Addressing geographic objects of unique location areas

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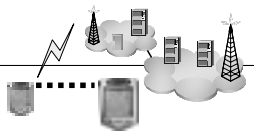
1. Motivation



- Mobile devices have more resources (CPU, main memory, battery, etc.)
- New devices support seamless communication by supporting different communication adapters
- Applications are becoming location-aware or location-based
- LBS for indoor and outdoor environment

- Issues:
  - More “intelligence” on the mobile side
  - Lots of applications rely on communication and require high-bandwidth
- Problem of addressing relevant geographic objects of a certain area
  - How can we address geographic objects without communication effort (e.g. spatial query of a GIS)?
  - How can we locally on a mobile device search for geographic objects?

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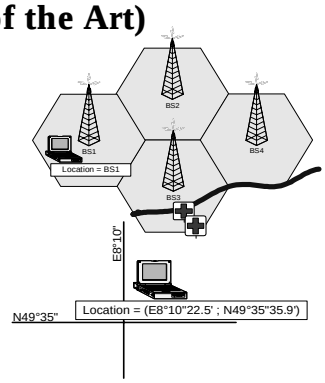
2. Positioning and Locations (State of the Art)

- for ***outdoor*** environment
  - Location defined by infrastructure Cell-based locations
  - Location defined by coordinates e.g. latitude, longitude, altitude
  - Location defined by logical or semantic description e.g. Street, Postal code, city, country



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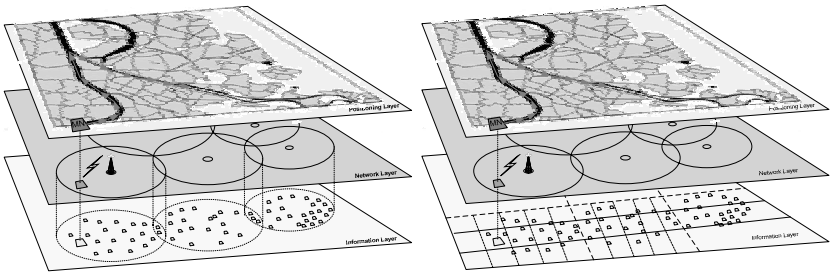
2. Assessment of Positioning and Location Descriptions

Cell-Based locations	Coordinate-Based locations	Semantic and logical locations
+ simple ID (cell ID)	+ simple (lat./long.)	− complex structure
– locations of base stations are often not known	+ locations are known	+ locations are known
− accuracy (from 100m to 3 km)	+ accuracy (from 3cm to 5m)	+ accuracy (depending on model)
− not available worldwide	+ everywhere available	+ everywhere available
− no computation	+ can be computed	− no computation
− self describing	− self describing	+ self describing
+ no “resolution required”	+ no “resolution required”	– “resolution required”

3. Addressing objects by geographic locations

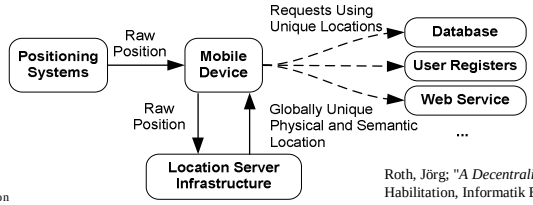
- Geographical information
  - Positioning for outdoor should be accurate (GPS)
  - geo. information search should be adaptive (depending on data)



a.) target areas defined by cells b.) target areas defined by areas

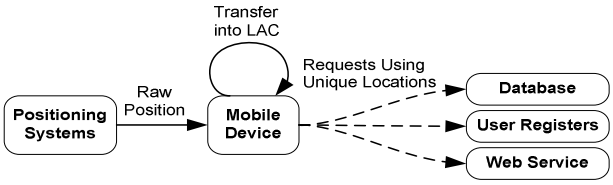
4. Resolving geographic locations

- Classical Location resolution and geographic information search



Roth, Jörg; *"A Decentralized Location Service Providing Semantic Locations"*, Habilitation, Informatik Bericht 323, Fernuniversität Hagen, Jan. 2005.

