
- Keine Änderung vorhandener Hardware/Infrastruktur
- Hoheit über die eigenen Positionsdaten

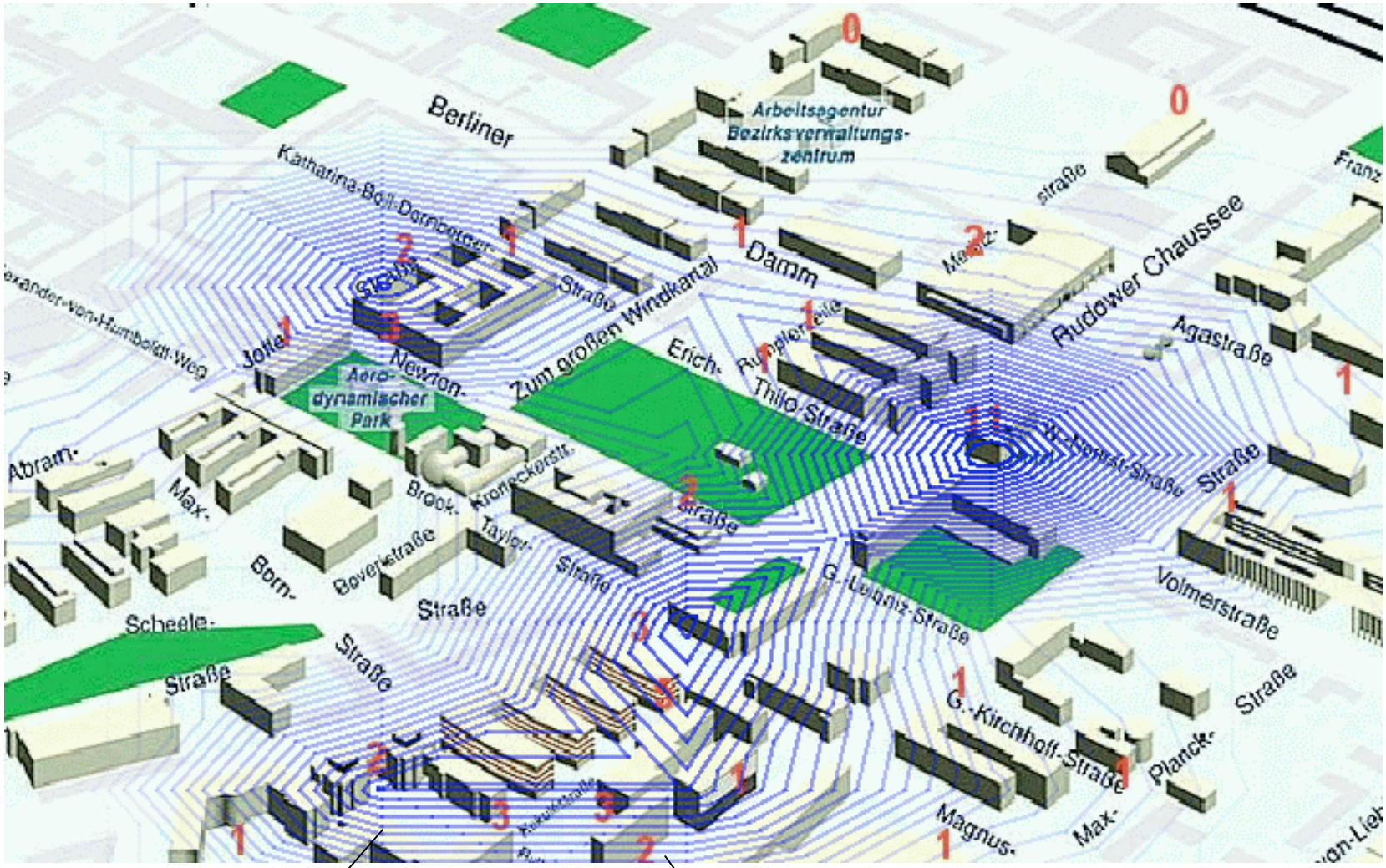
➡ **Signalstärke-basierte Ortung über WLAN?**

Hot Spots in der City Frankfurt



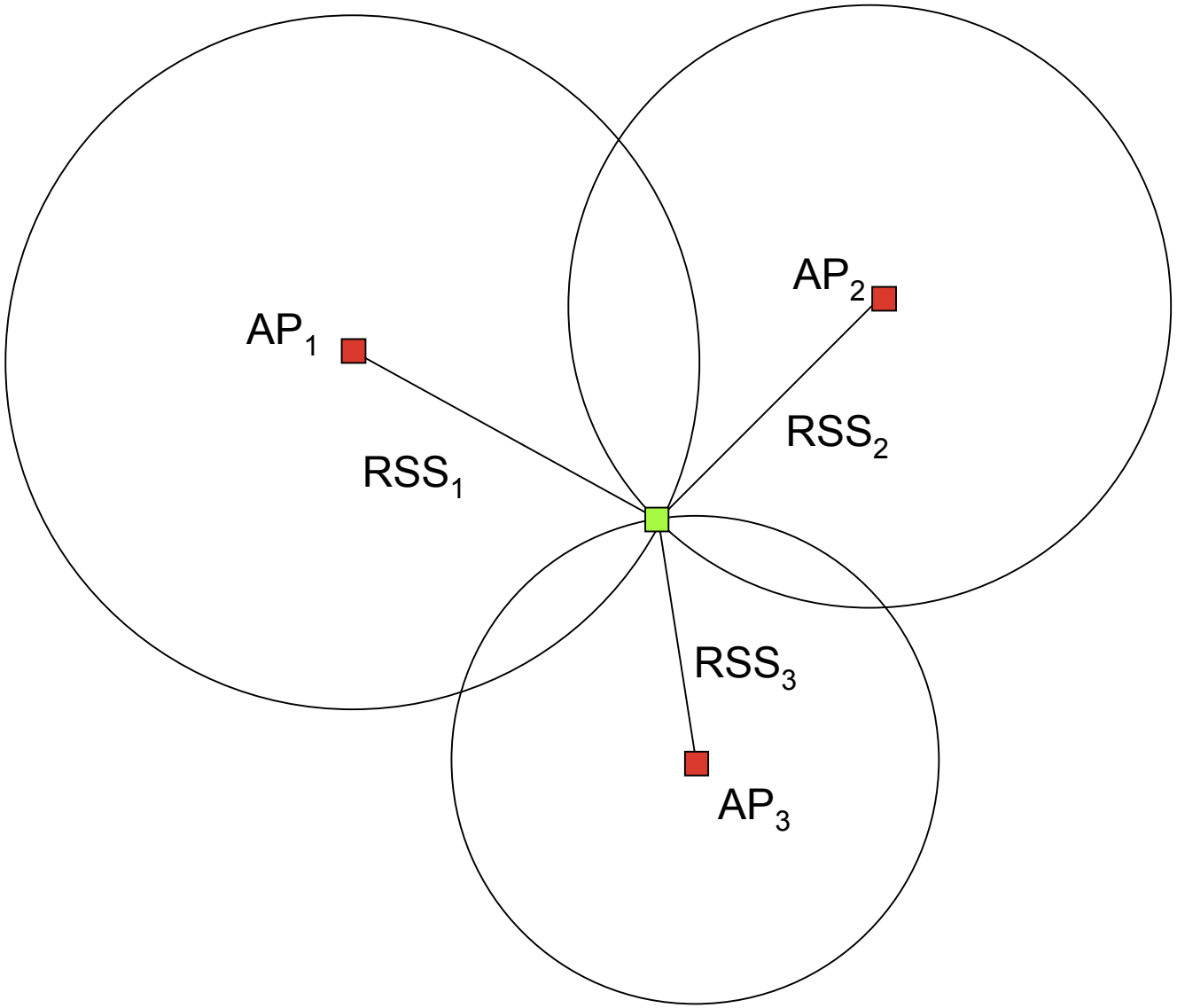
Quelle: Lindner, Fritsch, Plank, Rannenberg (2004)

