DIMENSIONING RESOURCES OF NETWORK SLICES FOR ENERGY-PERFORMANCE TRADE-OFF

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Partenaires

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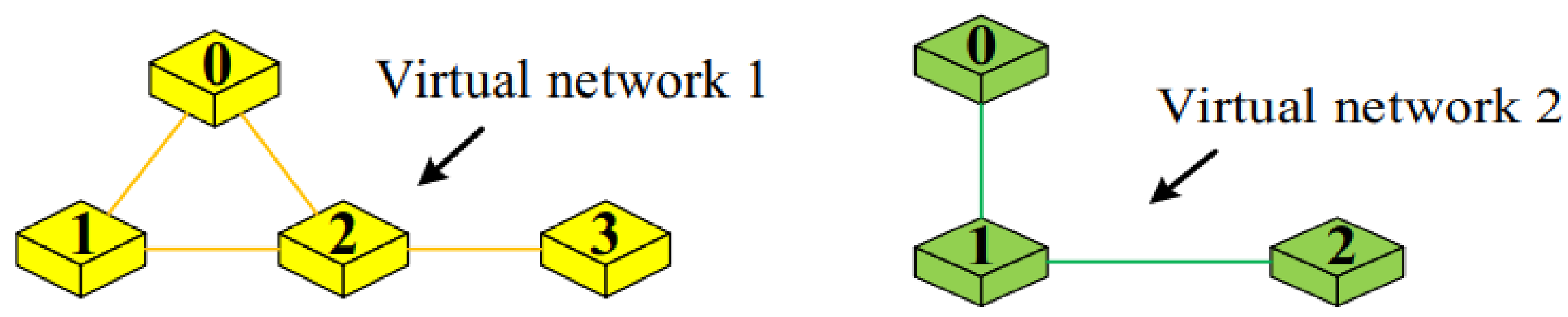
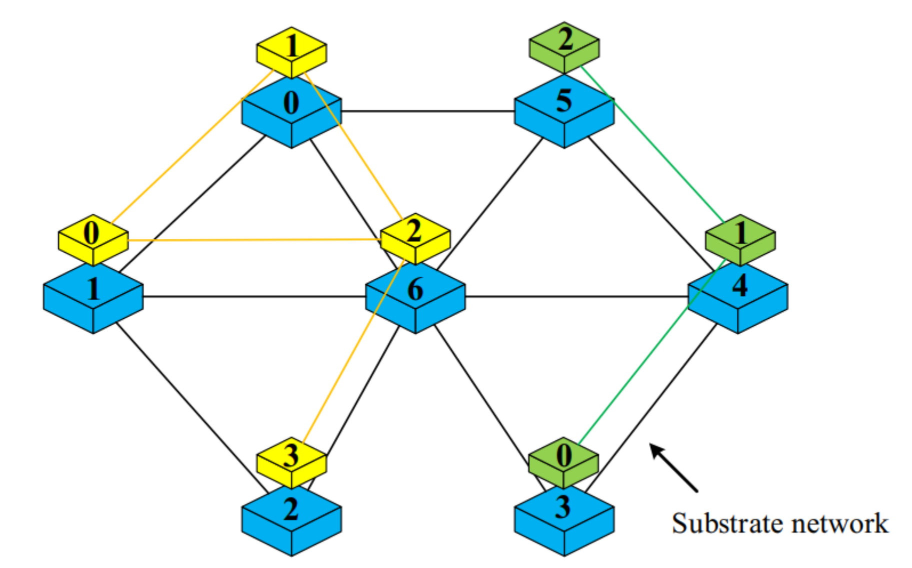
NETWORK SLICING

A SLICE CAN BE SEEN AS AN INDEPENDENT VIRTUAL NETWORK COMPOSED OF A SET OF VIRTUAL NETWORK FUNCTIONS





RESOURCE ALLOCATION PROBLEM DEFINITION

PHYSICAL NETWORK modelled as a graph G(V, E)

1. Each node v∈ V has CPU capacity R_V
2. Each edge (v ,v')∈ E has bandwidth capacity $R_{V,V'}$

SERVICE PROVIDER (SLICE)

