UNIVERSITÄT BERN

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Vehicular Networking in RINA

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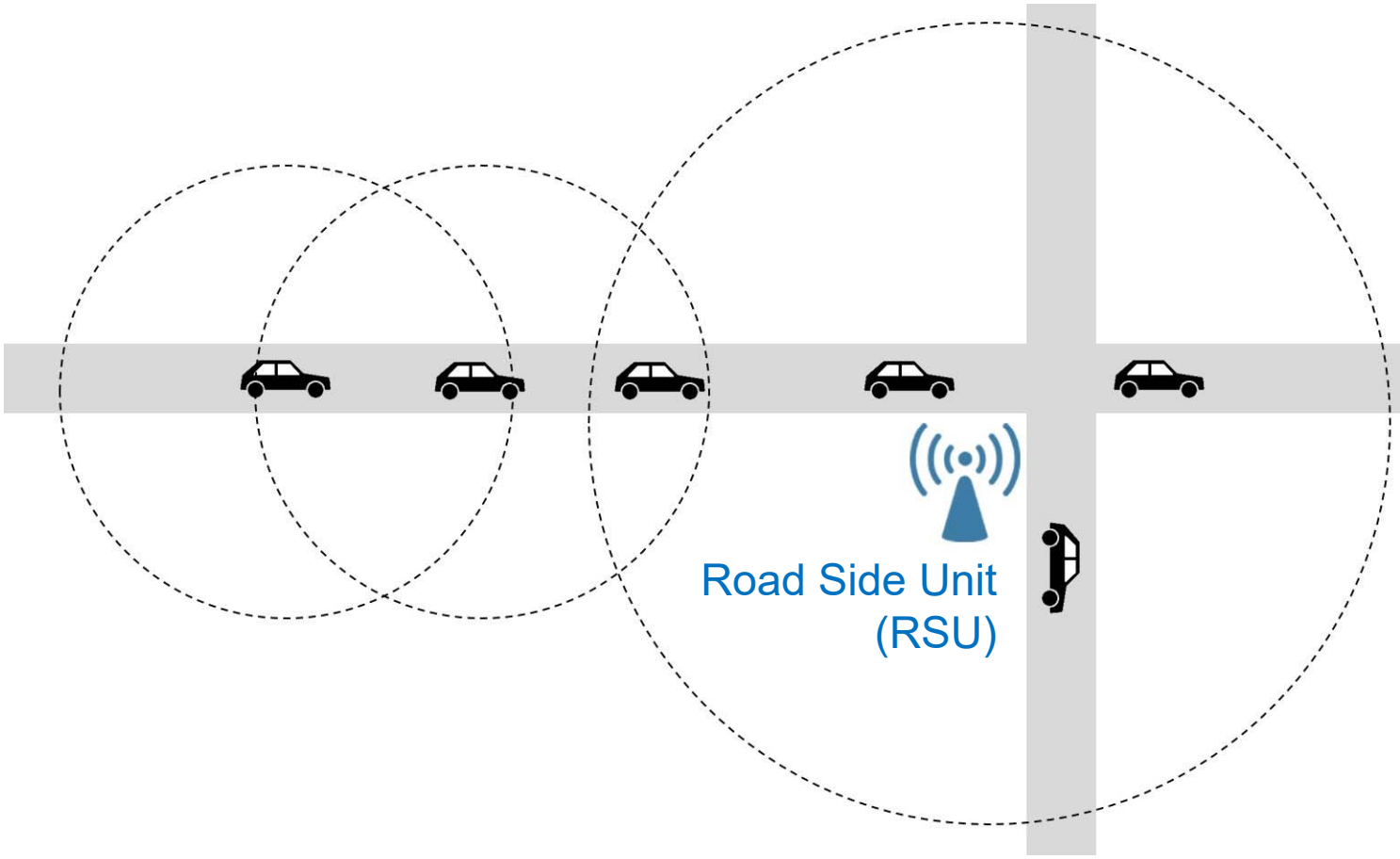
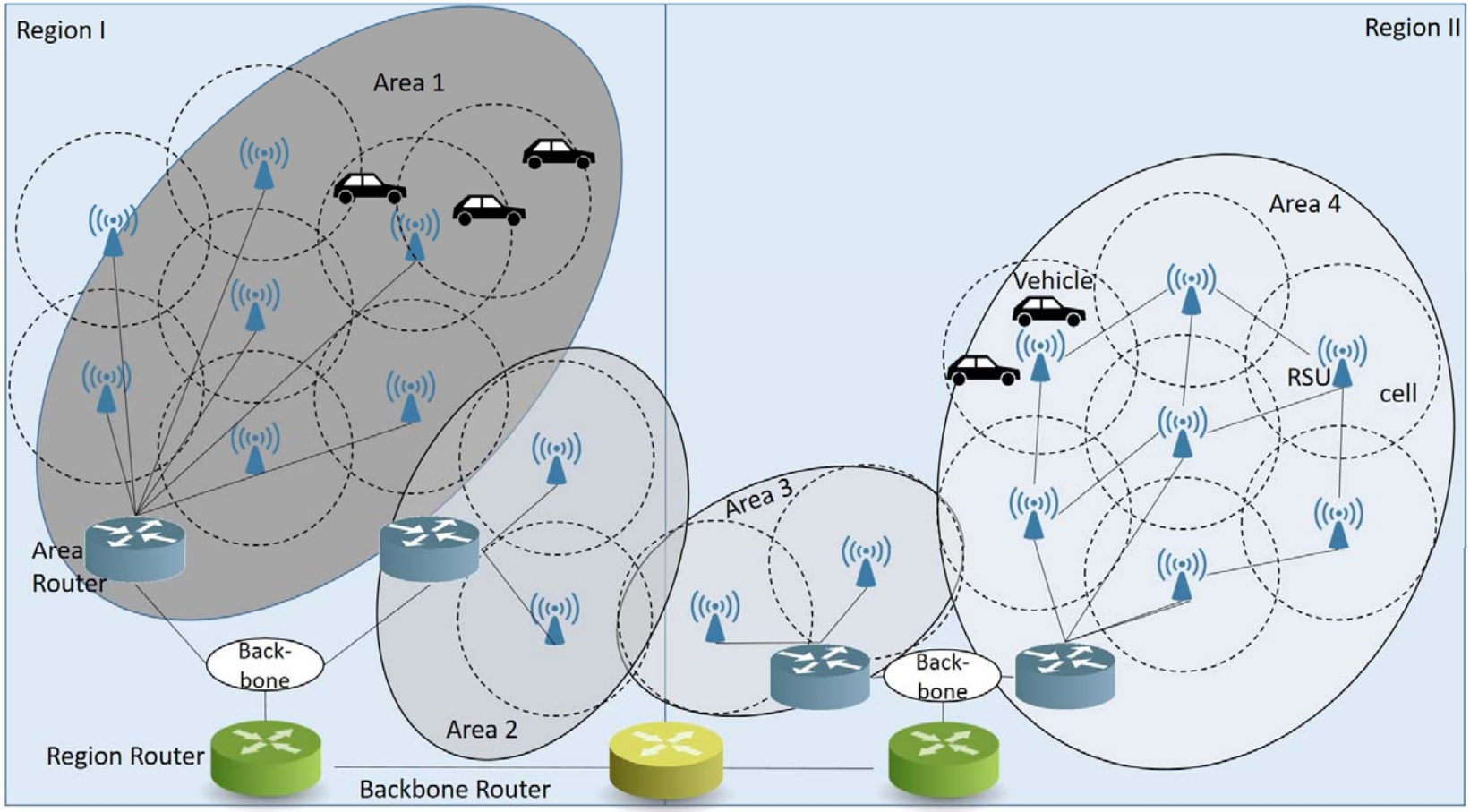
Motivation

