

Trading Service Level Agreements within a Peer-to-Peer Market

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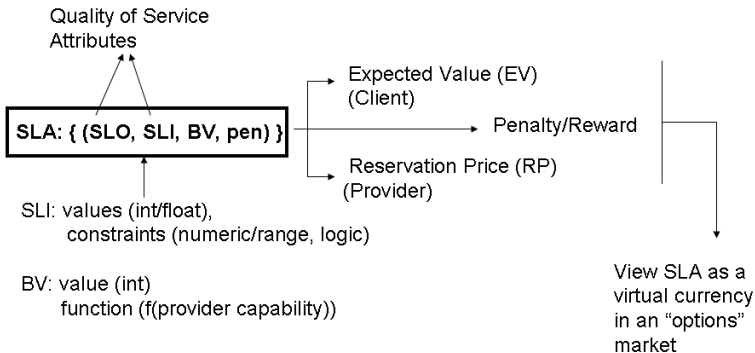
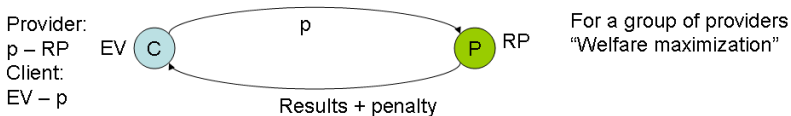
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General idea

Using computing resources as tradable objects in P2P systems – with SLA based access to these objects.

A key observation

An SLA is itself a “resource” – may be traded as an “option”. As it refers to *an allocation that has yet to take place*.

- User model: Availability of capacity that is not of interest to a user directly – but something already payed for.
- Provider model: Ability to support capacity planning – once sold, provider agrees to offer service. No need to re-establish contract or look for alternative buyers.
- Market model: Ability to aggregate capacity from multiple providers to provide a combined service.

Focus: How can we vary demand for SLAs, identify how SLAs are traded, and price SLAs to provide “welfare” within a community of users and providers

Complementary Currencies

Identify commonality with the use of complementary currencies – especially the circulation of such a currency.

- Work alongside a real currency – and need to be mappable – and also called “local money”
- Key issue: rate of exchange, circulation scope & value fluctuation over time
- Some currencies backed by real assets – e.g. gold, oil – and more interestingly services (i.e. amount of time spent by individual A for activity B)

Example usage:

- Encourages *localisation* of trade & relationships
- Encourages use of under-used resources
- Recognises an informal economy

Considerations

We use SLAs (Service Level Agreements) as tradeable objects within a P2P system

- SLAs are particularly useful when considering interactions in environments with limited trust between participants
- An SLA may be used for: (i) an expression/proof of debts as well as credits –debts to the client and credits to the service provider; (ii) as a token of exchange between participants; (iii) as an identification of responsibilities of participants involved (such as the client and service provider)
- An SLA refers to a service that is to be provided in the future, thus it is possible to consider an SLA-based options market

Previous alternative systems

- WAT is a debt-oriented (i.e. a capability is used before payment) approach based on WAT tickets, and provides an alternative currency to facilitate local exchanges.
- iWAT is the internet version of WAT that implements the WAT core and examines the problem of ticket exchange by designating the drawer as the responsible party for ticket authenticity
- Samsara concentrates on establishing service relationships between peers, minimising risk due to failure and claim, to ensure equivalence between the contribution and consumption of peer nodes.
- PPay is a token-based system which implements a protocol for coin assignment at the level of peer nodes using signature generation, verification and network messages.

