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CloudMTD: Using Real Options to Manage Technical Debt in Cloud-Based Service Selection

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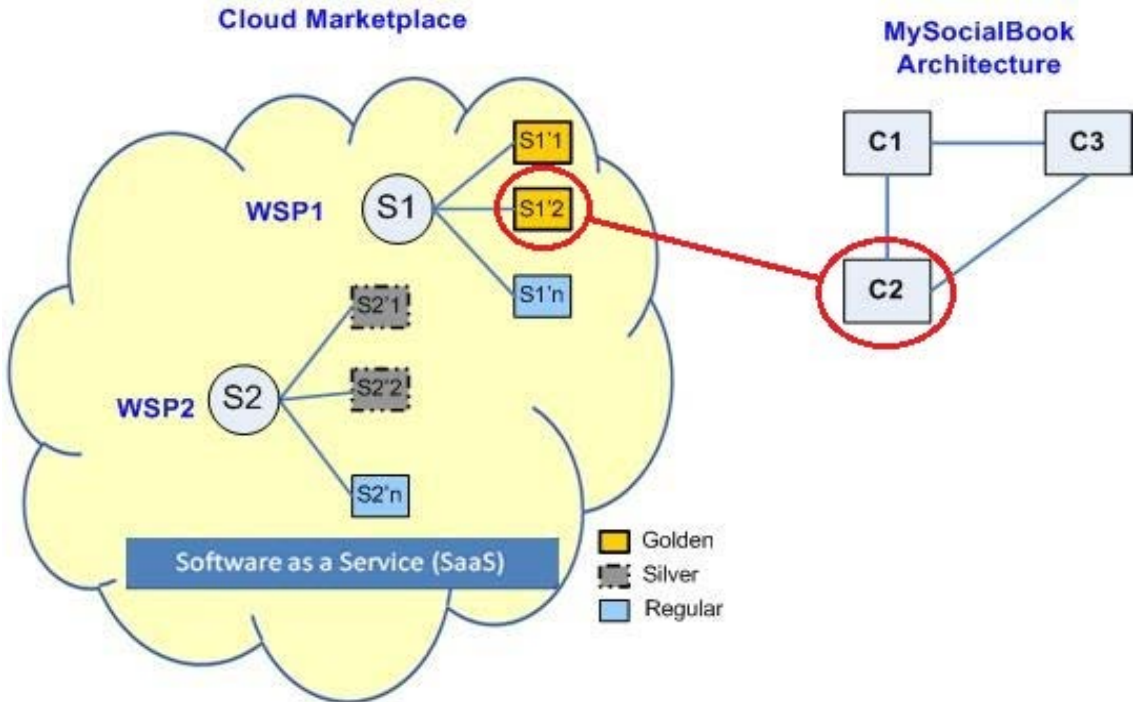
Paper Contribution

- Introduced the concept of Technical Debt on service-level.
- Described situations leading to Technical Debt on service-level.
- Unlike the classical work on cloud-based service selection and composition, we used Technical Debt as an additional dimension to inform the selection decisions.
- Modeled the Technical Debt using Real Options.

Context: Cloud Services Substitution

- Cloud as a marketplace [Buyya et al. 2009].
- Cloud-based architectures can be composed of web services.