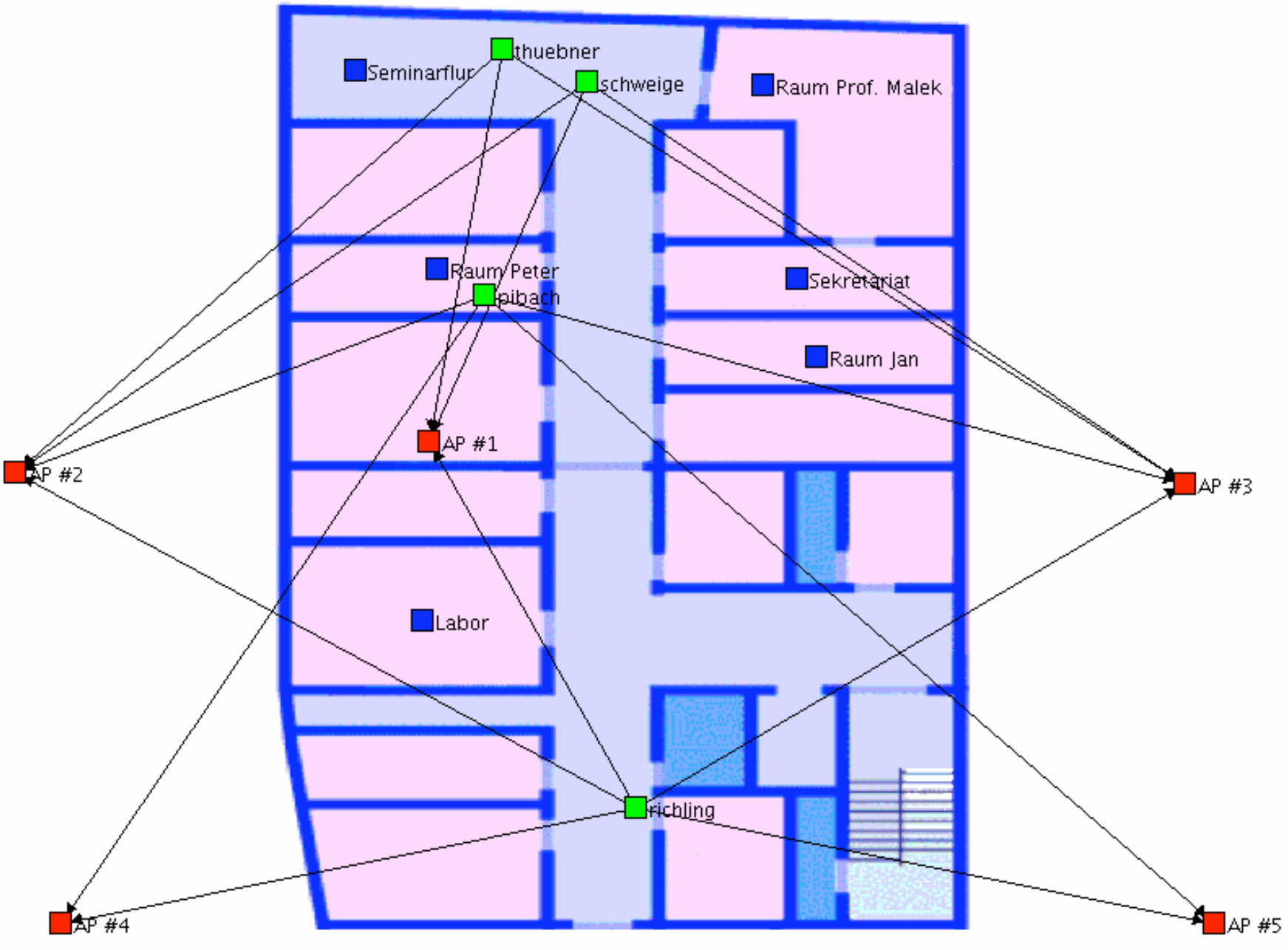
WLAN Abdeckung – Uni Campus Adlershof



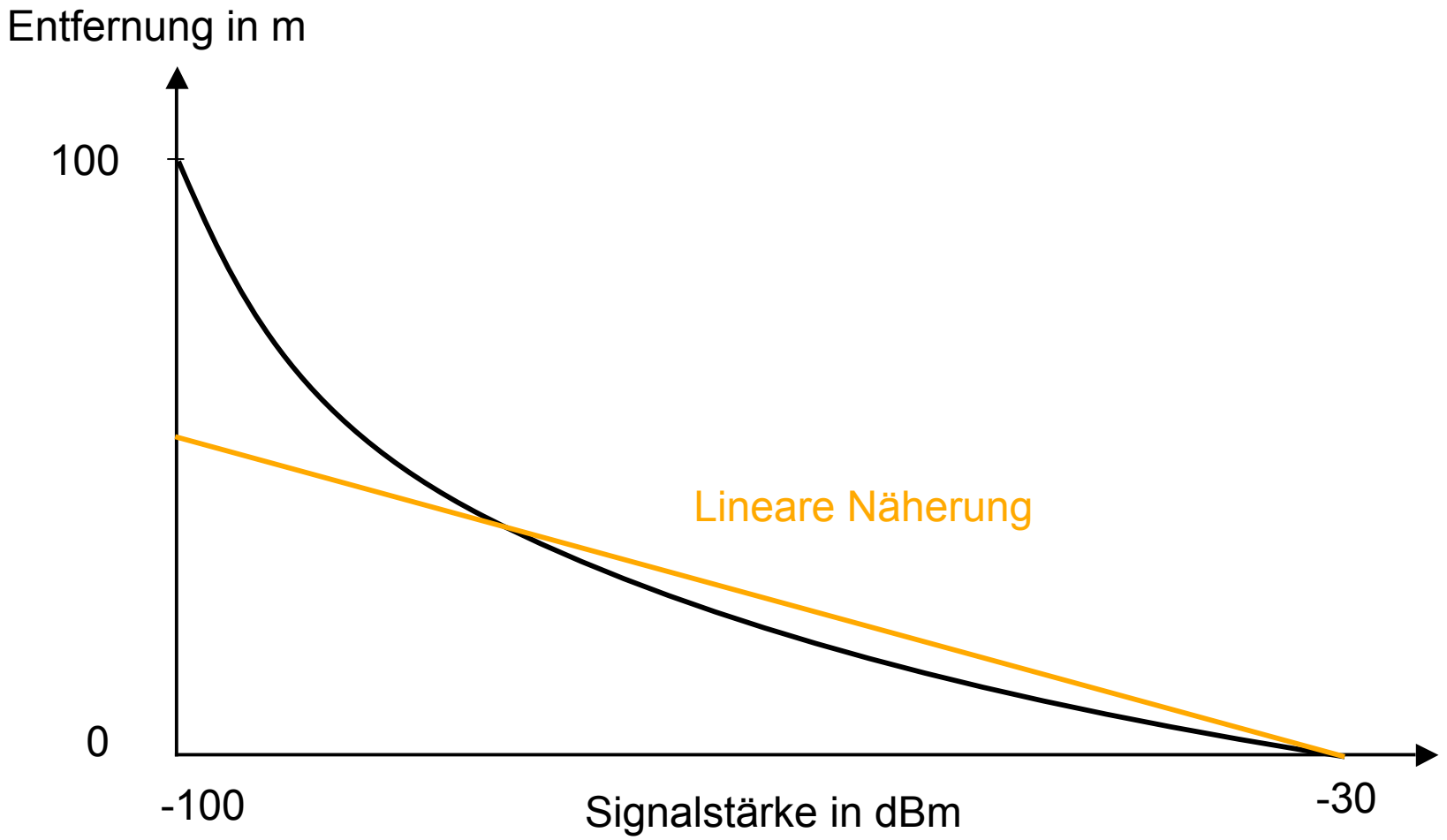
$$\sum_i RSS(AP_i) \qquad 2 = \#APs$$

Signalstärke-basierte Triangulierung