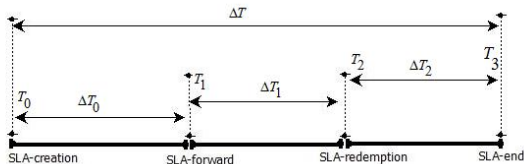
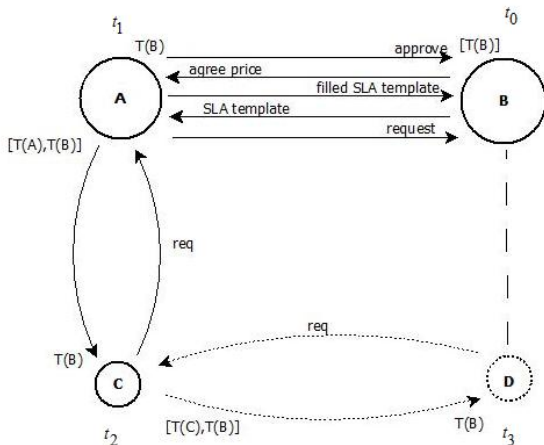


Figure: SLA Use: Time Line

- $\Delta T_0 = T_1 - T_0$: SLA held by the initial client
- T_1 : Client node no longer needs service identified in the SLA; or Client gets an offer from another node. Client forwards SLA and receives payment.
- ΔT_1 : forwarding (and payment) process may continue a number of times.
- ΔT_2 represents the time over which service execution takes place, and at T_3 the SLA expires and is no longer valid.

The workflow



The details of protocol

Operations

- SLA issuing $t_0 - t_1$
- SLA forwarding $t_1 - t_2, t_2 - t_3$
- SLA redemption t_3

Two types of provision:

- direct provision – those that it provisions through it's locally owned resources (corresponds to SLA creation)
- indirect provision – those that it defers to other providers through previously acquired SLAs (involves advertising SLAs that a provider already holds with others)

The details of protocol

Roles and responsibilities

- For issuing – $[T(B), \{t_1, t_2, \dots, t_n\}]$ identifies the list of services that node B can provide, where $t_i = SLA_B^X$ is an SLA that node B has with node X, and which node B is willing to trade. At this point node A holds an SLA with B (SLA_A^B) which has a monetary value (equivalent to what node A has paid node B)
- For forwarding – $[T(A), \{t_1, t_2, \dots, t_m\}]$ is the list of service that node A can provide. The client of the agreement has changed, as SLA_A^B becomes SLA_C^B , and the value of SLA_A^B is different from SLA_C^B .
- For redemption – occurs after an SLA has been agreed between two parties, and may take place after several forwarding operations. In the previous example, node D redeems the SLA with provider B.

Considerations

We calculate the economic benefit expressed in terms of profit or loss

- Cost during exchanges: $C_s = \sum_{i=1}^k P_{SLA_i}$; where P_{SLA} represents the price of one acquired SLA; k represents the number of SLAs that are acquired during the experiment;
- Income during exchanges: $I_s = \sum_{i=1}^k P_{SLA_i}$; where P_{SLA} represents the price of a sold SLA; k represents the number of SLAs that are sold during the experiment.

According to a probability distribution the system can express statuses by: Profit: $P_s = I_s - C_s$; and Loss: $L_s = C_s - I_s$.

Simulation environment

Simulator

PeerSim: Open source, Java-based simulation framework for developing and testing P2P algorithms in a dynamic environment.

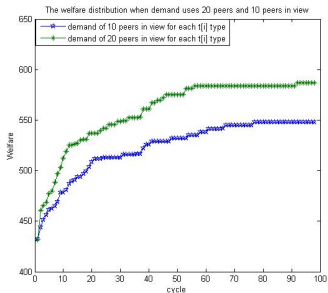
Our simulation:

- A *pay-before-use* payment scheme. Once paid, actual currency is not involved.
- Peer p_i provides one or more services s_i of type t_i . One type per peer in simulation.
- Type: storage, computation or aggregate – can be user defined
- $P = \{p_1, p_2, p_3, \dots, p_n\}$ – list of types $T = \{t_1, t_2, t_3, \dots, t_m\}$, where t_i represents the type of service that a set of peers $P_j = \{p_1, p_2, p_3, \dots, p_k\}$, ($P_j \subset P$)
- Demand based on a view parameter – how many peers are requesting a particular type of service at a given point in the simulation

