Scalable Opportunistic VANET Content Routing With Encounter Information

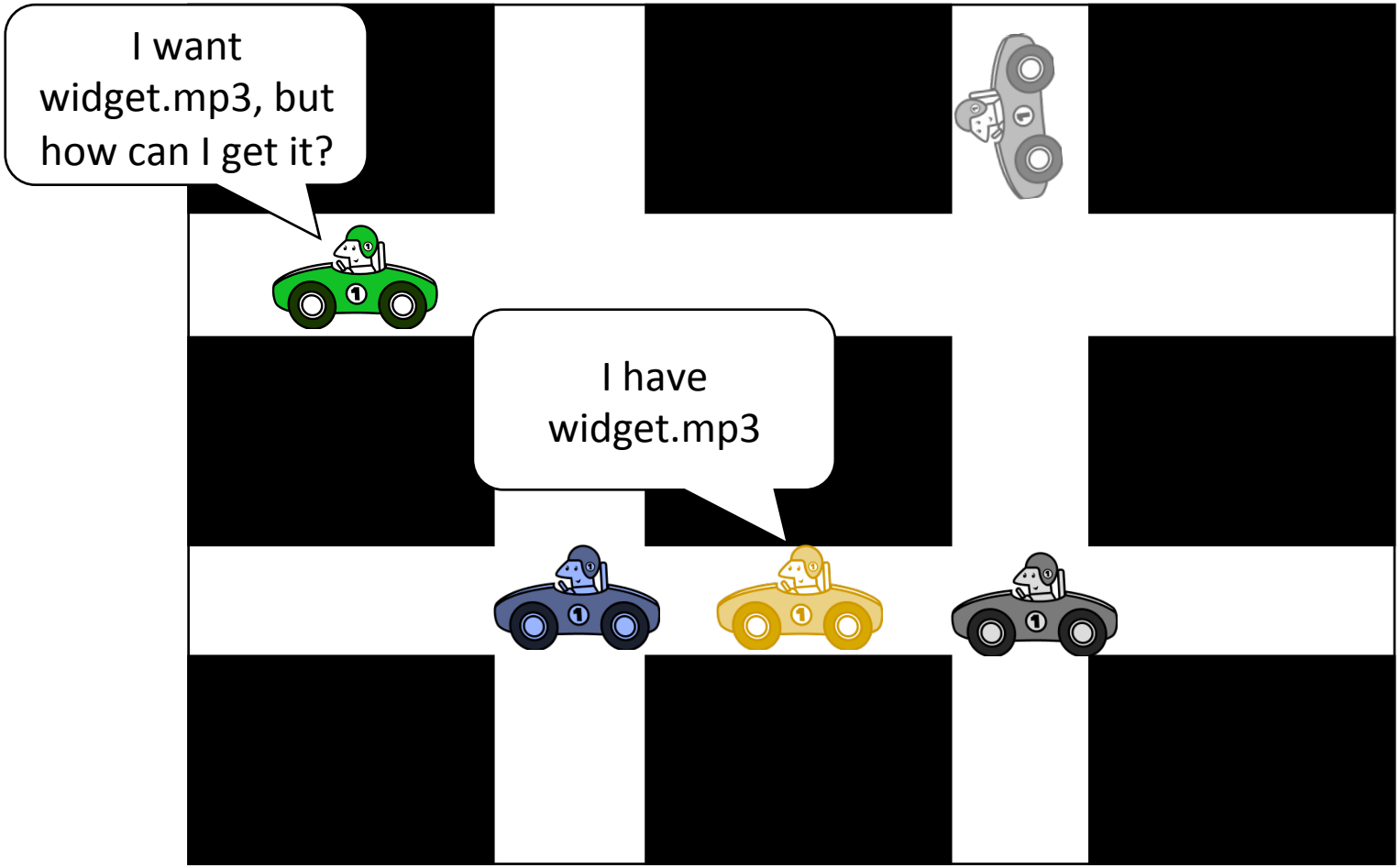
Yu-Ting Yu, Yuanjie Li, Xingyu Ma, Wentao Shang, M. Y. Sanadidi, Mario Gerla