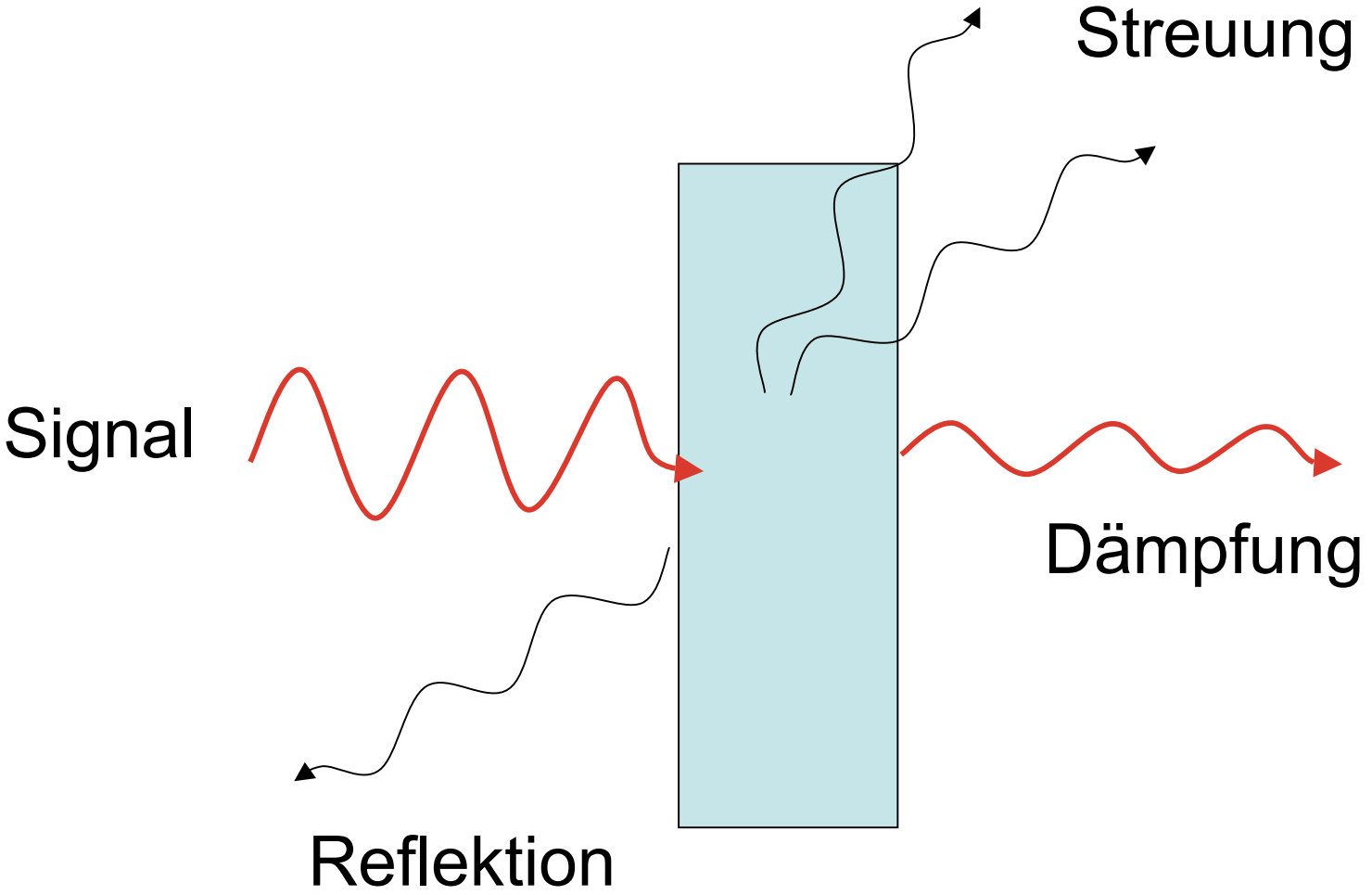



thuebner
Seminarflur
schweige
Raum Prof. Malek
Raum Peter
pibach
Sekretariat
Raum Jan
AP #1
AP #2
AP #3
Labor
richling
AP #4
AP #5

