QUEUE MANAGEMENT IN DISTRIBUTED INFOCOMMUNICATION SYSTEMS WITH SERVICE ORIENTED ARCHITECTURE

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Abstract — In this work a mathematical model of active queue management in a system with Service Oriented Architecture (SOA) according to a Random Early Detection algorithm is presented. Analysis of the algorithm efficiency for overload prevention in SOA systems is done. Influence on the system performance of such algorithm's parameters as mark probability denominator, minimal and maximal threshold values of queue length is studied. Recommendations on selection of the values of algorithm's parameters to increase the efficiency of overload prevention in distributed infocommunication SOA systems are formulated.

УПРАВЛЕНИЕ ОЧЕРЕДЯМИ В РАСПРЕДЕЛЕННЫХ ИНФОКОММУНИКАЦИОННЫХ СИСТЕМАХ С СЕРВИС-ОРИЕНТИРОВАННОЙ АРХИТЕКТУРОЙ

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Аннотация — В работе представлена математическая модель активного управления очередями в системе с сервис-ориентированной архитектурой (Service Oriented Architecture, SOA) в соответствии с алгоритмом произвольного раннего обнаружения (Random Early Detection, RED). Проведен анализ эффективности данного алгоритма для предотвращения перегрузок в системах SOA. Исследовано влияние на работу алгоритма таких его параметров как показатель граничной вероятности, минимальное и максимальное пороговые значения длины очереди. Сформулированы рекомендации по выбору значений указных параметров для повышения эффективности борьбы с перегрузками в распределенных инфокоммуникационных системах SOA.

I. Introduction

The onrush of technologies of virtualization and cloud computing and introduction of "Everything as a Service" (EaaS) concept that one can see during the last years raises new requirements to telecommunication infrastructure providing communication in these complex distributed infocommunication systems. Today most of such systems are built according to a Service Oriented Architecture (SOA) approach [1]. When SOA is used, all system functions are represented as independent distributed components – services, which can be both whole applications and their separate functional modules. These services allow providing different business-processes communicating over the network in a certain sequence. Services must have standardized interfaces to ensure their reusability for development of new applications as well as modification and enhancement of existing ones. Interaction of services is realized according the principle of "publishing-search-connection" (fig. 1): application that provides a certain service (service provider) places information about it in a service catalogue (repository). Service consumer — application that needs functionality of this service, finds information about it in repository to establish connection with this service and send a request.

One of the key roles in providing the required quality of service when such a complex service is proposed belongs to a Service Level Agreement (SLA). So the methods of control of system (computer and network) resources become very important. These methods include such mechanisms as queue management, load balancing, traffic control [2]. Methods of active queue management (ACM) are one of the most important in preventing the system overload by dropping the packets from queue (fig. 2). The Active Queue Management (AQM) algorithms based on average queue length such as Random Early Detection (RED) algorithm studied in this work are the most popular and most challenging [2, 3]. Though their efficiency for SOA systems at different values of parameters of the algorithm still needs to be studied.

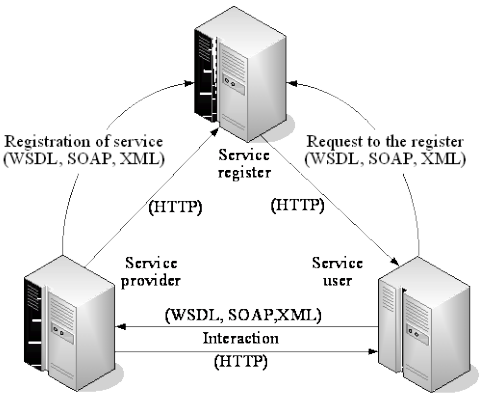

Fig. 1. Principle of "publishing-search-connection" in distributed SOA systems

Рис.1. Взаимодействие сервисов по принципу «публикация-поиск-соединение» в распределенных системах SOA

II. Main Part

The RED algorithm is based on calculation of the average queue length [3] according to the next formula:

$$avg = (1 - W) \cdot avg + W \cdot q \qquad (1)$$

where W — weight of a queue, $W = 2^{-\frac{1}{n}}$; n — exponential weight; q — current queue length.