Network Research Lab
Communication Innovation

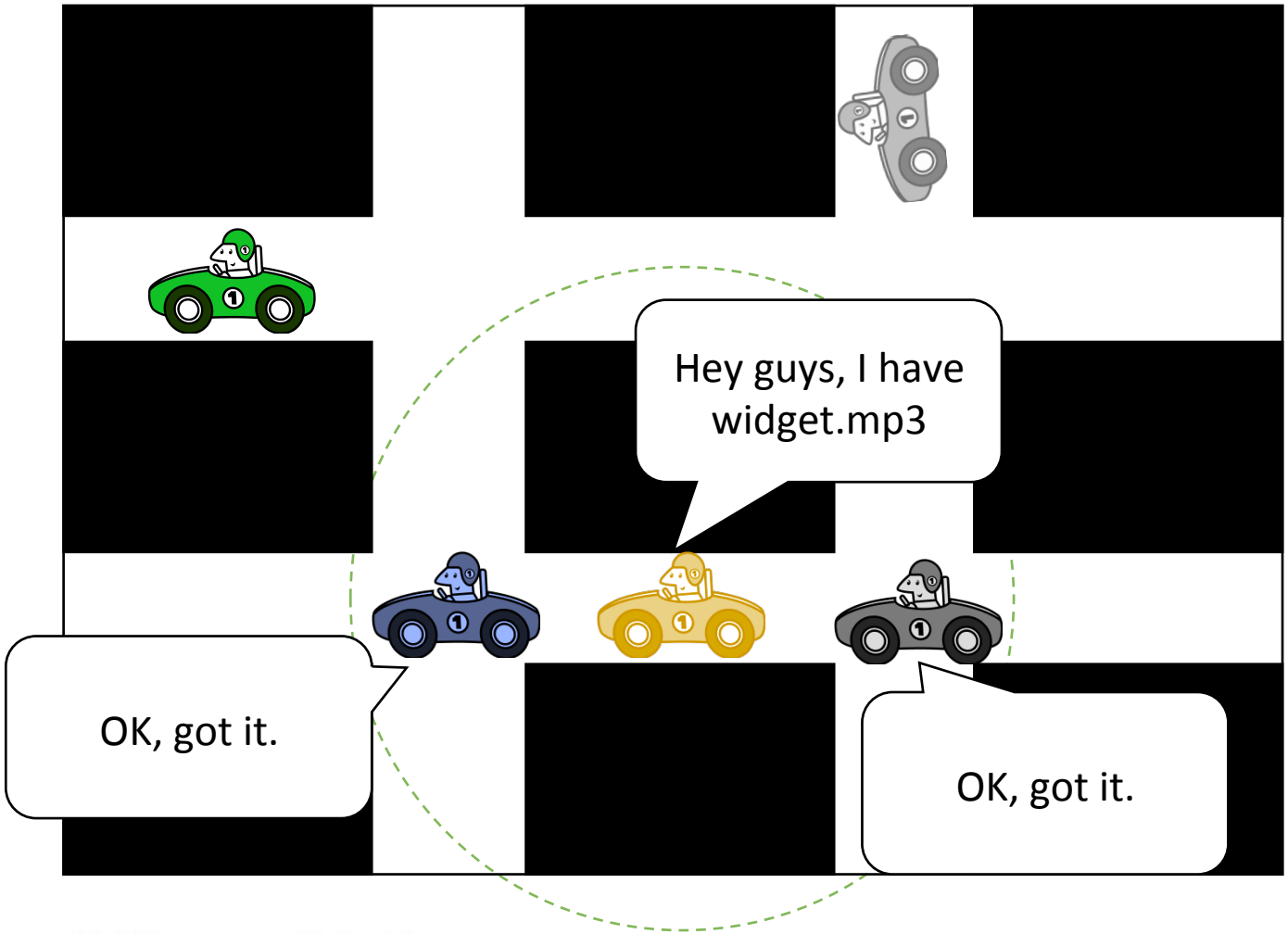
Problem Statement

- Named Data Networking (NDN) is beneficial for VANETs
  - In-network caching
  - Multi-source downloading
- In VANET, we categorize the contents as
  - Location-dependent: “traffic jam information on highway 110 North at exit 35B”
  - Location-independent: “gangnam_style.mp3” or “nearest ambulance”
- We explore how to retrieve **location-independent** content from other vehicles ***unambiguously*** and ***efficiently*** in the NDN architecture

