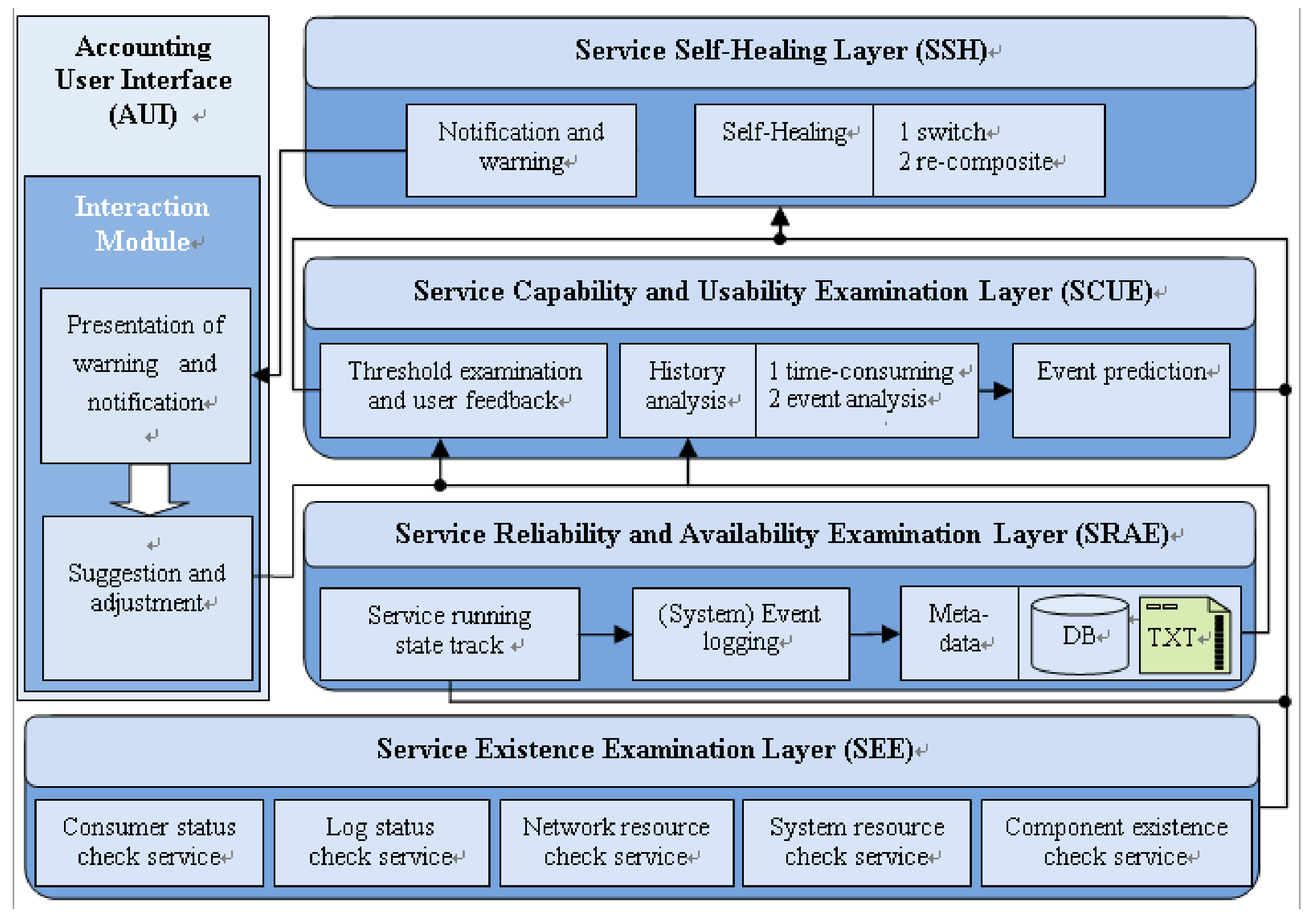
An Accounting Framework for Federated Service-Oriented Architecture

Peng Su, Zhengping Wu
Department of Computer Science and Engineering
University of Bridgeport, Bridgeport, CT
pengsu@bridgeport.edu, zhengpiw@bridgeport.edu

Abstract

Service-Oriented Architecture (SOA) is used in more and more scientific and business applications. But self-examination and adaptation are overlooked by most system designers. Extant service accounting functionalities mainly focus on error causes, which are insufficient for history analysis and event prediction. This paper not only analyzes system events from both service consumers and providers, but also, starting from Maslow's needs hierarchy, provides a layered accounting framework for service federations. More than that, in matching and prediction model, a pipeline approach is employed rather than deterministic finite automaton (DFA), and a dependence estimator algorithm is introduced avoiding the deficiency in naïve Bayes network for machine-learning and prediction. And then, based on these modules, a self-healing layer is built up to achieve decomposing, ranking, re-composing functionalities.