- Question: How to use / adapt RINA for a Vehicular Network Architecture ?
- Solution: Vehicular-RINA (V-RINA)

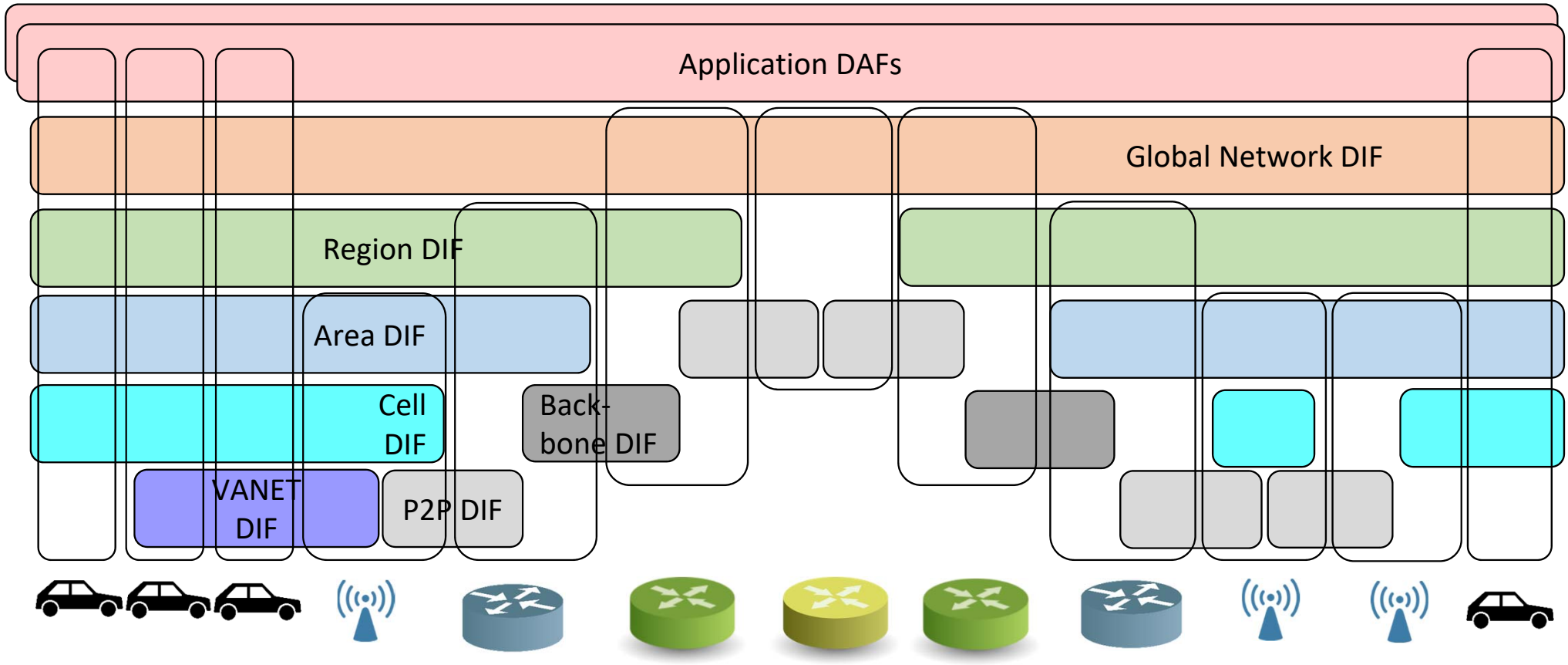
Vehicular Network Scenario



Example Vehicular Network Scenario



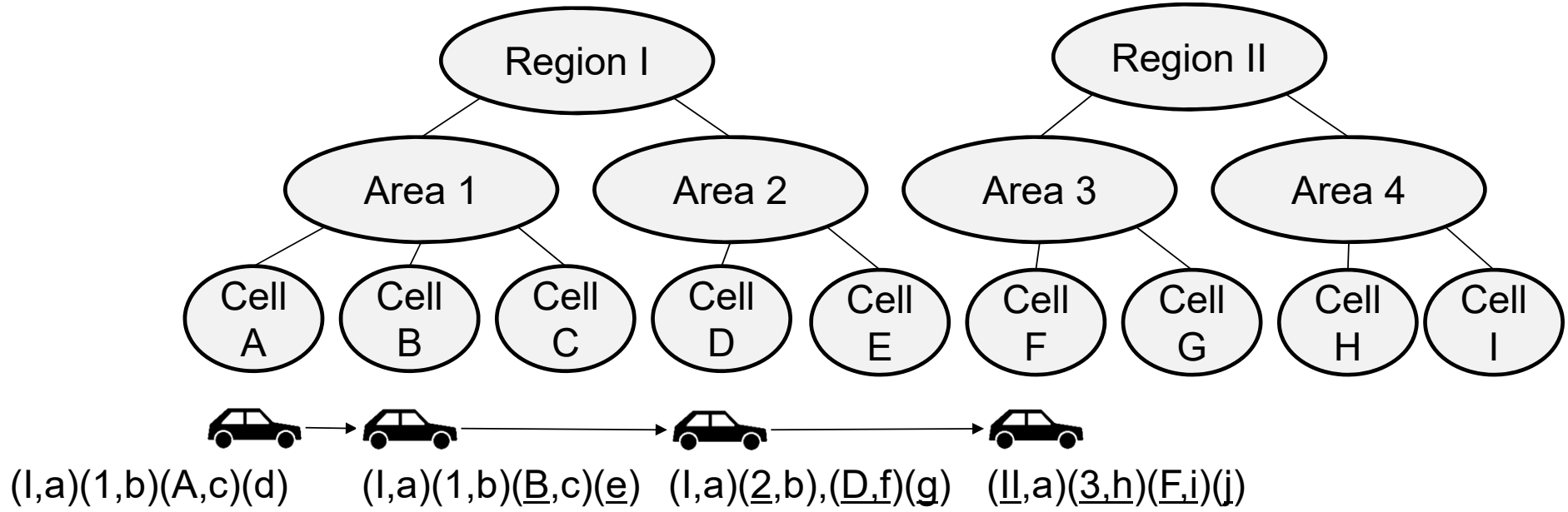
V-RINA


Application DAFs
Global Network DIF
Region DIF
Area DIF
Cell DIF
Back-bone DIF
VANET DIF
P2P DIF

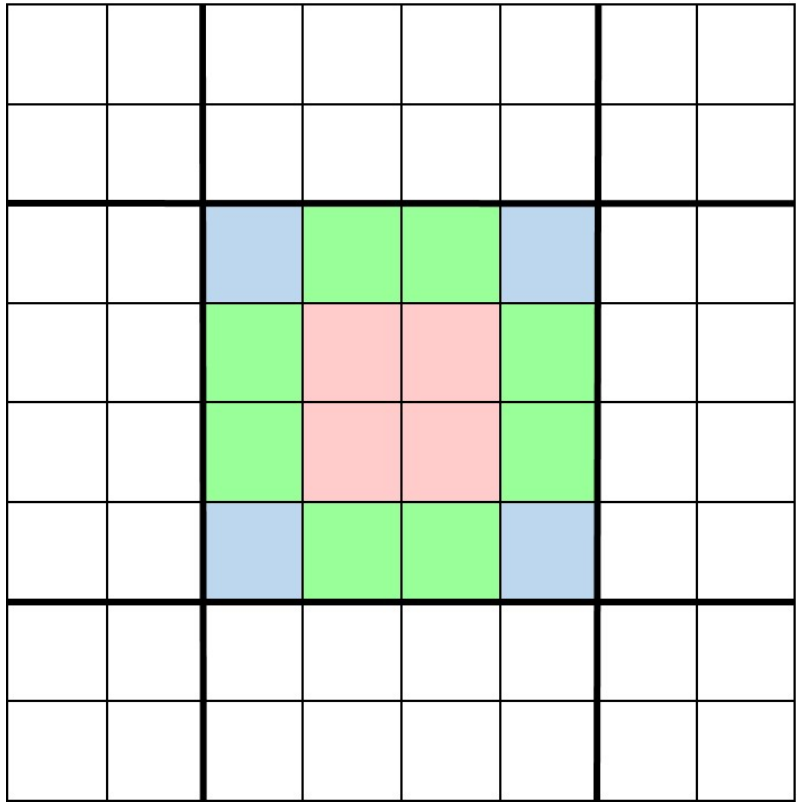
Addressing

- Assumption: hierarchical geographical network
  - Here: 3 layers: Region, Area, Cell → DIF per layer
  - Node registers address when joining a DIF and releases it when leaving the DIF.
    - → low frequency for registrations in higher layer DIFs, but many nodes per DIF
    - → high frequency for registrations in lower layer DIFs, but fewer nodes per DIF
- Topological addresses indicate in which lower layer DIF a node has registered to enable aggregation of routing information, e.g.,
  - Global Network DIF: <region_id; unique_global_id>
  - Region DIF: <area_id; unique_region_id>
  - Area DIF: <cell_id; unique_area_id>
  - Cell DIF: <unique_cell_id>