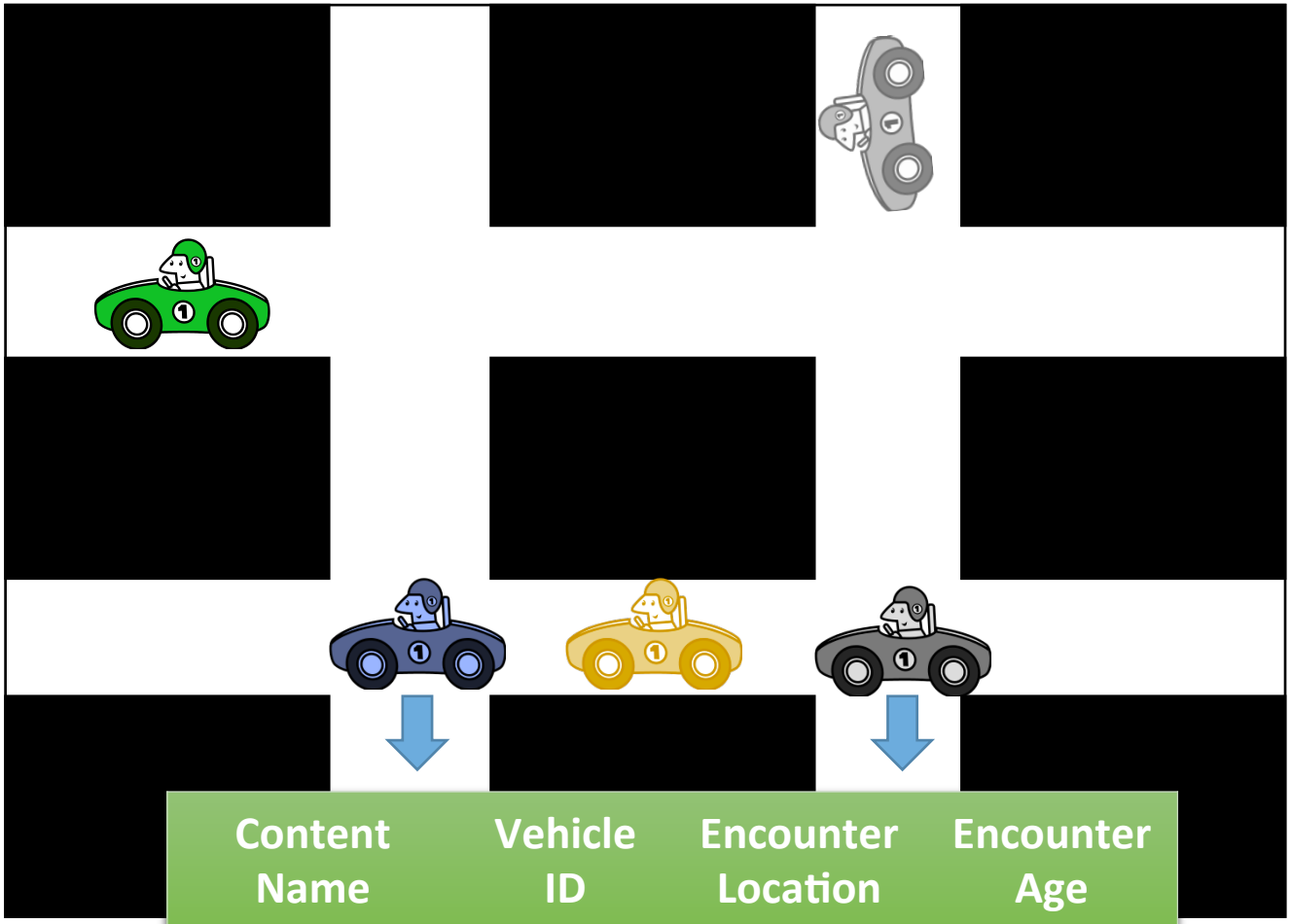
Motivating Example



Solution: Last Encounter Content Routing

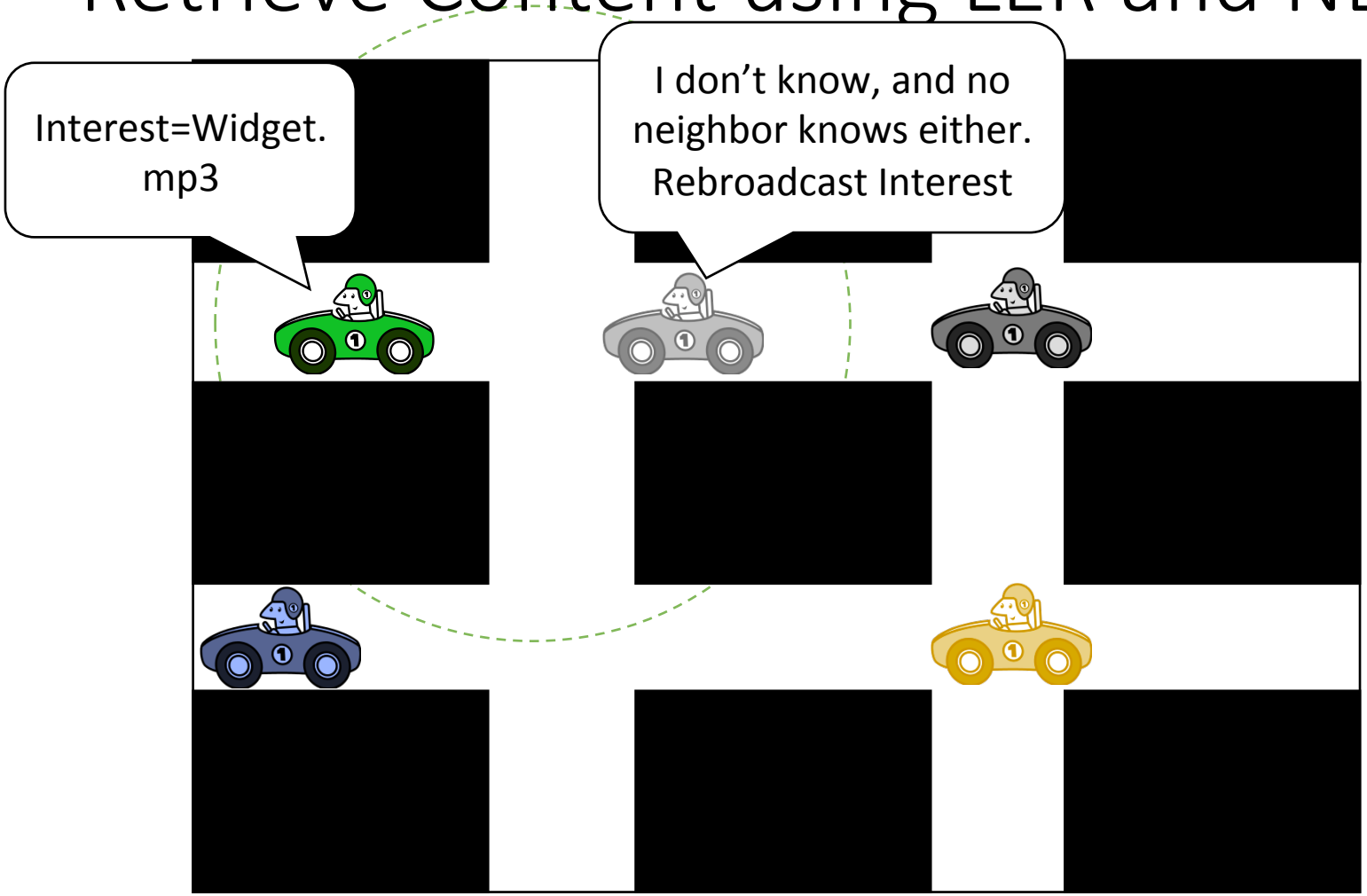


Solution: Last Encounter Routing



Content Name	Vehicle ID	Encounter Location	Encounter Age
Widget.mp3	MAC	(x,y)	12:00pm