Korrelation Signalstärke zu Entfernung

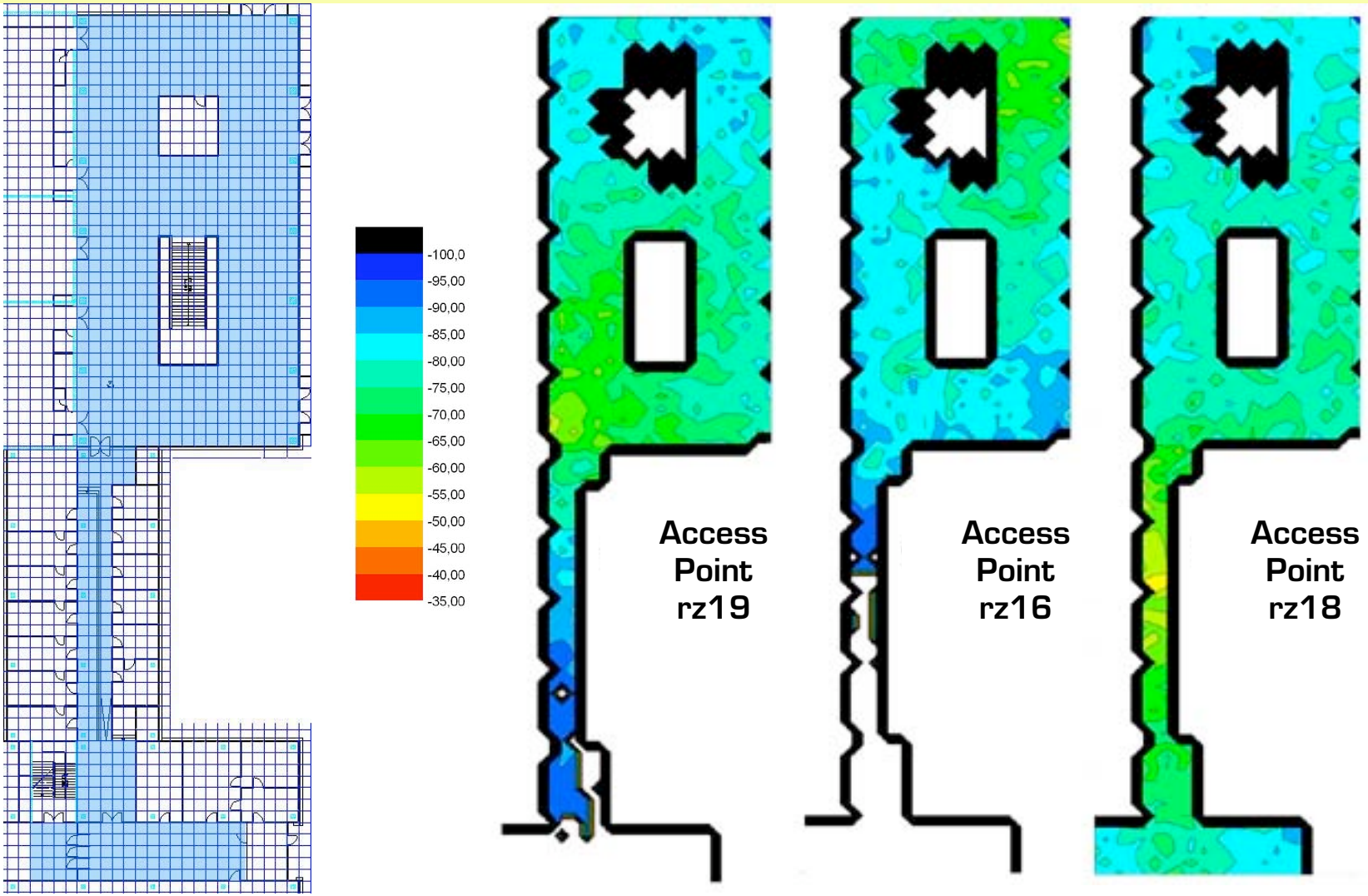


Probleme



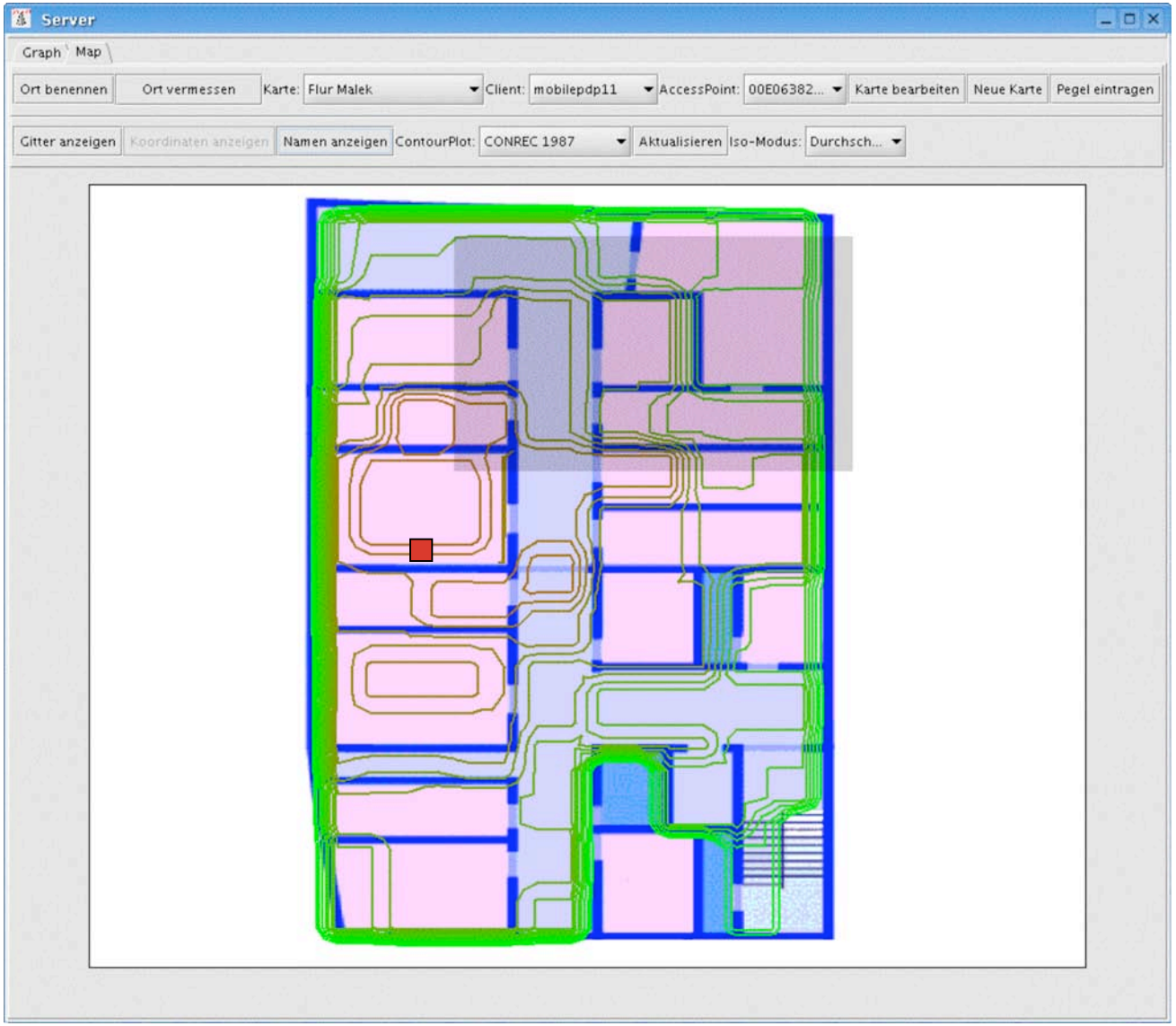
➡ **Radio-Map**

Radio-Map Beispiel

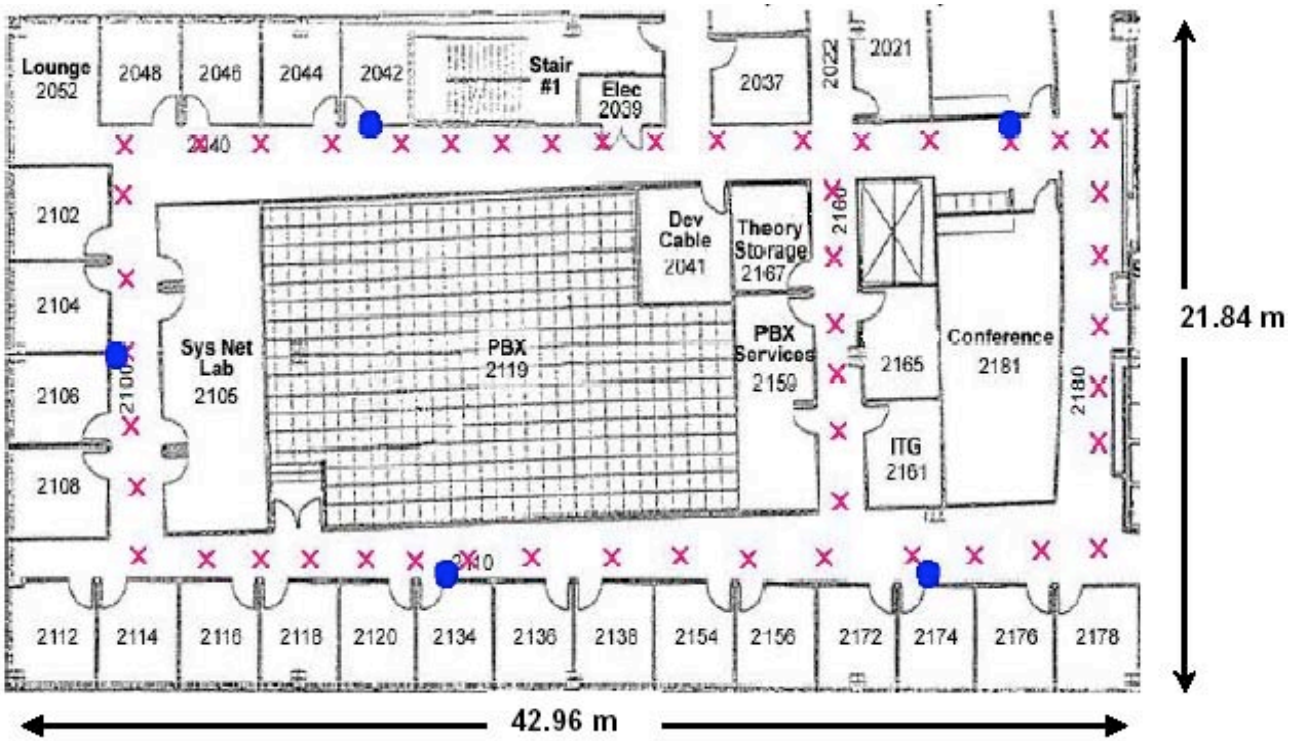


Erdgeschoss Jura/Wirtschaft der Universität Regensburg
Zellgröße: 1,2 m_, Anzahl Messpunkte: 1012
Quelle: Denise Reinert, Uni Regensburg