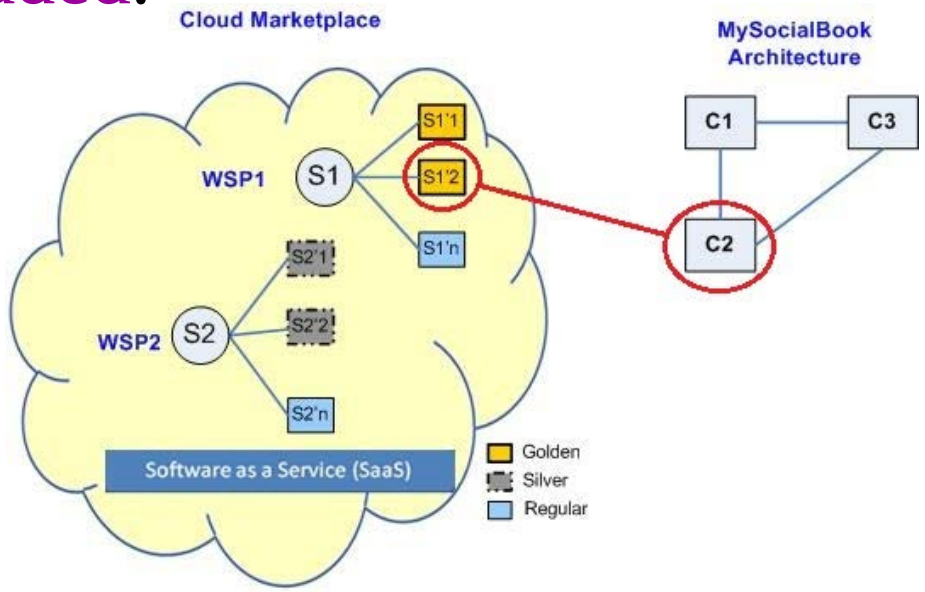
Cloud Services Substitution

- The need for Cloud-Based service substitution could be driven by business objectives or a technical ones.
  - Changes in QoS requirements.
  - Improving operational cost.
  - upgrading to a new web service.

Need: Cloud Services Substitution

- Research has focused on technical aspects in selecting web services (QoS and cost).

- None of the approaches, have linked selection decision to technical debt and long-term value-added.



Hypothesis: Cloud Service Selection

- Dynamic composition of cloud-based architectures through substitution can introduce a technical debt, which needs to be monitored, and managed for value creation.

Current Focus: Technical Debt

- Brown et al. (2010) reported that:

  "*like financial debt, technical debt incurs interest payments in the form of increased future costs owing to earlier quick and dirty design and implementation choices.*"

- Representative applications:
  - Code-quality and refactoring,
  - Software architecture,
  - Documentation, and
  - Software testing.

Technical Debt in Cloud Services and Architectures

- Technical debt in cloud-based architectures can be attributed to poor and/or quick substitution and composition decisions.

Origins of Technical Debt in Cloud Architectures

Technical debt in cloud-based architectures can be caused by:

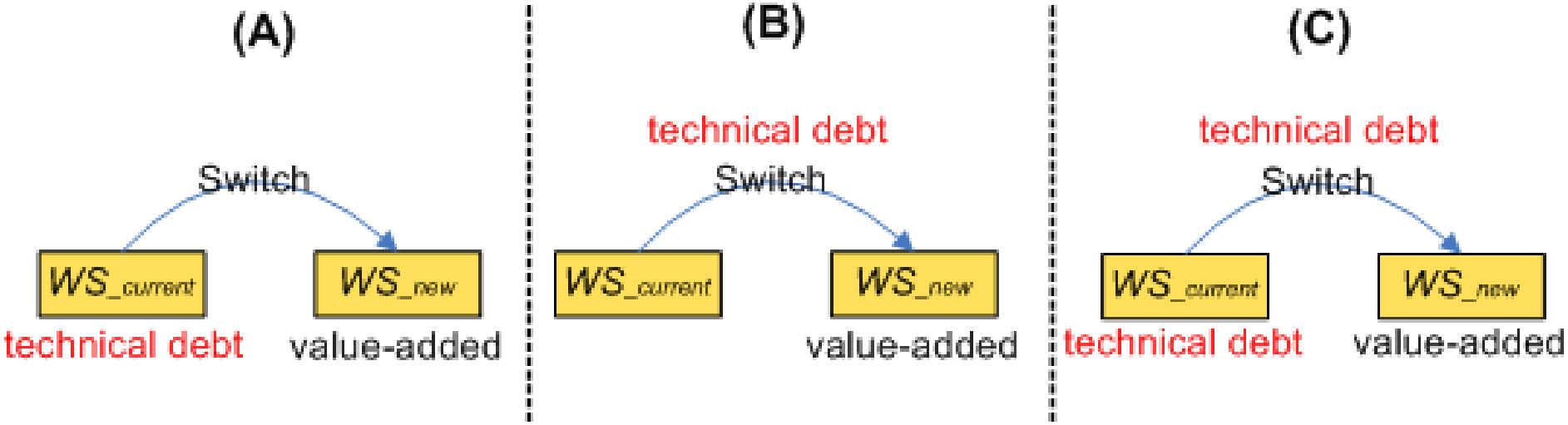
- Possible mismatch of the service features and applications' requirements.
- Likely SLA Violations.
- Under- or overutilization: demand and supply dynamics.
- Accidentally from providers to consumers