 ISBN: 978-966-335-395-1. IEEE Catalog Number: CFP13788

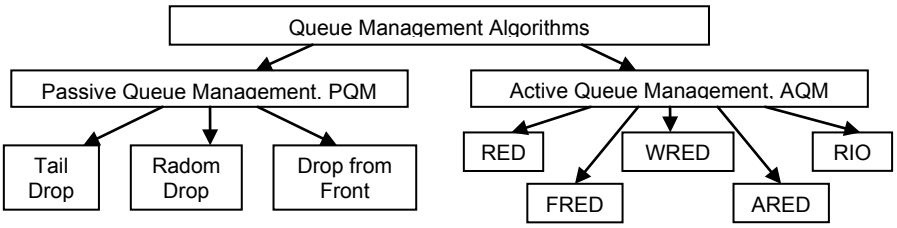

Fig. 2. Queue management algorithms classification.

Рис. 2. Классификация алгоритмов управления очередями

The probability of packet dropping depends on average queue length and RED algorithm parameters: mark probability denominator max_p and minimal and maximal threshold values of queue length — min_th and max_th respectively:

$$P_a = \begin{cases} 0, & avg < min\_th \\ max\_p \cdot \dfrac{avg - min\_th}{max\_th - min\_th}, & min\_th \le avg < max\_th \\ 1, & max\_th \le avg \end{cases} \quad (2)$$

The model of queue management according to the RED algorithm was developed using Coloured Petri Nets (CPN) [4]. The CPN module of queue management was integrated into the hierarchical Petri Net model of distributed SOA system described in [5]. Simulation was carried out in CPN Tool program package.

Results of studying the influence of minimal threshold value of queue length on efficiency of RED algorithm is presented on fig. 3, 4.

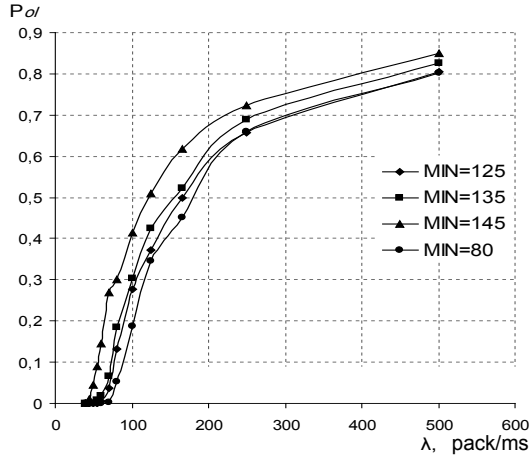

Fig. 3. Diagrams of dependency of packet loss probability on intensity of input traffic at different minimal threshold values of queue length.

Рис. 3. Графики зависимости вероятности потери пакетов от интенсивности входного трафика при различных минимальных пороговых значениях длины очереди

The diagrams show that increasing this parameter leads to decrease of packet drop probability and thus increases the probability of buffer overflow, reducing the efficiency of the algorithm.

III. Conclusion

A mathematical model of active queue management based on Coloured Petri Nets is presented. Analysis of efficiency of the Random Early Detection algorithm for overload prevention in systems with Service Oriented Architecture is done. The carried out research has shown that the RED algorithm shows the better efficiency at lower minimal threshold values of queue length min_th and higher maximal threshold values max_th. Increasing the value of mark probability denominator max_p also helps to prevent the buffer overflow making the performance of the SOA system more efficient at high load conditions, though when the load factor exceeds the value of 2 the efficiency of the RED algorithm decreases and loss as a result of “tail drop” mechanism is unavoidable.

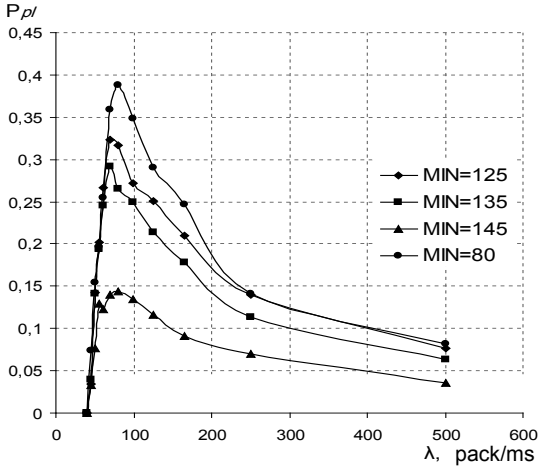

Fig. 4. Diagrams of dependency of packet drop probability on intensity of input traffic at different minimal threshold values of queue length.

Рис. 4. Графики зависимости вероятности отбрасывания пакетов от интенсивности входного трафика при различных минимальных пороговых значениях длины очереди

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2013 23rd Int. Crimean Conference “Microwave & Telecommunication Technology” (CriMiCo’2013). 9—13 September, Sevastopol, Crimea, Ukraine