Radio Map Tool - Screenshot



RADAR (Microsoft Research)

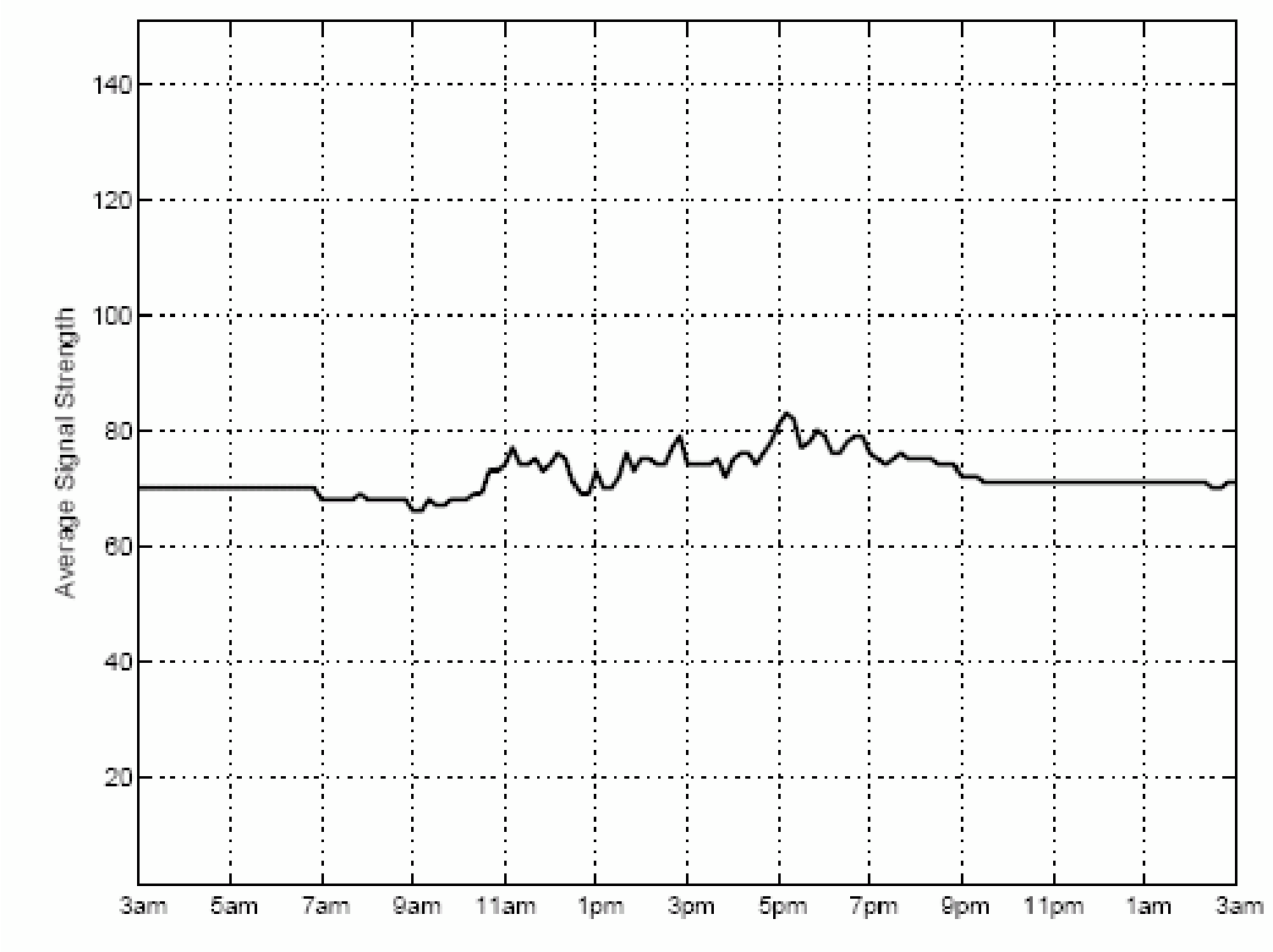


Testumgebung RADAR

42,96m x 21,84m

49 Messpunkte

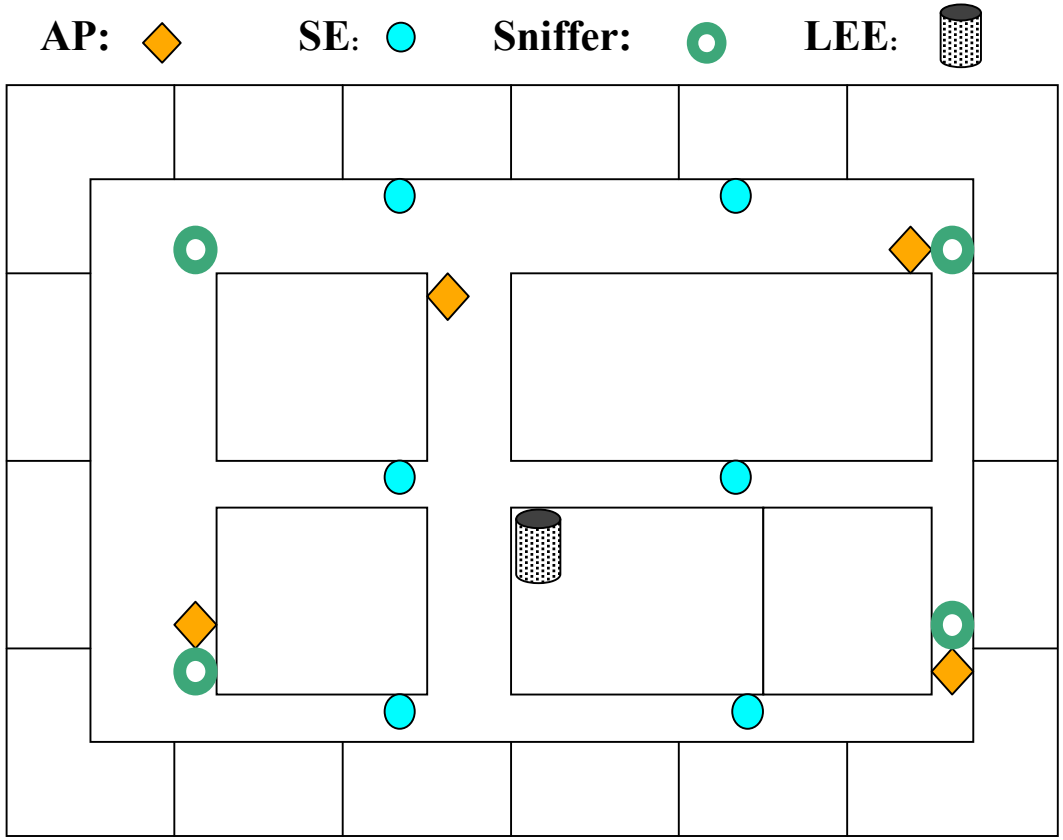
Signalstärke über der Zeit



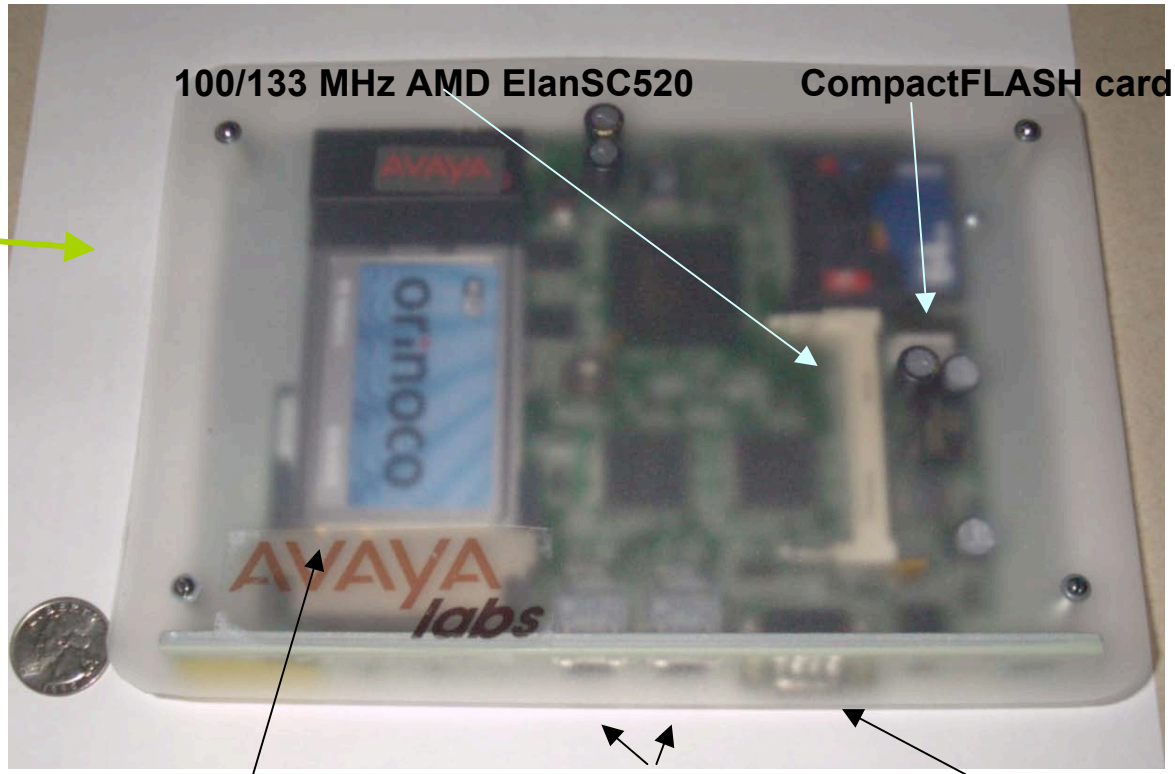
Quelle: Tao et al. 2003

LEASE (Avaya Labs Research)

- **Signal Emitter (SE)**