Retrieve Content using LER and NDN



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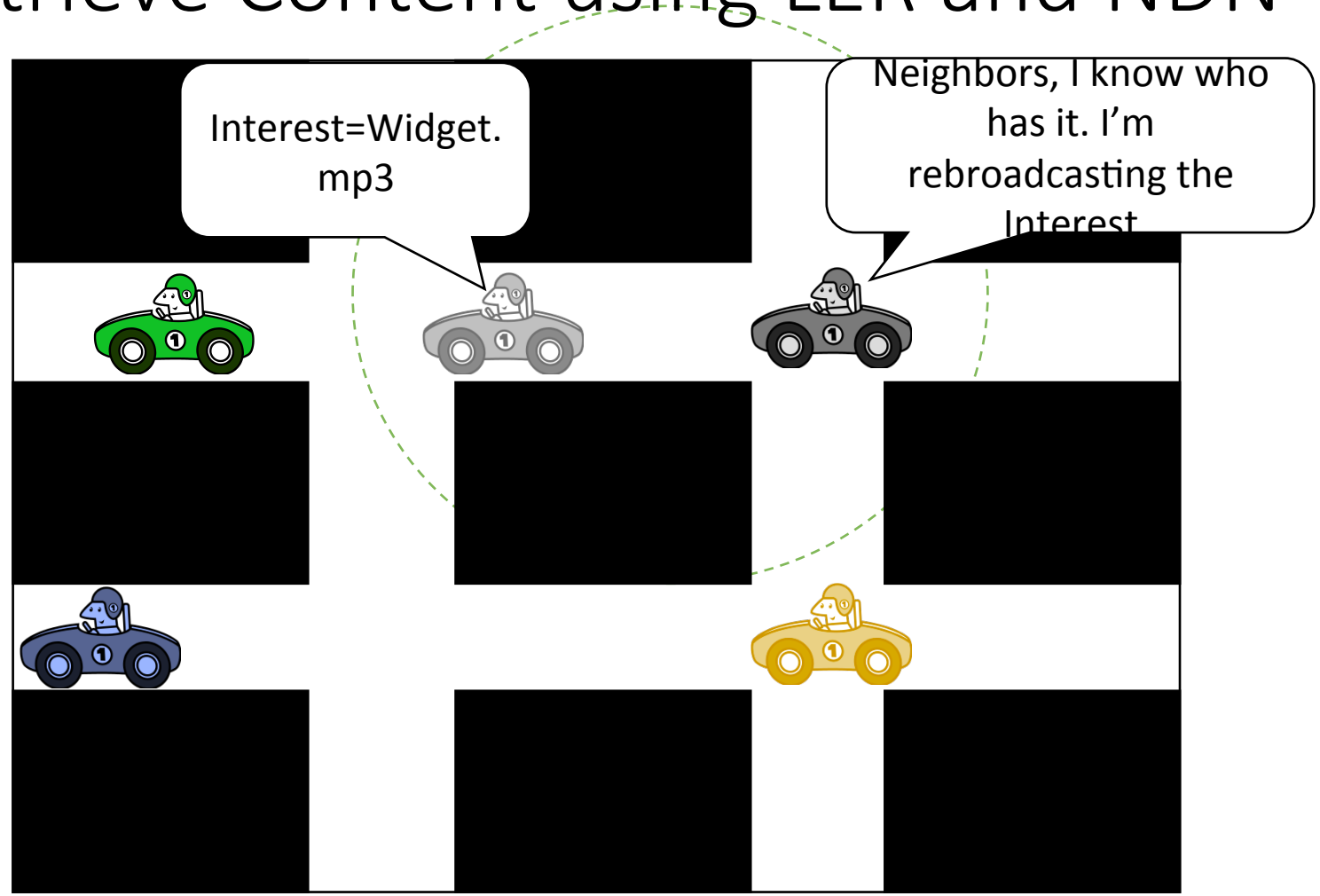

