Non-cooperative RSU Deployment in Vehicular Networks

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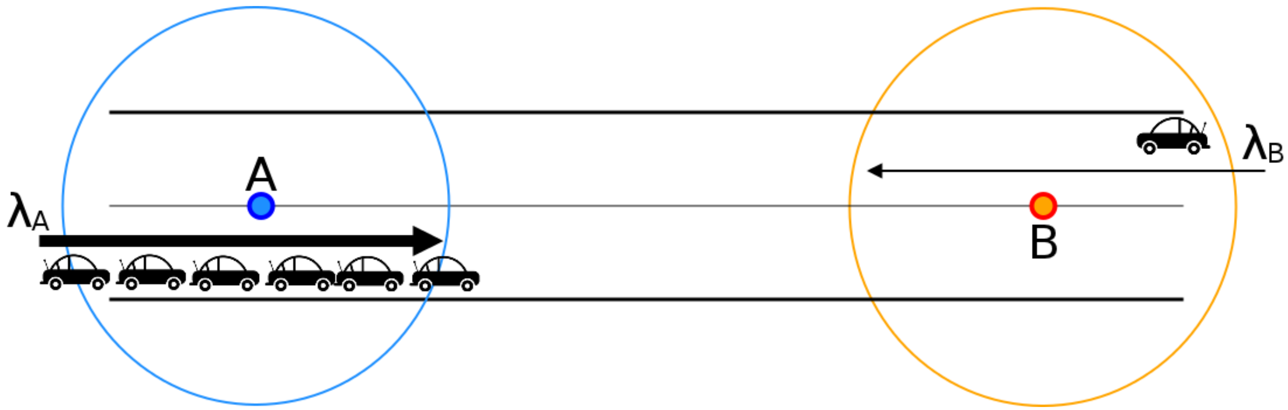
Introduction

- Vehicular networks may develop in several waves, with **no central planning**
- New operators will deal with a **partially deployed** network
  - Owned by other, competing operators
- All operators try to maximize their **utility**
  - Either a simultaneous or a leader/follower game
- Concerns about the resulting **efficiency**

Scenario

- Two **RSUs**, located over a road segment
- **Unbalanced** vehicular flows in the two directions ($\lambda_A > \lambda_B$)
- Vehicles try to **upload** a file through RSUs
- They first try the **first RSU** on their route
  - If the transfer fails, they try the other

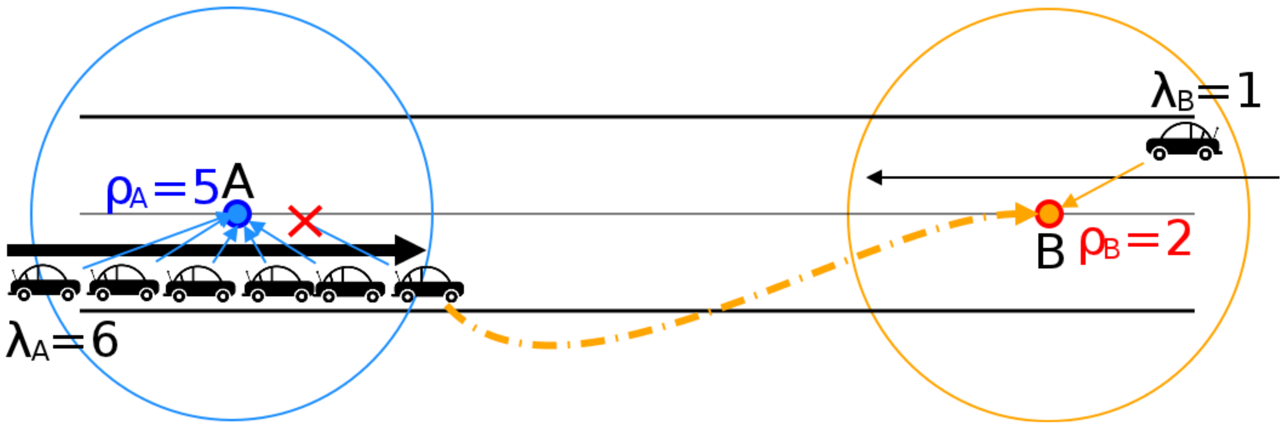


Unlimited-capacity case

- All transfers succeed, and the **offered traffic** at each RSU is $\rho_{A,B}=\lambda_{A,B}S$
  - Since $\lambda_A>\lambda_B$, then $\rho_A>\rho_B$
- If the two players control **different** locations
  - The owner of location A gets ρ_A
  - The owner of location B gets ρ_B
- The players may occupy the **same** location
  - Each gets $(\rho_A+\rho_b)/2$
- **Co-location** would always be preferred