  Tags an bekannten Positionen senden periodisch
- **Sniffer**
  Messen Signalstärke an bekannten Positionen und schicken diese an einen Server (LEE)
- **Location Estimation Engine (LEE)**
  berechnet dynamisch die Radio-Map aus den Signalstärkemessungen



Sniffer Prototype

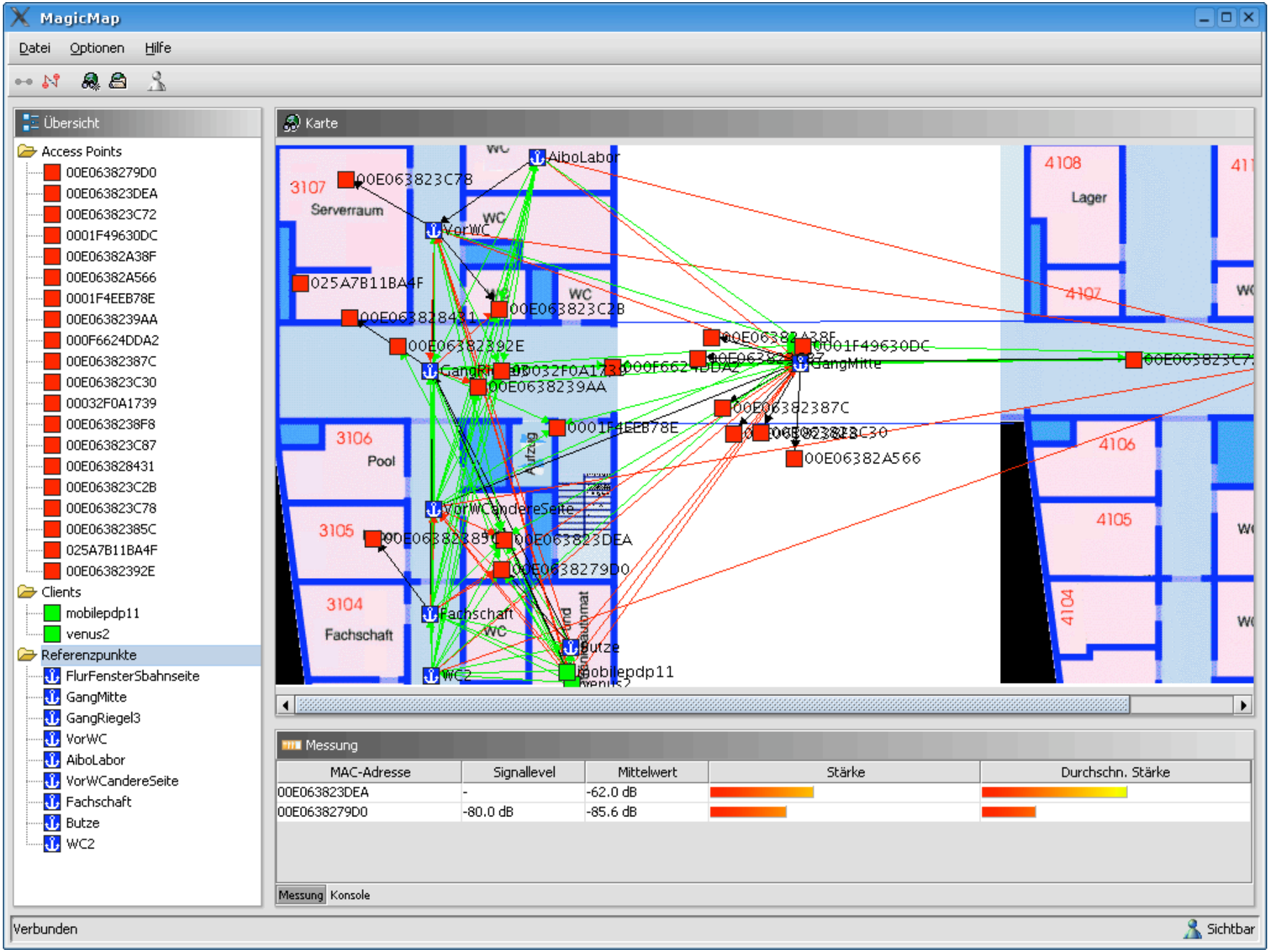


Orinoco 802.11b PCMCIA card (in promiscuous mode)

