Mechanism Design for Ridesharing
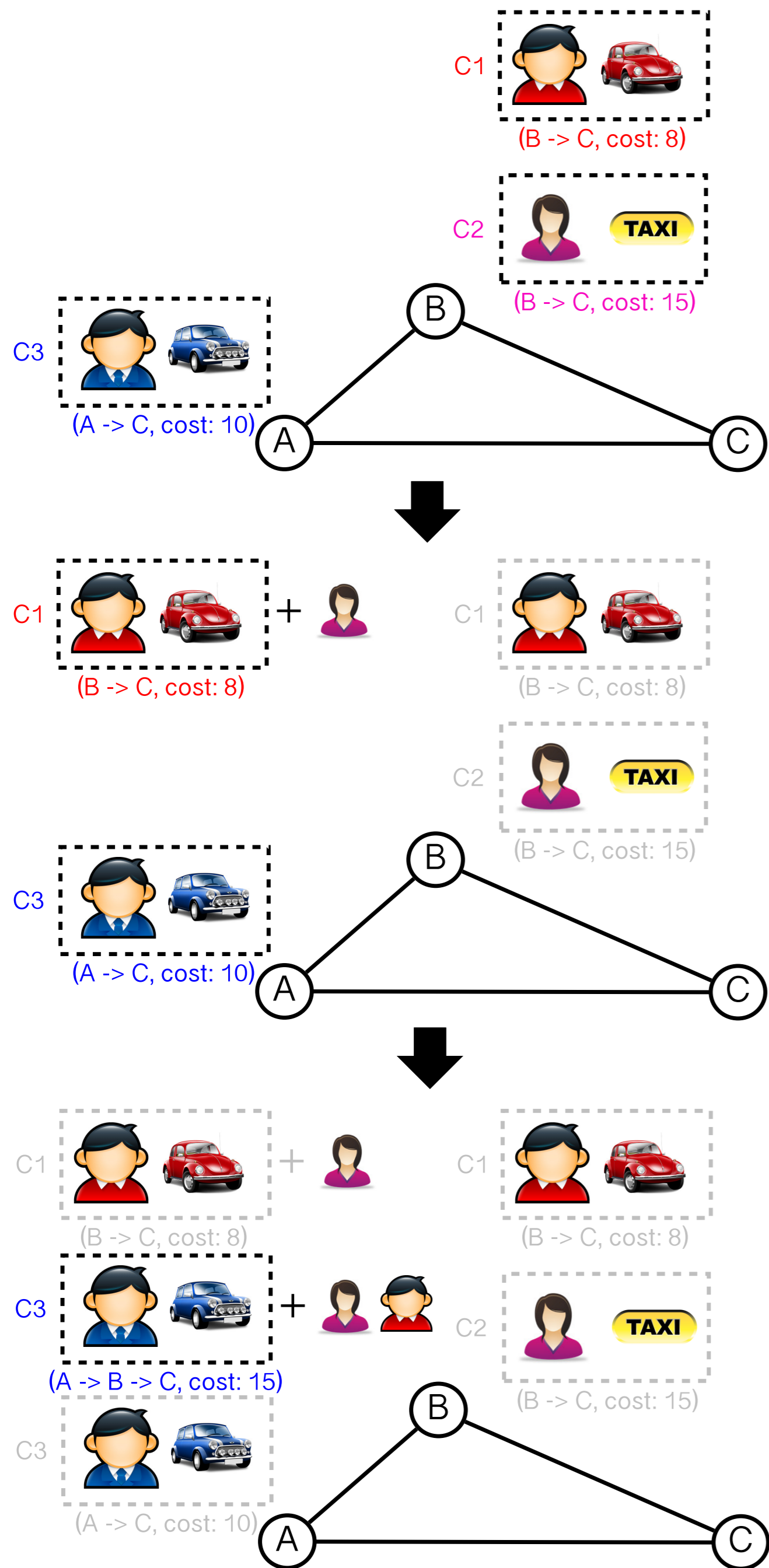
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Ridesharing Example

Challenges and Aims

Challenges of the existing ridesharing services:
- Flexibility, reliability, safety and privacy,
- Complicated ride-matching and ride arrangement, *e.g. commuters have to search/contact others to arrange the sharing.*
- No free market competition, *e.g. commuters have to setup the prices by themselves without the knowledge of the market.*

Aims of this research:
- Automated ride-matching/ride arrangement,
- Automated price setting,
- Incentivize participation and prevent manipulations.