Limited capacity: spillover

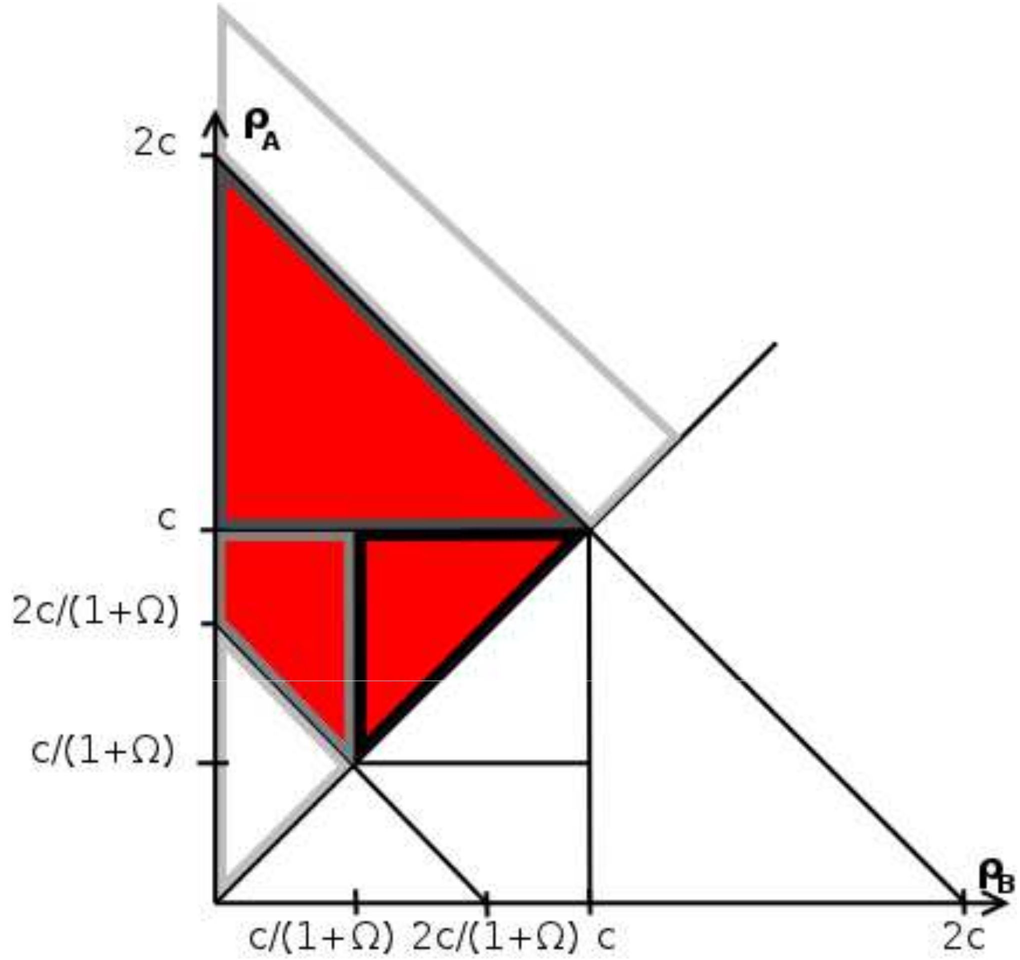
- If the offered traffic exceeds the RSU capacity c, some traffic **spills over** to the other RSU
  - Increasing its own offered traffic
- If RSUs are **co-located**, each has a capacity of $2c/(1+\Omega)<c$
  - Co-location is never socially optimal



Equilibrium Deployments

Depending upon the values of ρ_A, ρ_B, Ω, co-location may be a **Nash equilibrium**

However, such an equilibrium is not **efficient**: its price-of-anarchy is greater than one