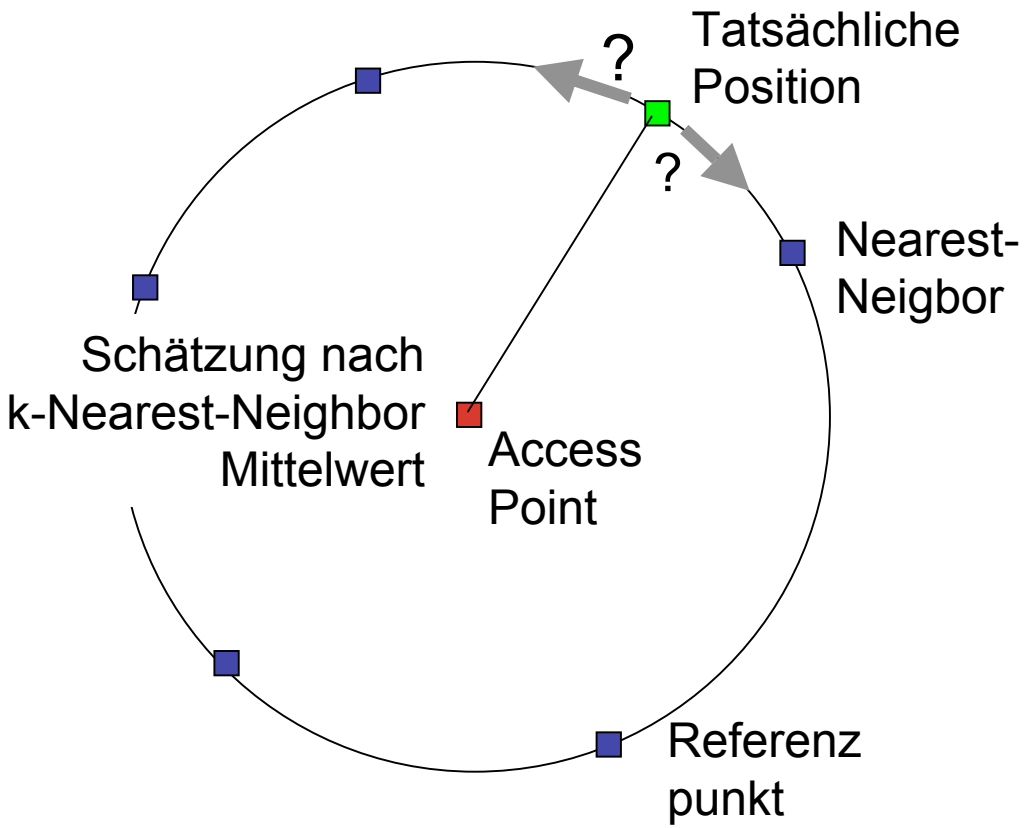
Two 10/100 Mbps Ethernet ports (Power over Ethernet)

1 Serial port

Institut für Informatik in Berlin-Adlershof


MagicMap
Datei
Optionen
Hilfe
Übersicht
Access Points
00E0638279D0
00E063823DEA
00E063823C72
0001F49630DC
00E06382A38F
00E06382A566
0001F4EEB78E
00E0638239AA
000F6624DDA2
00E06382387C
00E063823C30
00032F0A1739
00E0638238F8
00E063823C87
00E063828431
00E063823C2B
00E063823C78
00E06382385C
025A7B11BA4F
00E06382392E
Clients
mobilepdp11
venus2
Referenzpunkte
FlurFensterSbahnseite
GangMitte
GangRiegel3
VorWC
AiboLabor
VorWCandereSeite
Fachschaft
Butze
WC2
Karte
3107
Serverraum
4108
Lager
3106
Pool
3105
3104
Fachschaft
4107
4106
4105
4104
WC
Aufzug
Getränkeautomat
AiboLabor
VorWC
025A7B11BA4F
00E063823C2B
00E06382392E
GangRiegel3
00E0638239AA
0001F4EEB78E
VorWCandereSeite
00E063823DEA
00E0638279D0
Fachschaft
Butze
WC2
mobilepdp11
00E06382A38F
0001F49630DC
GangMitte
00E06382387C
00E06382A566
Messung
MAC-Adresse
Signallevel
Mittelwert
Stärke
Durchschn. Stärke
00E063823DEA
-
-62.0 dB
00E0638279D0
-80.0 dB
-85.6 dB
Messung
Konsole
Verbunden
Sichtbar

Positionierungs-Mehrdeutigkeiten



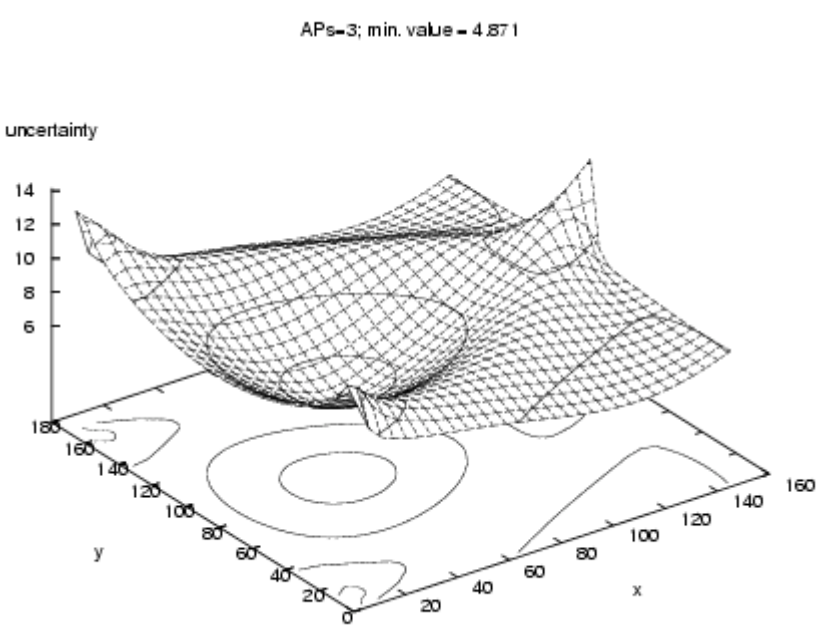
Genauigkeit

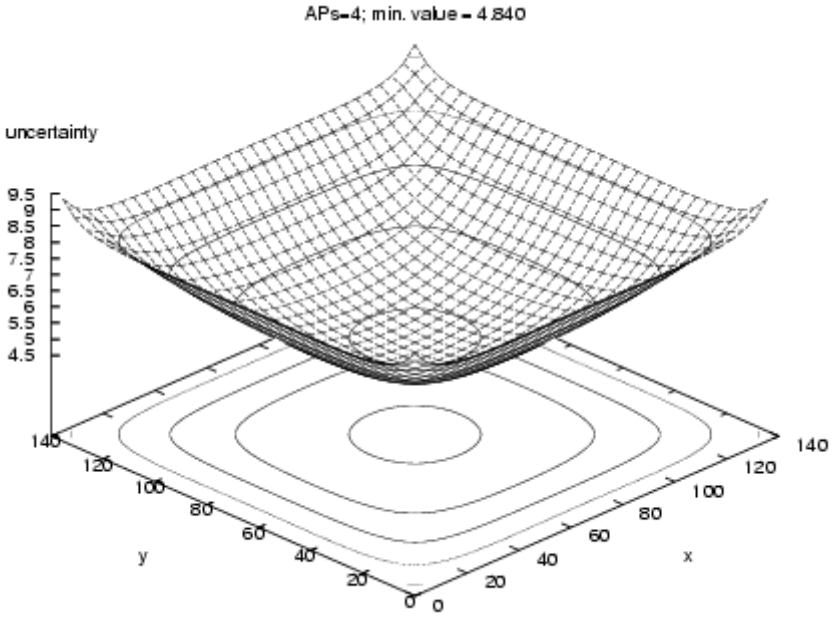
Verfahren	Mittlerer Fehler
RADAR (Profiling)	~3m
RADAR (Propagation)	~4.3m
HORUS (Probabilistic)	~2m
LEASE (Dynamic Profiling)	~2m
PlaceLab (Triangulation)	~10m
Ekahau (Profiling)	~1m
WhereNet, Aeroscout (TDOA)	~1m
MagicMap (Hybrid)	~10m (Triangulation) ~3m (Profiling)