Address Changes in Case of Mobility

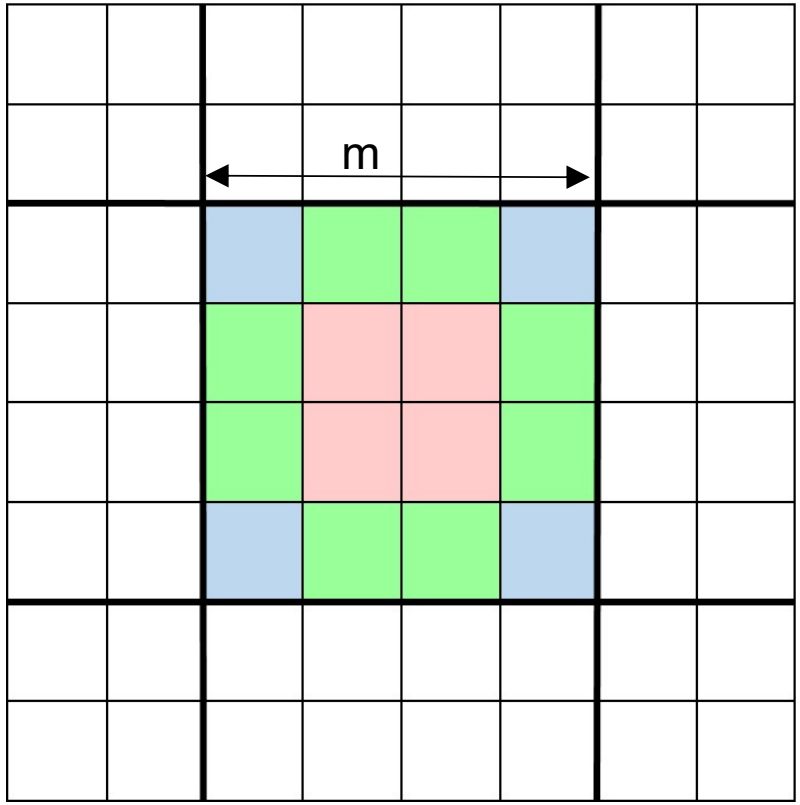


Analysis of Signalling Overhead



N: no. of vehicles, K: no. of regions,
L: no. of areas per region, M: no. of cells per area
register in new Cell DIF [1 message]
deregister in old Cell DIF [1 message]
update old Cell DIF routing table [N/(K*L*M) messages]
update new Cell DIF routing table [N/(K*L*M) messages]
if (Area DIF remains the same) then
    update Area DIF address [1 message]
else {new area}
    register in new Area DIF [1 message]
    deregister in old Area DIF [1 message]
    if (Region DIF) remains the same then
        update Region DIF address [1 message]
    else {new region}
        register in new Region DIF [1 message]
        deregister in old Region DIF [1 message]
        update Global Network DIF address [1 message]
    end if
end if

Analysis of Signalling Overhead



- Probabilities for area change (AC)
  - 0
  - ½
  - ¼
- Number of cells per area
  - Total: m^2
  - $(m-2)^2 = m^2 - 4(m-1)$
  - 4
  - $m^2 - 4 - (m-2)^2 = m^2 - 4 - (m^2-4m+4) = 4m-8$
- $p(AC) = \frac{0 \cdot (m^2-4(m-1)) + \frac{1}{2} \cdot 4 + \frac{1}{4} \cdot (4m-8)}{m^2} = \frac{1}{m}$

Analysis of Signalling Overhead

- N: #vehicles
- K: #regions
- L: #areas per region
- M: #cells per area
- AC: Area Change
- RC: Region Change
- $m^2 = M \rightarrow p(AC) = \frac{1}{\sqrt{M}}$
- $p(RC) = \frac{1}{\sqrt{LM}}$