Auction Based Ridesharing System
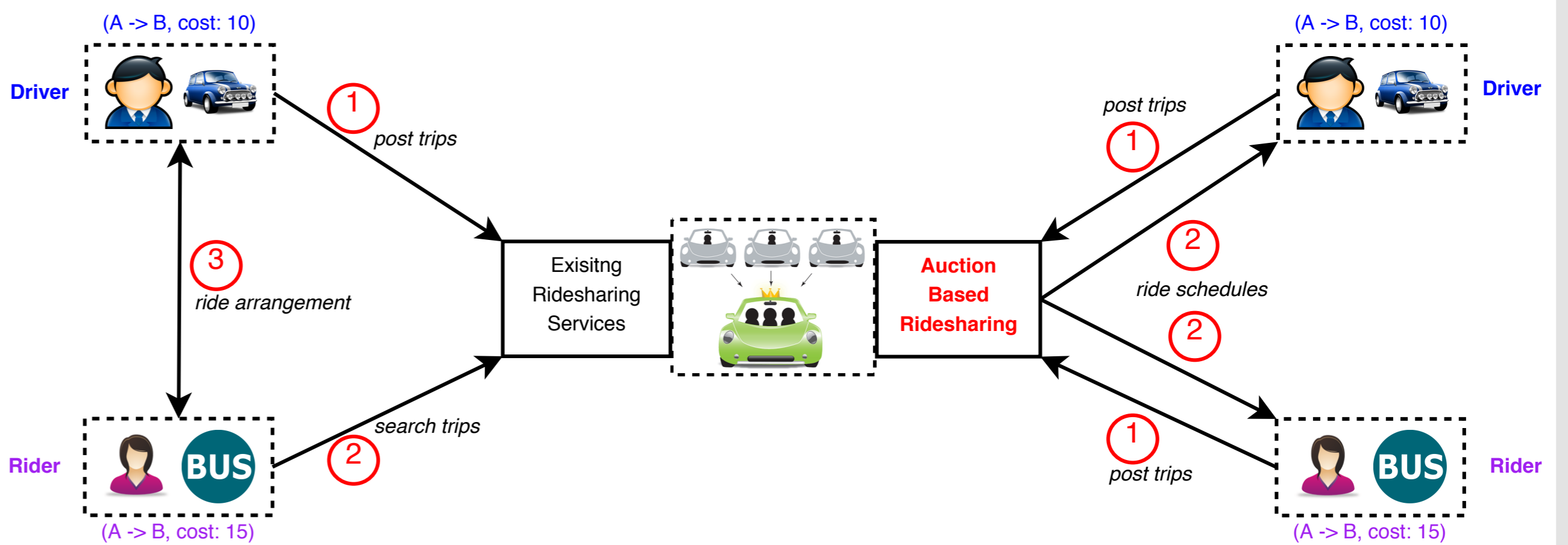
**Features of auction based ridesharing:**

1. Commuters only need to report/post their trips, no additional ride arrangement
2. The system consists of
   - an allocation mechanism:
     - computes the optimal allocation, e.g. minimizing travel cost
   - a payment/price mechanism:
     - calculates a payment for each commuter, which maximizes commuters' utility/profit

Challenges of auction based ridesharing:

1. Incentivize participation and prevent manipulation
   - the system should maximize commuters' utility/profit such that they are not incentivized to manipulate the system in order to gain more.
2. Deficit control
   - well-known mechanism VCG gives the optimal outcome for all commuters, but produces a very large deficit to the system.
3. Computational complexity
   - the automated ride-matching and the payment computation is very difficult.