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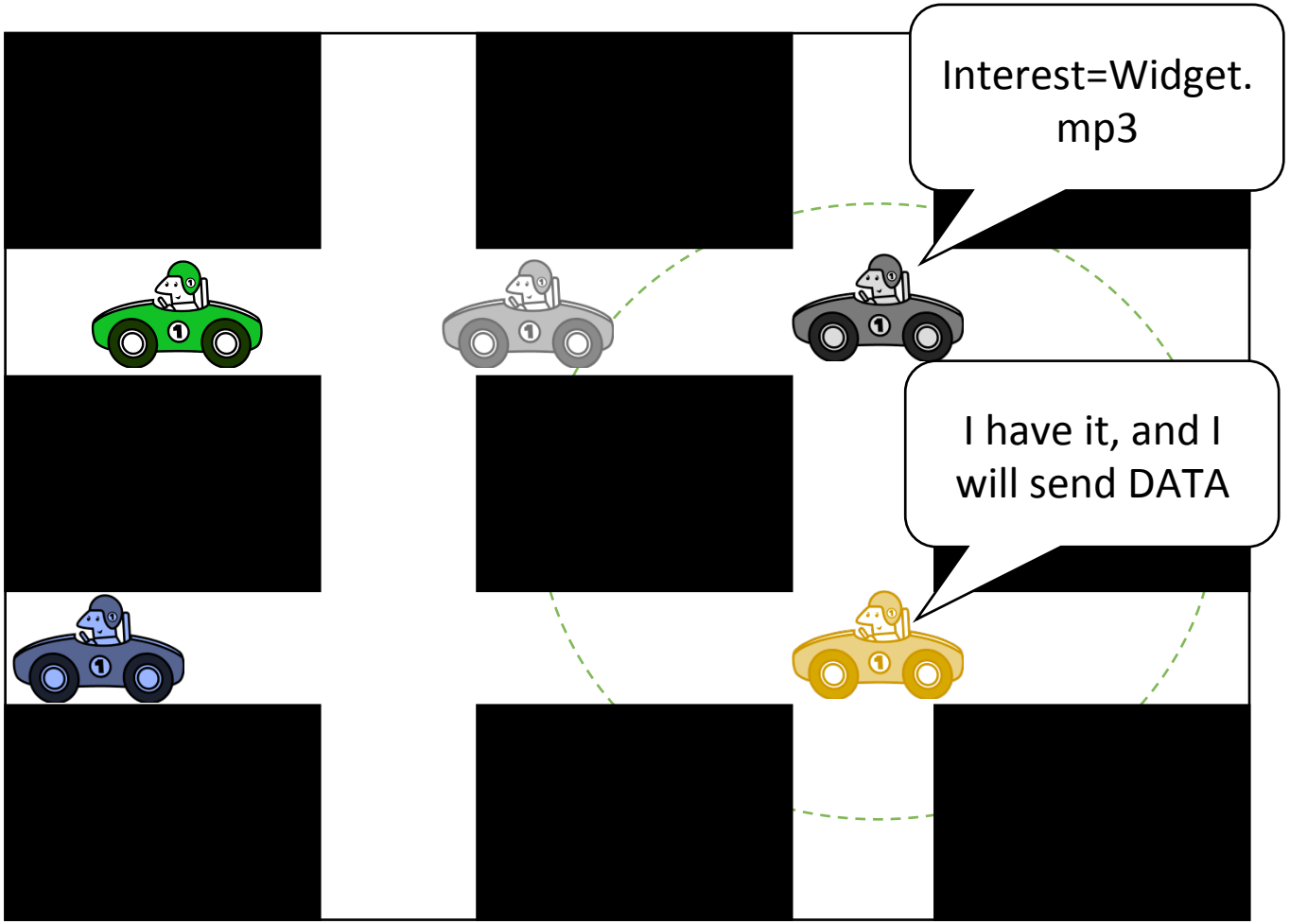
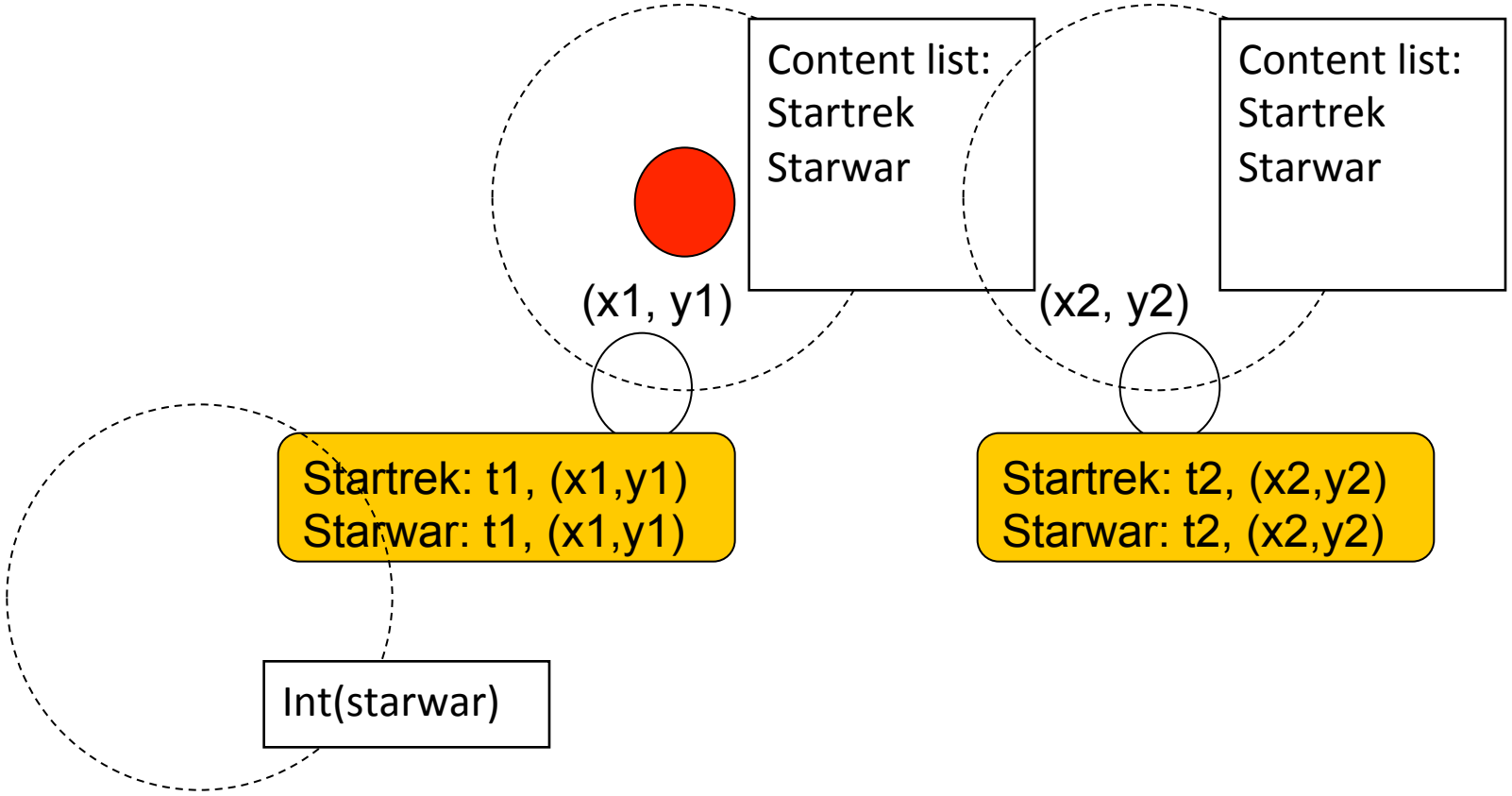