Theoretisches Optimum

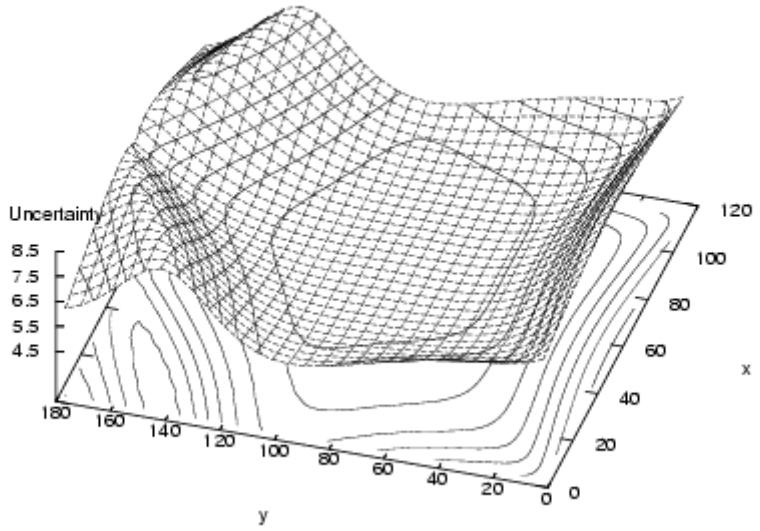
Range of σ (dBm)	0.818-1.179
Mean value of σ (dBm)	0.993
Propagation constant	2.4
Probability, _	0.5
Number of APs, n	3
Distance between APs	50m
Rn for n=3 and _=0.5	1.549
Minimum uncertainty	1.5m

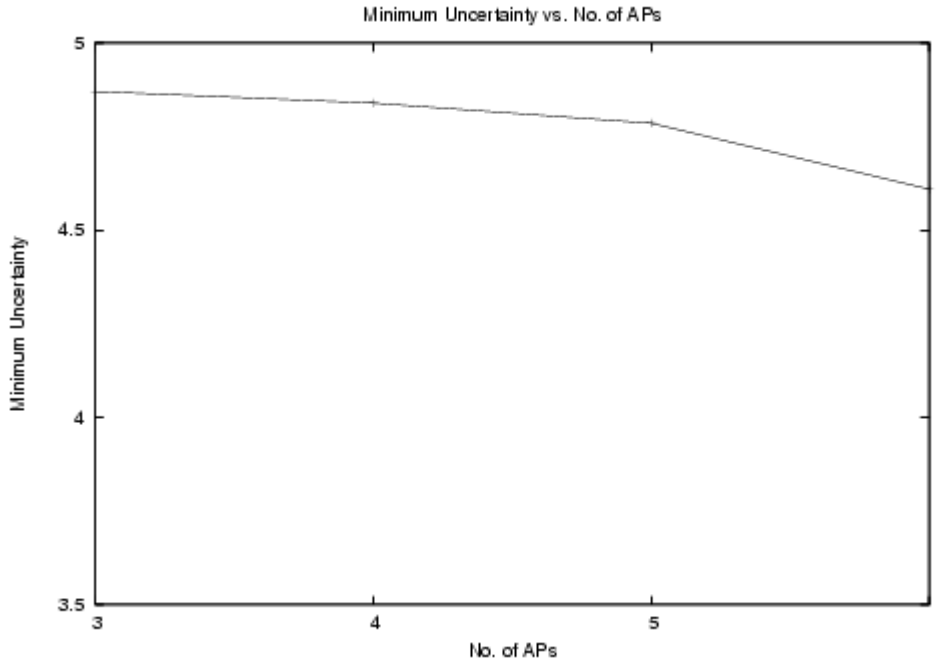
Quelle: Krishnakumar et al. 2005





Uncertainty as a function of location





Minimum Uncertainty

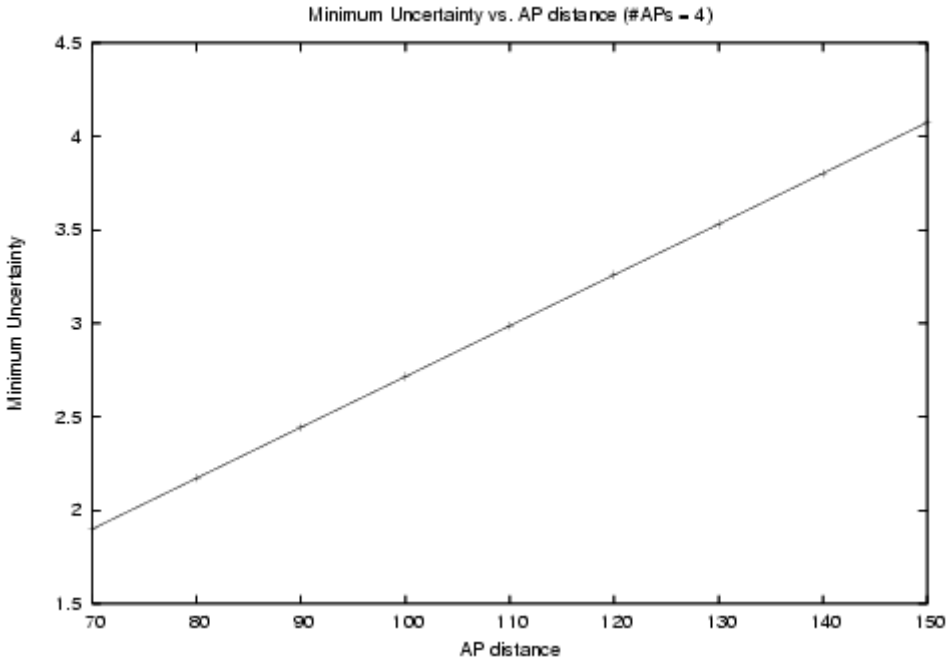
Vs.

Number of APs

Minimum Uncertainty

Vs.

Distance between APs



Ausblick

- Privacy Enhancing Technologies (PET)
- 3D-Triangulation und -Visualisierung
- Transparenter Übergang zwischen den Karten
- Peer-to-Peer Signalstärke

Zusammenfassung

- Positionsbestimmung ist Voraussetzung für LBS
- Indoor-Positionsbestimmung über WLAN ist in Grenzen möglich
- MagicMap: hybrides Verfahren mit Kooperation für dynamisches Profiling
- Open Source, Point-n-Click-Tool für Experimente
- Ebenso für GSM/Bluetooth anwendbar
- Download (Windows/Linux): www.informatik.hu-berlin.de/rok/MagicMap/webstart