1. Service Provider is deployed as a chain of n^s software components $\{c_i^S\}$ for i = 1, …,n^s

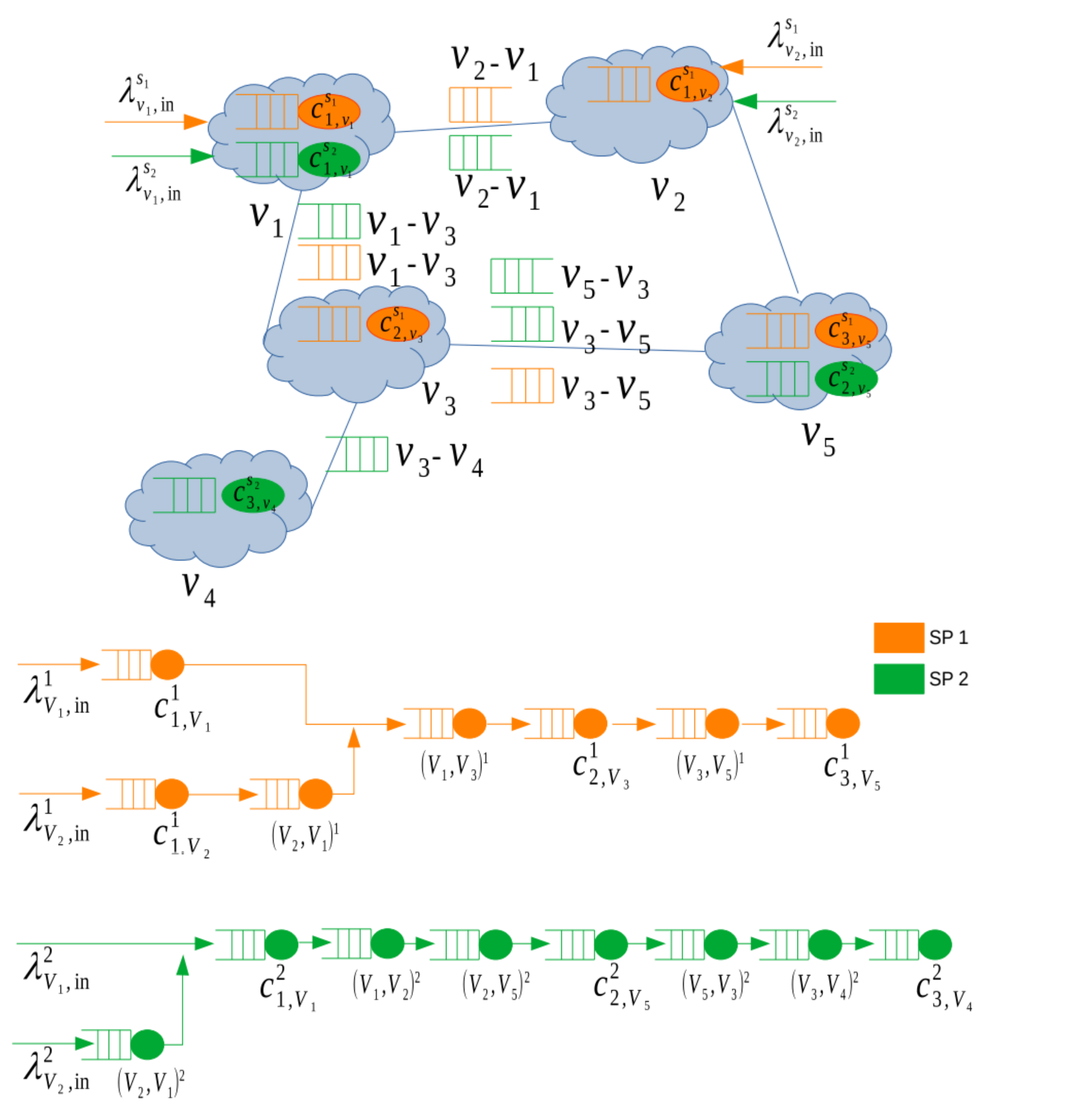
DECISION VARIABLES

1. $r_{i,v}^S$: The CPU allocated by the network operator to component replica $c_{i,v}^s$
2. $r_{i,v,i+1,v'}^s$: The bandwidth allocated by the NO for the communication between component replicas $c_{i,v}^s$ and $c_{i+1,v'}^s$

OBJECTIVE

1. **Minimize** total power consumption meanwhile satisfying the delay constraints of the different SPs