Protocol Design

- Content providers periodically advertise contents to one-hop neighbors
  - *Haggle Content Based Routing Philosophy(2003)*
- Interest Routing
  - Interests are flooded at the beginning with expanding scope (1 hop, then 2 hops etc)
  - Switch from flooding to opportunistic **GEO-ROUTING** once the *interest* matches a forwarder that **LAST ENCOUNTERED** the *provider*
  - Forwarders with fresher provider (Last Encounter) information are given higher priority

Provider location changes from advertising to interest propagation => must repeat flood search



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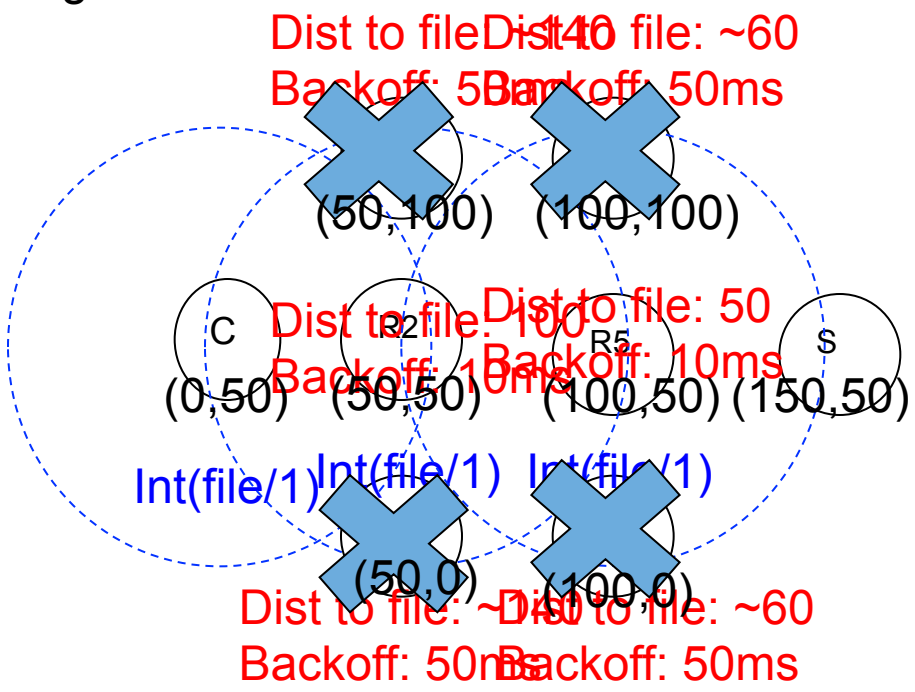
Opportunistic Geo-Routing is realized by staggered rebroadcast timers

Assuming file geo-location is known



Regular Geo Routing uses single path => not reliable
Opportunistic Geo-Routing exploits multiple paths

Phase 1: flooding-based content search

- Initially, expand search range with minimized redundant transmissions
- The farthest nodes from the last hop are given highest priority

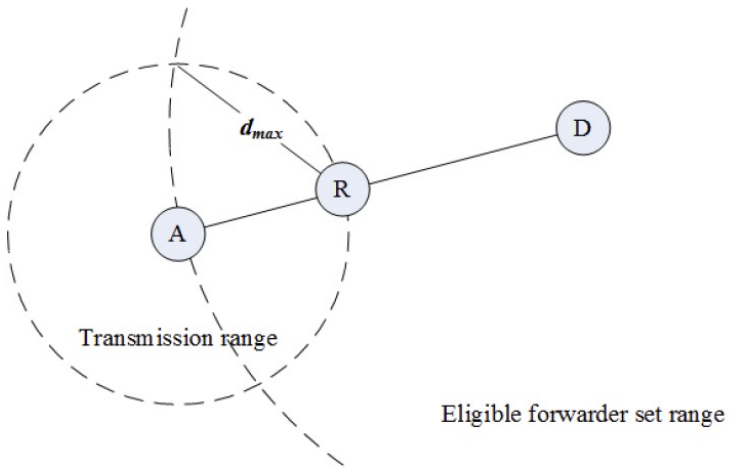
$$T_1 = T_{update} + (T_{dist} - T_{update}) \frac{D_{max} - min(D_{max}, D_{transmitter})}{D_{max}}$$