- Local location resolution and geographic information search

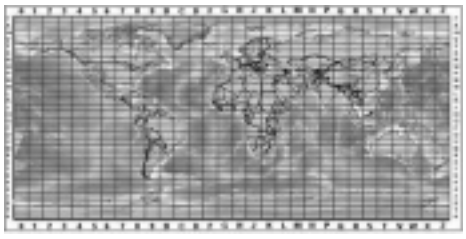


[Kirchner, Holger et. al 2005]

5. Natural Area Code (NAC)

- **Transformation from (Longitude, Latitude, Altitude) into NAC**

LONG = (Longitude + 180)/360
x1 = Integer part of(LONG*30)
x2 = Integer part of((LONG*30-x1)*30)
x3 = Integer part of(((LONG*30-x1)*30-x2)*30)
x4 = Integer part of((((LONG*30-x1)*30-x2)*30-x3)*30)
...
LAT = (Latitude + 90)/180
y1 = Integer part of(LAT*30)
y2 = Integer part of((LAT*30-y1)*30)
y3 = Integer part of(((LAT*30-y1)*30-y2)*30)
y4 = Integer part of((((LAT*30-y1)*30-y2)*30-y3)*30)
...
ALT = Arctan(Altitude/R)/90
z1 = Integer part of(ALT*30)
z2 = Integer part of((ALT*30-z1)*30)
z3 = Integer part of(((ALT*30-z1)*30-z2)*30)
z4 = Integer part of((((ALT*30-z1)*30-z2)*30-z3)*30)



[NAC, http://www.nacgeo.com/nacsite]

Characteristics:

- Divide world into 30 areas
- Each area is represented as a symbol
- Representation as a set of predefined symbols

6. Location Area Code (LAC) – Contribution

- **Transformation from (Longitude, Latitude, Altitude) into LAC**

LONG = (Longitude + 180)/360
x1 = Integer part of(LONG*16)
x2 = Integer part of((LONG*16-x1)*16)
x3 = Integer part of(((LONG*16-x1)*16-x2)*16)
x4 = Integer part of((((LONG*16-x1)*16-x2)*16-x3)*16)
...

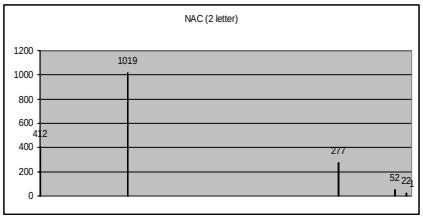
LAT = (Latitude + 90)/180
y1 = Integer part of(LAT*16)
y2 = Integer part of((LAT*16-y1)*16)
y3 = Integer part of(((LAT*16-y1)*16-y2)*16)
y4 = Integer part of((((LAT*16-y1)*16-y2)*16-y3)*16)
...

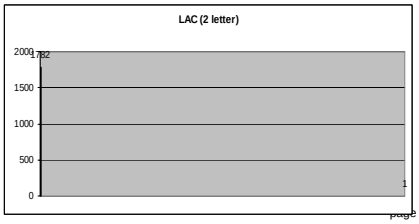
ALT = Arctan(Altitude/R)/90
z1 = Integer part of(ALT*16)
z2 = Integer part of((ALT*16-z1)*16)
z3 = Integer part of(((ALT*16-z1)*16-z2)*16)
z4 = Integer part of((((ALT*16-z1)*16-z2)*16-z3)*16)

Characteristics:
- Divide world into 16 areas
- Each area is represented as one bit
- Representation is hexa-decimal

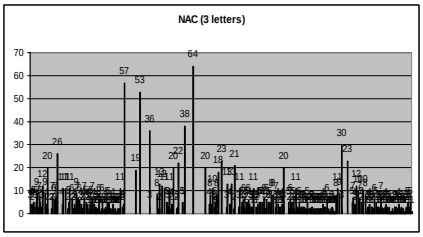
7. Comparison of NAC and LAC

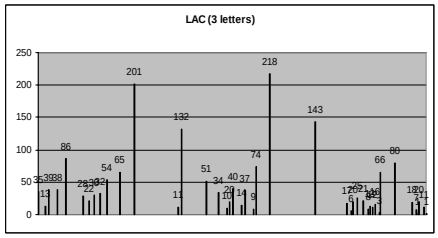
- Information distribution of geo. objects by a predefined set of data
- 1783 records for evaluation
- Information distribution of 2 letters make no difference (only data for a certain area)
- Y-axis: shows inf. distribution
- X-axis: shows unique areas (sorted)