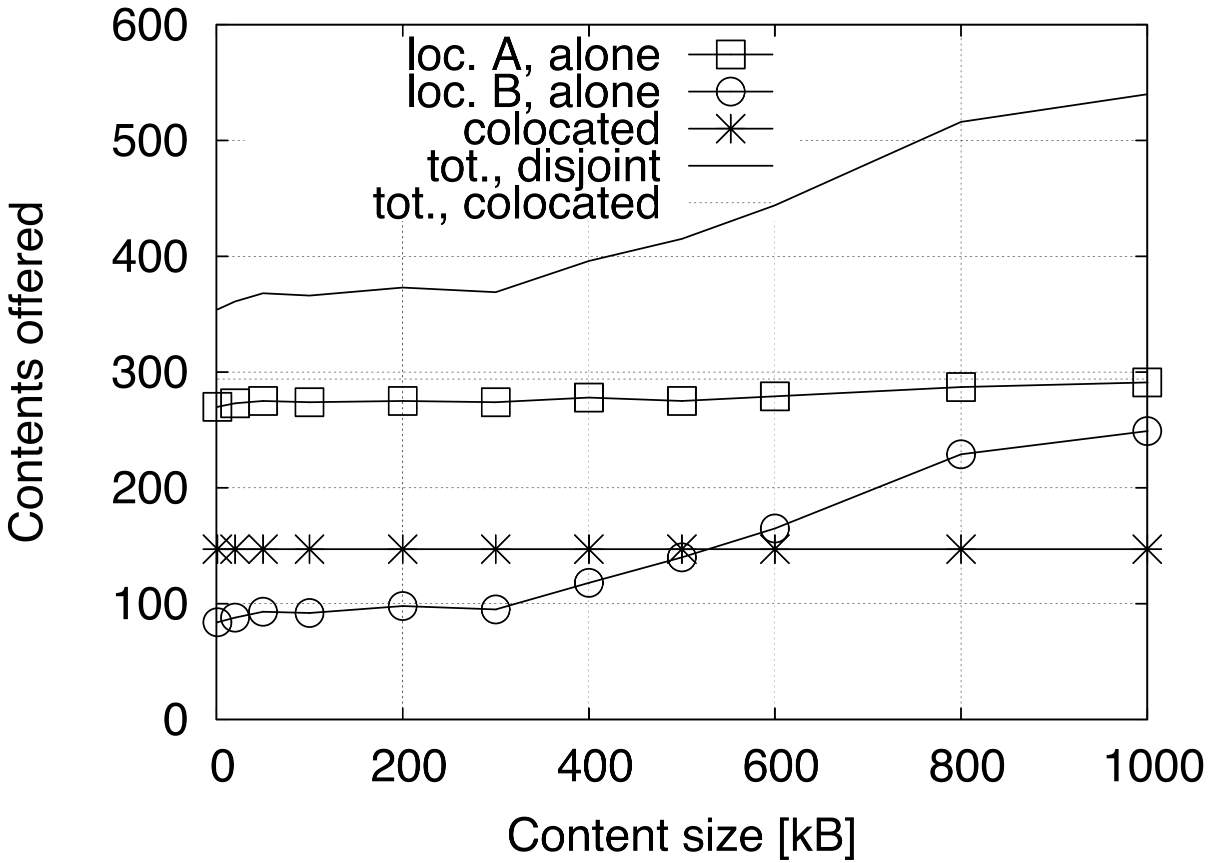
$$1 < PoA = \frac{(\rho_A + \rho_B)(1+\Omega)}{2c} < 1 + \Omega$$

Content size, Ω and co-location

The **size** S of the content being transferred influences the amount of data offered to each RSU

For big contents, using location B alone becomes **preferable to co-location**

Bigger contents increase the **interference** factor Ω, degrading the co-location performance



Conclusions

- We proposed a game-theoretic approach to **non-cooperative** RSU deployment
- We modeled the **spillover** phenomenon
  - Congestion at one RSU affects the traffic offered at the other
- The reached equilibrium may be **inefficient**
- **Bigger contents** improve efficiency
  - Co-location becomes less profitable

Future work

- **Adjustable distance** between RSUs
  - Partially-overlapping coverage
- RSU location **auctions**
  - Potentially, a good compromise between competition and planning