  - T_{dist}: maximum waiting time
  - D_{max}: estimated transmission range
  - $D_{transmitter}$: distance from last hop
  - T_{update}: time gap for nodes with updated provider location to rebroadcast

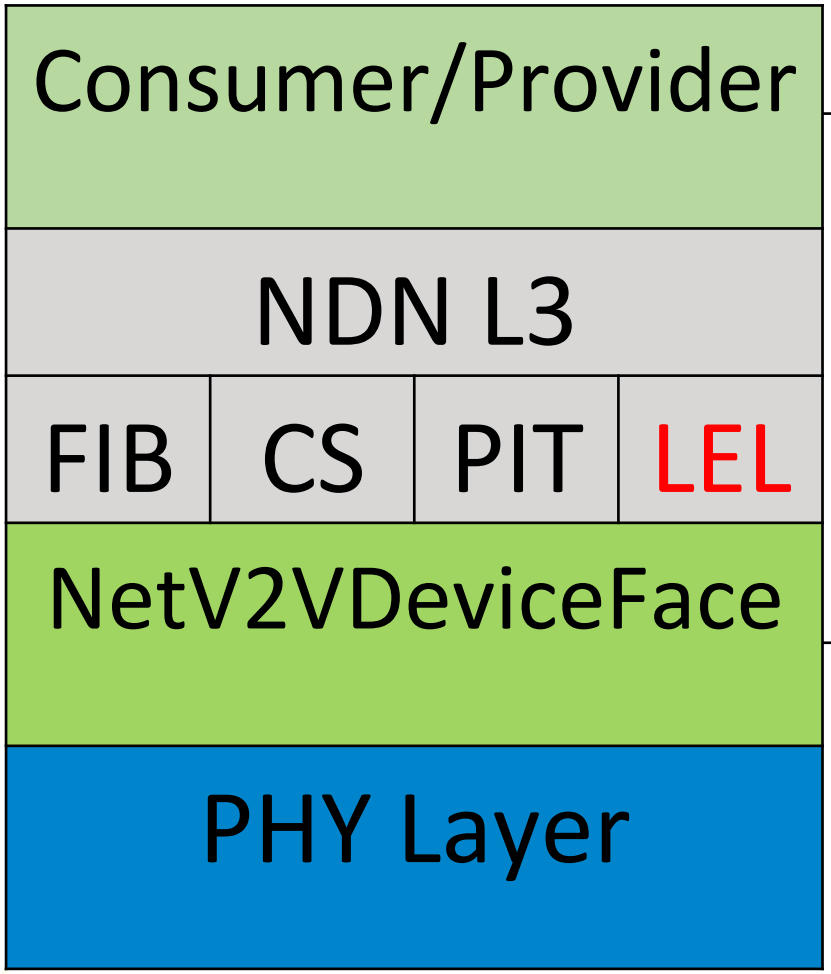
Phase 2: Opportunistic Geo-Routing

- A destination location is carried by the Interest
- Relays nearer the destination are given higher priority

$$T_2 = T_{update} + (T_{dist} - T_{update}) \frac{D_{ref}}{D_{max}}$$



Implementation: Overview



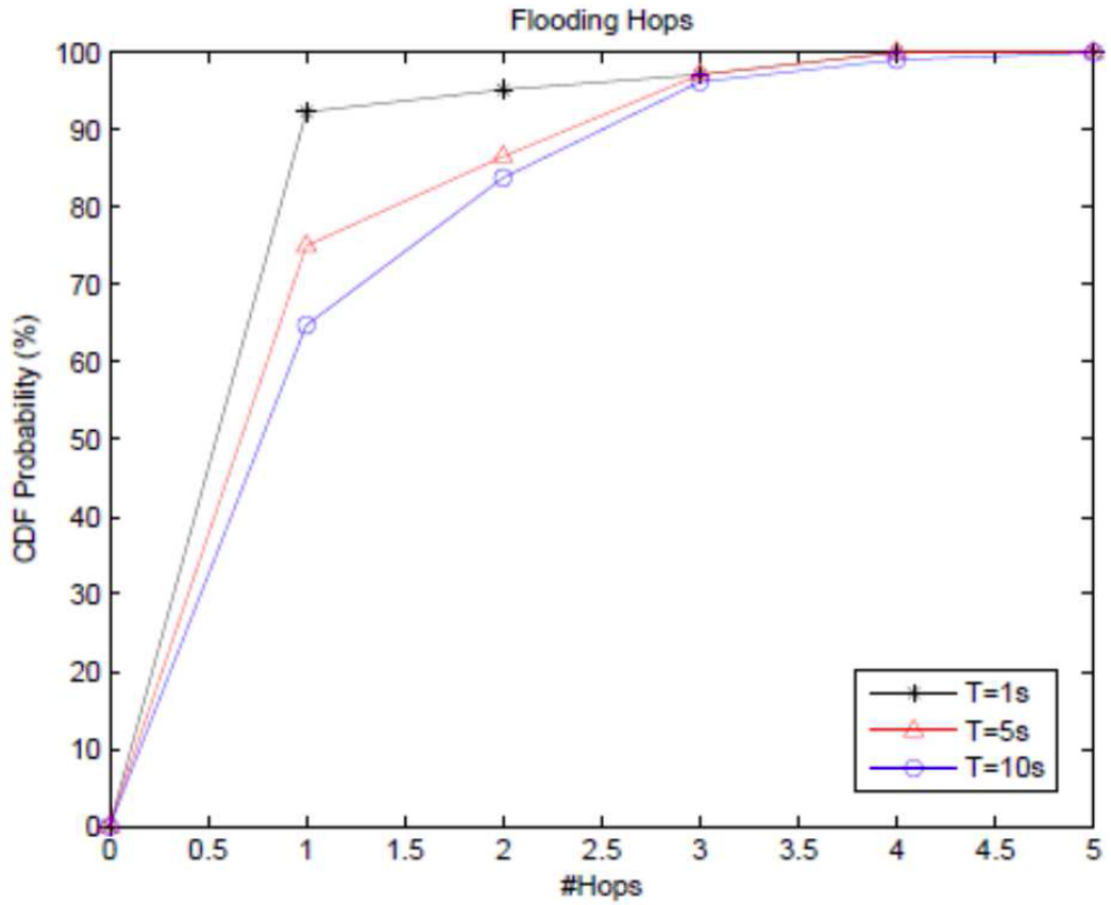
- Periodically generates LEL Request (Interest)
- Merge received LEL into its own LEL