Simulation Objectives

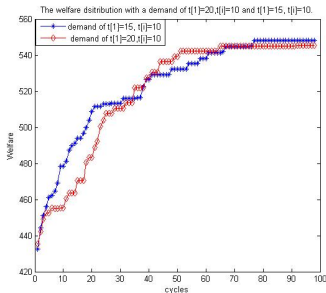
- SLA value fluctuates based on level of demand in the system – configuration parameter – defined by view
- $V.type_{c_{i+1}} = V.type_{c_i} \times f(d)$ – where c_i represents the i^{th} cycle of the simulation
- Evaluate the variation of budget (at start and at i^{th} cycle) associated with a particular peer, budget distribution: $B_i = \{b_1, b_2, b_3, \dots, b_n\}$.
- Identify a “Welfare” (W) metric – indicating the value benefit observed by a Peer over time – $W = \sum_{i=1}^n b_i$

Experiment 1



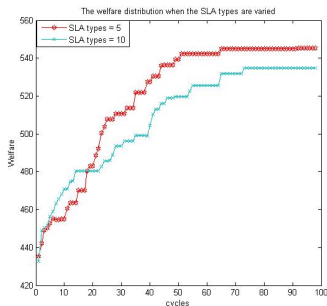
- Demand is varied from 20 peers to 10 peers in view for each t_i , $i = \overline{1, 10}$. View for each peer type set to 20 requesting peers.
- Configuration with 10 maximum issuing nodes and 10 maximum SLAs per node.
- After 60 cycles – no further SLAs being exchanged in the system – therefore no further trading takes place.

Experiment 2



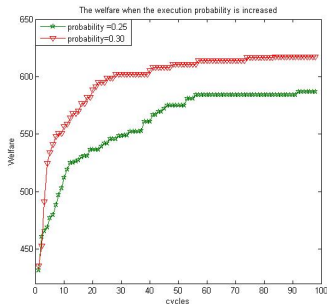
- Demand uses 10 peers in view for each t_i type (for $i = \overline{2, 10}$) and the view for t_1 being changed from 20 to 15 peers. 10 maximum issuing nodes and 10 maximum SLAs per node.
- Welfare affected by changes in any particular type – and relationship between types

Experiment 3



- 10 maximum issuing nodes and 10 max. SLAs per node – demonstrates Welfare with different SLA types.
- Demand is configured at 10 requesting peers for each t_i , $i = \overline{1, 10}$, in the context of 5, respectively 10 SLA types.
- Impact on Welfare based on diversity of SLA types being exchanged – keeping demand constant.

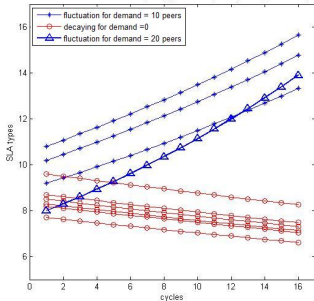
Experiment 4



- Execution Probability: controls transition between the issuing and the forwarding process.
- The experiment is configured to use 10 maximum issuing nodes and 10 maximum SLAs per node. The demand is configured to 20 requesting peers for each t_i type, $i = 1, 10$.
- Increase in exchange increases welfare

Experiment 6

The fluctuation for a demand of 20 requesting peers for t_1 , 10 requesting peers for t_2, t_3, t_4



- Use 10 SLA types, with significant demand for only one type, in this case t_1 , and less demand for other types t_2-t_4
- Keep user count fixed – hence increase in one type influences other types.
- Relevant when considering resource aggregates – i.e. combining storage and computation.

Conclusions

The benefit of the system is influenced by:

- the number of participants
- the level of demand – identified by the “view” parameter in our simulation
- type of SLAs used – and variation in demand based on SLA types

Using the view of peers (i.e. how many partners a peer can trade with) we demonstrate that:

- the benefit depends on the view parameter
- greater exchange leads to greater welfare – and influenced by the time period over which exchange takes place (execution probability)

- Scalability:
 - Increasing number of participants in the market.
 - Increase diversity of SLA and participant types.
- Real business applicability:
 - Use within a Re-seller market
 - Used by a broker to support service aggregation