Ridesharing Market

Workers Commuting by Carpool in USA
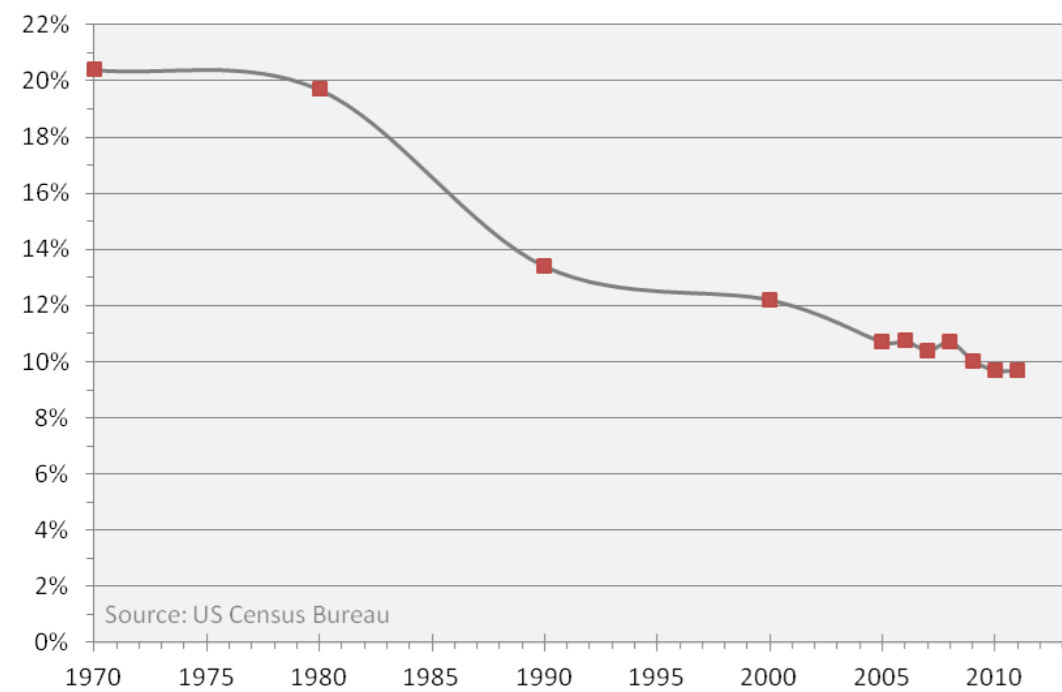
- More than 600 ride-matching services in US in 2011.
- European ridesharing platform providers *Carpooling.com* and *BlaBlaCar* claimed more than 6 million users in 2012.
- *BlaBlaCar* arranges 400,000 rides a month, equal to 1,000 French high-speed trains.

However,
- Australia (Queensland) will end ridesharing lanes.
- The average car carries just 1.6 people.

Solutions

1. Incentivize participation and prevent manipulation
   - Vickrey–Clarke–Groves (VCG) based mechanisms [1,2].
2. Deficit control
   - trade reduction [2,3], adapt fixed/reserve prices [1].
3. Computational complexity
   - limit the outcome space [1] and empirical studies [2,4].

[1] Zhao, D.; Zhang, D.; Gerding, E. H.; Sakurai, Y.; and Yokoo, M. 2014. Incentives in ridesharing with deficit control. In Proceedings of AAMAS'14.
[2] Parkes, D. C.; Kalagnanam, J.; and Eso, M. 2001. Achieving budget-balance with vickrey-based payment schemes in exchanges. IJCAI'01.
[3] McAfee, R. P. 1992. A dominant strategy double auction. Journal of Economic Theory 56(2).
[4] Agatz, N. A.; Erera, A. L.; Savelsbergh, M. W.; and Wang, X. 2011. Dynamic ride-sharing: A simulation study in metro Atlanta. Transportation Research Part B: Methodological 45(9).