$$\text{minimize} \quad \sum_{(o,t,i)\in\Theta} \sum_{v\in V\setminus\{o\}} f^{(o,t,i)}_{(o,v)} \cdot d_{(o,t,i)} \cdot r \tag{1a}$$

$$\text{subject to} \quad \sum_{v\in V\setminus\{z\}} f^{(o,t,i)}_{(v,z)} - \sum_{w\in V\setminus\{z\}} f^{(o,t,i)}_{(z,w)} = 0, \qquad \forall\ z \in V \setminus \{o,t\},\ \forall (o,t,i) \in \Theta, \tag{1b}$$

$$\sum_{v\in V\setminus\{o\}} f^{(o,t,i)}_{(o,v)} \leq 1, \qquad \forall\ (o,t,i) \in \Theta, \tag{1c}$$

$$\sum_{v\in V\setminus\{t\}} f^{(o,t,i)}_{(t,v)} = 0, \qquad \forall\ (o,t,i) \in \Theta, \tag{1d}$$

$$\sum_{(o,t,i)\in\Theta} f^{(o,t,i)}_{e} \cdot d_{(o,t,i)} \leq \sum_{i\in N} q^i_e, \quad \forall\ e \in E, \tag{1e}$$

$$f^{(o,t,i)}_{e} \in \{0,1\}, \quad \forall\ e \in E,\ \forall (o,t,i) \in \Theta \tag{1f}$$

Constraint (1e) ensures that the commodities sent through an edge doesn't exceed the total capacity available in that edge (the sum of the capacities each agent has for that edge).

REMARKS:

1. Constraints ensuringthat every agent would end up with profitable payoff from this cooperation? For example, only route a commodity if the payment for it is smaller than the revenue from satisfying it.

2. Seems necessary to know the revenue associate with each commodity to be able to route the flow in the cooperation stage. The motivation of sharing the costs of using edges from other agents with a proportional rule was to avoid it. But it seems necessary in any case, maybe we could comeback to an allocation of the total profits?