Service Accounting Framework

Avižienis defined accountability only as the availability and integrity of a person who performed an operation for dependable and secure computing. More than that, in FSOA, accountability can be extended to five aspects following the Maslow human-needs theory, as illustrated in the figure above.

1.Service Existence Examination (SEE): check system resource and federated components' existence.

2.Service Reliability and Availability Examination (SRAE): examine whether the system components are reliable and available for providing services.

3.Service Capability and Usability Examination (SCUE): monitor services' performance in federated SOA.

4.Service Self-Healing (SSH): inform consumers the occurrence or the probability of system irregularities and heal the relevant services in case of the occurrence of system abnormalities and irregularities.

5.Accounting User Interface (AUI): interact with consumers to present warning messages and notifications received from SSH, and provide suggestions and adjustment advices according to various system messages.

Advantages for Learning and Prediction

1 Number based Logging System

Following the definition of "The Syslog Protocol", eight (0-7) levels (types) of logs are designed for the entire system and individual services respectively.

2 Refined Matching Algorithm

Among pattern matching algorithms, deterministic finite automaton (DFA) and cached deterministic finite automaton (CDFA) seems to be good choices. For most of the solutions, Aho-Corasick (AC) and its derivative algorithms are widely used. They are based on the DFA model but utilize large amount of memory because of so many transition rules and cross links. So, in this paper, we introduce a pipelined processing approach called pipelining Aho-Corasick (P-AC) that can remove all cross links in the DFA state graph.

3 More Robust Prediction Solution

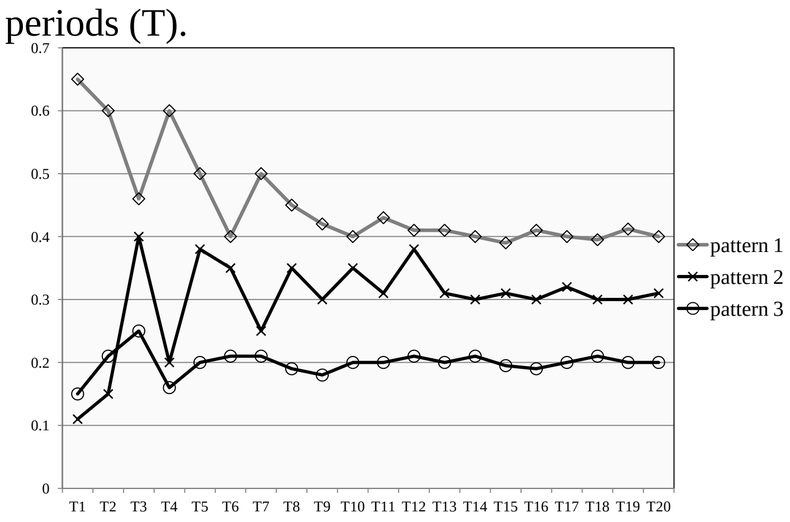
As soon as P-AC locates certain event, this module invokes prediction procedure adopted from averaged One-Dependence Estimators (AODE) to make a prediction. Simultaneously, the upcoming event will be transmitted to AUI, and occurrence of irregularity will trigger the functions of SSH to heal the system.

$$P(y \mid x) = \frac{\sum_{i:1\le i\le n} P(y \mid x_i) \prod_{j=1}^{k} P(y, x_j \mid x_i)}{\sum_{y\in Y} \sum_{i:1\le i\le n} P(y \mid x_i) \prod_{j=1}^{k} P(y, x_j \mid x_i)}$$

$$x \in (X \mid x_1, x_2, ..., x_i, ...x_n) \quad y \in (Y \mid y_0, y_1)$$

Implementation and Experiment

After implement this framework on a federated service platform, we accumulate some patterns that can cause irregularities. Simultaneously, following a learning process and using AODE to make a prediction for the patterns, we find the probabilities that patterns predicted become more steady and more accurate with the increase of time. Therefore, in the following figure, we present them to illustrate the relationship availability between prediction accuracy and time periods (T).



Conclusion

Following the requirement definition of QoS for FSOA, the proposed accountability framework in this paper is not only able to keep the existence of services but also perform quantitative history analysis, real-time monitor, and prediction. Especially, it is designed for federated service environments as well as consumer-provider mode, where the objects of accounting can be a service, provider, consumer or a system. system, and thus take a better performance for the providers and consumers.