- #signalling messages
  - Cell Change

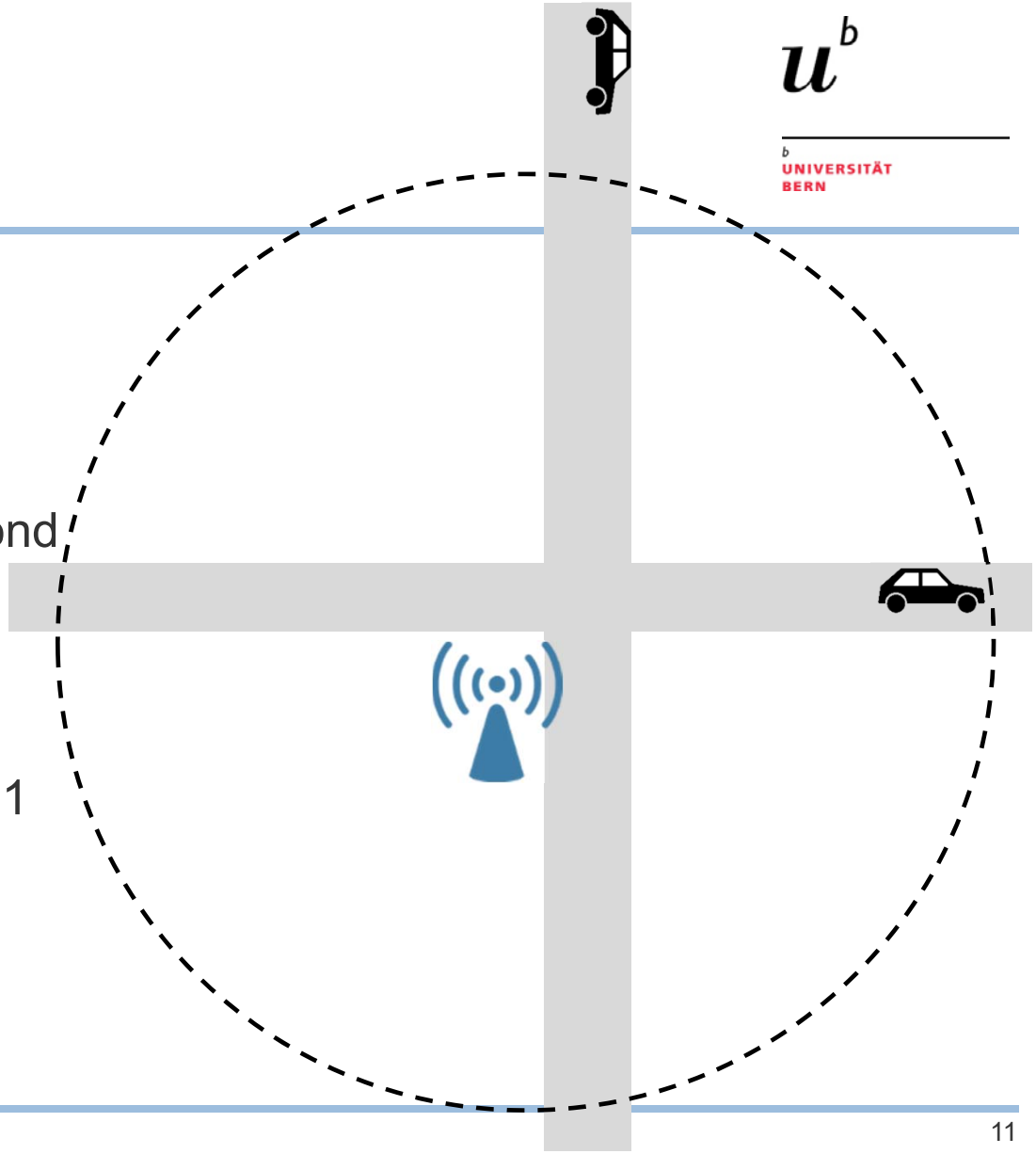
$$2 + \frac{2 \cdot N}{K \cdot L \cdot M} + 1 = 3 + \frac{2 \cdot N}{K \cdot L \cdot M}$$

  - Area Change
    - 3 additional messages
  - Region Change
    - 3 additional messages
- Average number of signalling messages in case of a cell change

$$3 + \frac{2N}{KLM} + \frac{3}{\sqrt{M}} + \frac{3}{\sqrt{LM}}$$

Estimation of Cell Changes

- California: #cars passing a certain point
  < 10’000 per hour
- Cell can be reached by 4 directions:
  < 40’000 cars enter/leave a cell per hour
  → < 11.1 cars enter/leave a cell per second
- M = 100 (10 x 10 cells): m = 10
- ACps: # area changes per second
- CCps: # cell changes per second < 11.1
- ACps = p(AC) * CCps < 1/10 * 11.1 = 1.11



Conclusions and Outlook

- Summary
  - Presentation of a possible DIF architecture
  - Topological addressing schemes allows scalable routing and limits signalling overhead for address management in case of mobility.
  - V-RINA seems to be well suited and scalable for vehicular networks.
- Future Work: Evaluation
  - OpenStack testbed
  - RINASim
  - …

Thanks for Your Attention

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- Torsten Braun, Davide Careglio, Ibrahim Matta:
  Vehicular Networking in the Recursive InterNetwork Architecture,
  87th IEEE Vehicular Technology Conference: VTC2018-Spring, Porto, June 3-6, 2018
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