PROPOSED MODEL USING JACKSON NETWORK



OPTIMISATION FORMULA

$$\text{OptRes}: \min \sum_{v\in\mathcal{V}} \sum_{q\in\mathcal{Q}_v} P_{q.v}(r_q) + \sum_{(u,u')\in\mathcal{E}} P_{u,u'}(r_{u,u'}) \quad (6)$$

$$\text{s.t.} \quad \sum_{q\in\mathcal{Q}_v} r_q \le R_v, \forall v \in \mathcal{V} \quad (7)$$

$$\sum_{q\in\mathcal{Q}_{u,u'}} r_q \le R_{u,u'}, \forall (u,u') \in \mathcal{E} \quad (8)$$

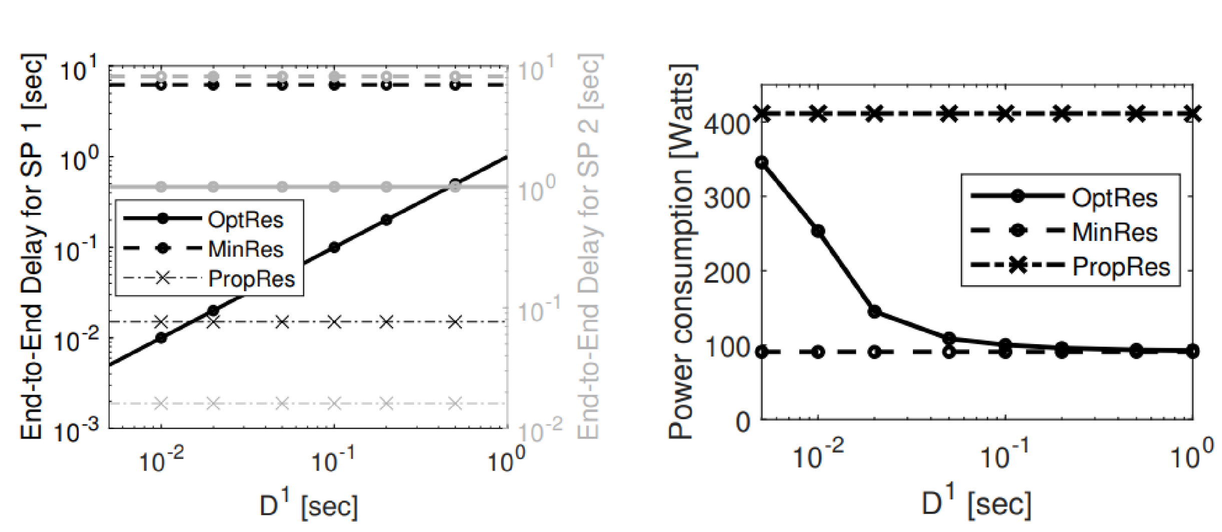
$$T^s\left(\{r_q\}_{q\in\mathcal{Q}^s}\right) \le D^s, \forall \text{SP } s \quad (9)$$

$$\mu_q(r_q) > \lambda_q, \forall q \in \mathcal{Q}^s \quad (10)$$

$$r_{u,u'} = \sum_{q\in\mathcal{Q}_{u,u'}} r_q, \forall (u,u') \in \mathcal{E} \quad (11)$$

1. Eqn(7)-(8) guarantee that we do not allocate, on nodes and links, more capacity than available.
2. Eqn (9) ensures that the average journey time of any request does not exceed the delay constraint of the respective slice.
3. Eqn (10) guarantees the stability of Jackson network.

NUMERICAL RESULTS



(a) Delay (b) Power consumption

Figure 3: Delay (SP1 in black and SP2 in grey) and system power used for different latency requirements D^1 of SP 1

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MinRes: Only the minimum resources needed to satisfy stability conditions (10) are allocated.

PropRes: All physical link and node resources are used: If a node v hosts replica $c_{i,v}^1$ of SP1 and replica $c_{j,v}^2$ of SP2, the allocation is $r_{i,v}^1 = \frac{\alpha_{c_{i,v}^1}}{\alpha_{c_{i,v}^1} + \alpha_{c_{j,v}^2}} \cdot R_v$, $r_{i,v}^2 = \frac{\alpha_{c_{ijv}^2}}{\alpha_{c_{i,v}^1} + \alpha_{c_{j,v}^2}} \cdot R_v$.

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