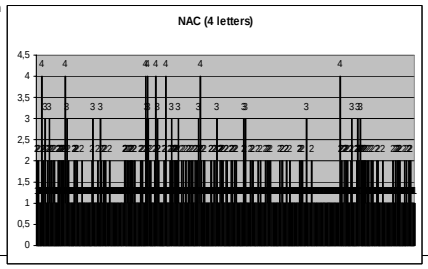


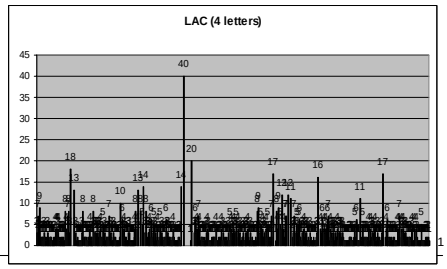


7. Comparison of NAC and LAC (3 + 4 letters)









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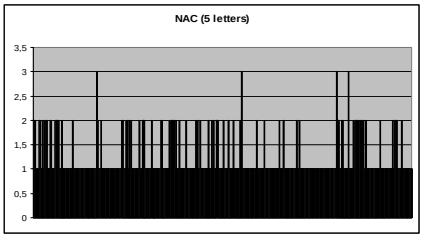
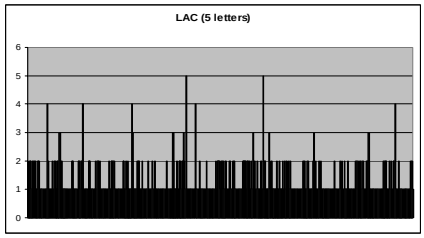
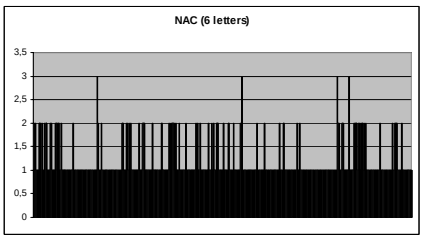
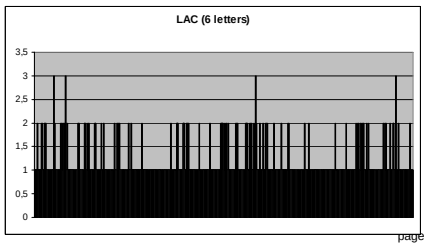
7. Comparison of NAC and LAC (5 + 6 letters)









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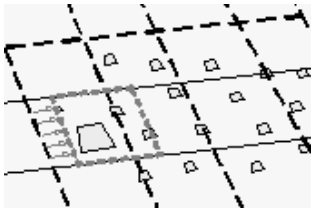
7. Comparison of NAC and LAC

NAC		Area	Size
NAC: H	R	Germany	1000km x 670km
NAC: HC	R8	Frankenstein and surrounding	33km x 22km
NAC: HC8	R8Z	Mountain top	1.1km x 0.7km
NAC: HC8G	R8Z1	Tower of Burg Frankenstein	36m x 25m
NAC: HC8GF	R8Z13	Platform of the tower	1.2m x 0.8m

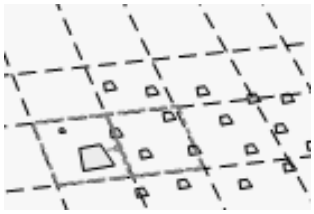
LAC (hexadecimal)		Area	Size
LAC: 8	C	Germany (+more)	1875km x 1256.3km
LAC: 86	C6	Hessen	117.2km x 78.5km
LAC: 862	**C6D**	**Frankenstein and surrounding**	**7.3km x 4.9km**
LAC: 862A	C6D1	Burg Frankenstein	458m x 306m
LAC: 862A1	C6D14	Tower of Burg Frankenstein	29m x 19m
LAC: 862A10	C6D14A	Platform of the tower	1.8 x 1.2m

8. Shifting Location Areas vs. Managing Multiple Location Areas

- User's position is in some cases closed to a border
- Information search of neighbor areas (target zone) is needed



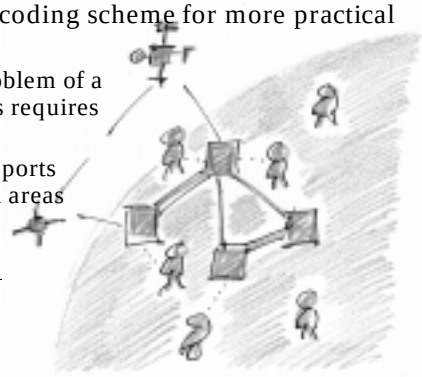
a.) shifting an area



b.) managing multiple areas

9. Conclusion and Outlook

- Need for addressing relevant geographical objects in many applications
  - Users are searching for information in their vicinity
  - Some applications do not allow com. to resolve raw position into locations
- Natural Area Code solves the problem to address objects by a global unique addressing scheme
- Location Area Code improves the coding scheme for more practical information distribution
- Shifting Location Areas solves the problem of a user is moving closed to a border (this requires additional computation)
- Managing multiple location areas supports a more flexible model to cover several areas
- More work on managing areas



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