Origins of technical debt

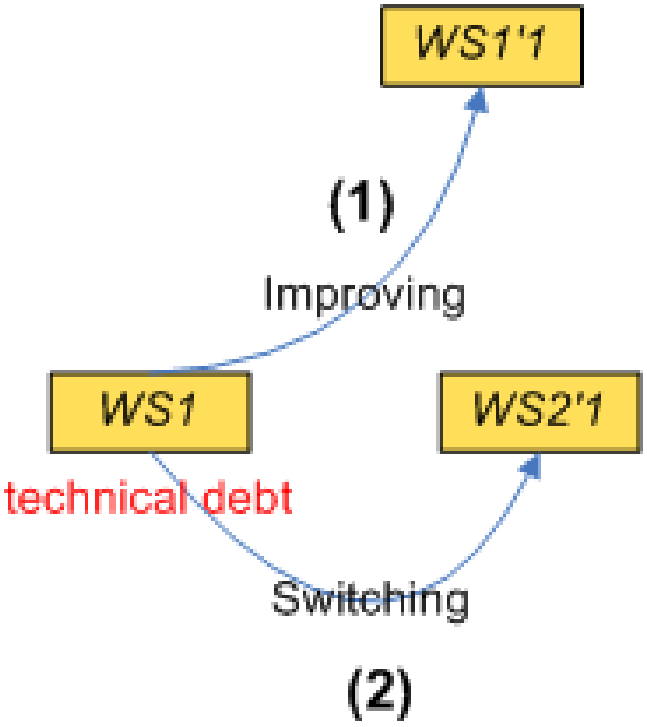
- Unintentional: that is because of bad and quick web service selection decision (unsuitable selection decision).

- Intentional: that is when we decide to take on a technical debt in order to gain future value-added or to clear the current technical debt.

Technical Debt positions on service-level



Example of actions for Managing Technical Debt on service-level



$$TD_{Switch/Impr} + TD_{NewS} << TD_{CurrS}$$

Scenario: Capacity Provisioning

- MySocialBook needs to select a service from the cloud.
- Likely future load is uncertain and cannot be predicted; therefore the value of the selection is uncertain and cannot be predicted.
- Overprovision or under-provision can lead to Technical Debt.
- Valuing flexibility of service selection under uncertainty can help in understanding the significance of technical debt on the new selection and compare it to the switching cost.

Options Perspective to Managing Technical Debt

- We value the flexibility of the provision under uncertainty using Real Options (Growth) to quantify the Technical Debt.
- The value can help in understanding the presence of Technical Debt, when it can be cleared, the behavior of Technical Debt relative to time and its dynamics.
- Assumptions: technical debt on the load dimension.

Options Perspective to Managing Technical Debt

- We model the selection of a web service as a Call Option:

  "The right - but not the obligation - to buy an asset (web service), where there is a potential benefit associated with exercising this option."

- Binomial Model is used for valuation.

Options and Technical Debt for Load Scenario

- *Positive Technical Debt scenario:*
  - If the value of the call option generated from supporting the load exceeds the switching cost, then the flexibility of the selection decision relative to the change in load is likely to pay off
  - Clearing the debt on the load, if the option is exercised.
- *Negative Technical Debt scenario:*
  - If the value of the call option generated from supporting the load continues to be zero (i.e. lags behind the switching cost).

Conclusion and Future Work

✓We have introduced a new concept of technical debt on service-level.

✓Analyzed the origin of Technical Debt for service selection.

✓We have taken an option-based approach to quantify the technical debt using growth options.

✓In future, we will look at different scenarios for managing the technical debt using options.

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Thank You!

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