- NDN WIFI Device in ndnSIM
- Geo Routing based on waiting timer
- Interest cancelling Mechanism

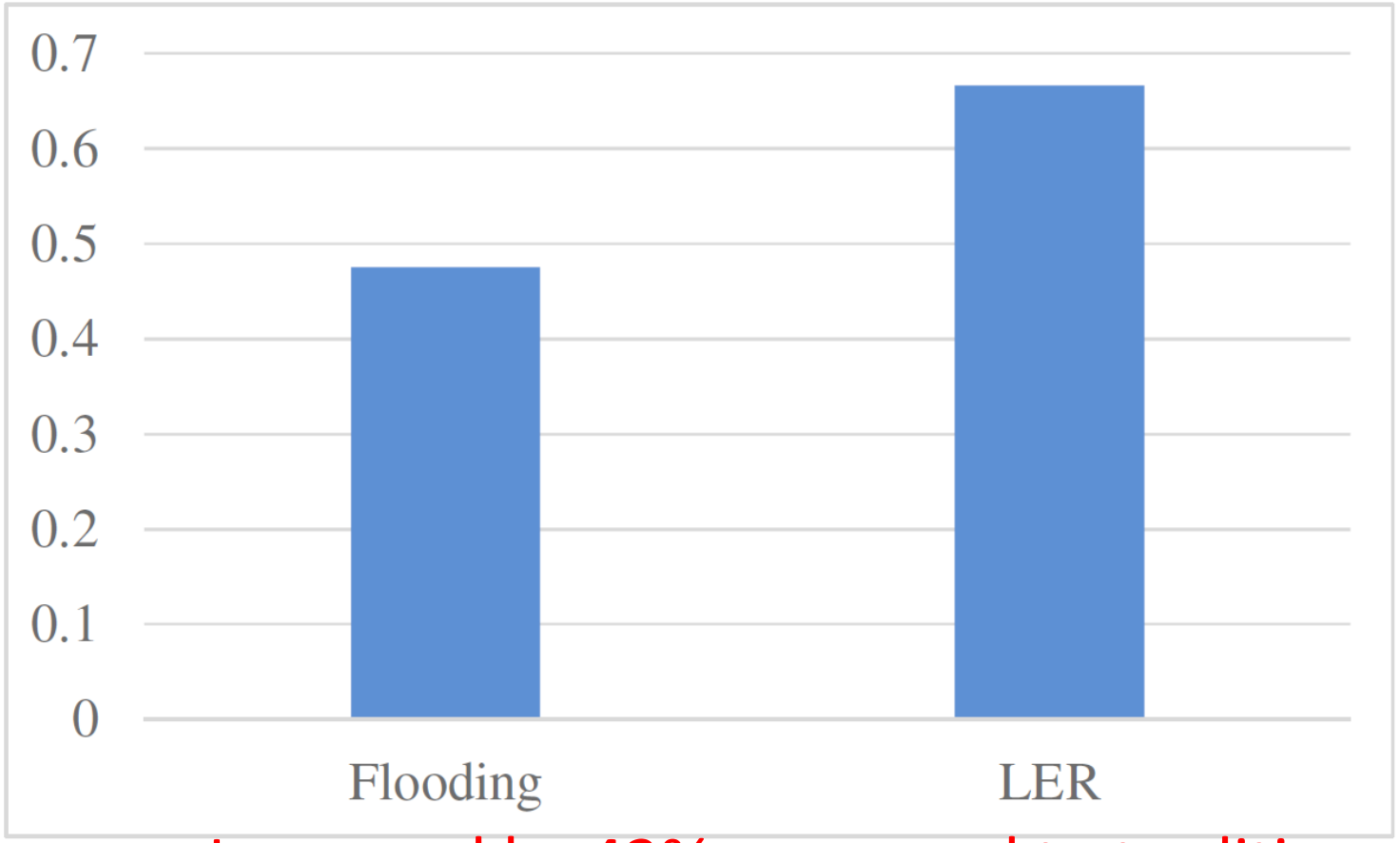
Simulation Settings

- Simulation urban environment in NS3
- Scenario
  - Physical layer: CORNER propagation model
  - 120 second mobility trace generated by SUMO using TIGER/Line files
- Application traffic
  - One provider
  - Interest is initiated randomly by a vehicle

Simulation Results: # hops in phase 1



Simulation Results: Retrieval Rate



Improved by 42% compared to traditional NDN!

Q & A