



Effective Capacity Analysis on Communication of Blockchain Synchronization Software-Defined Industrial Internet of Things

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Abstract. For the blockchain network, the status of the account is saved via the checkpoint nodes, and updated. These knots are decentralized connected to each other. To get the current status, the IOT device must synchronize with the blockchain replica stored in the test bench. Delay prediction is an important indicator, to define the performance of software block chain Internet of things to knives. Based on the transport model generated by the synchronization protocol and the effective capacity (EC) theory of the wireless channel, the connections of QoS requests and key parameters of the synchronization protocol are studied. Simulation results show the effect of the new block creation rate on QoS level.

Keywords: Software Defined Networks · Quality of Service · Internet of Things · Blockchain · Effective Capacity Analysis

1 Introduction

The network of blockchains is one important point in the information system [1, 2]. Thanks to the decentralized communication mechanism, which is used only for Internet of Things (IoT) network [3–5]. In recent years, the new research point of network architecture has changed to be algorithms of network routing [6, 7]. Many people focus on analysis of network and traffic behavior, which contributes to make improvements of Quality of Service (QoS), which is the main objective of optimizing traffic forecasts [13–16]; Through traffic forecasting, several important indicators (KPI) can be optimized [17–19]. These optimized KPIs include frequency efficiency [20–23] and energy efficiency [24–26]. Several traffic flow forecasting methods are proposed [27–29]. On the IoT internet, with limited resources, these optimizations are more important. Under some restrictions, a channel Limited capacity and an effective capability (EC) associated with the service [30–34] are analyzed. The focus of the survey in analysis is to measure network flow and rebuild river flow [35–37]. The IoT network communication efficiency defined by the software is analyzed.

Researchers have discovered that many antennas improve Spectrum efficiency and user experience. In this area, researcher studies that the arrival of traffic may affect the

quality. The service researchers study the number of scheduled users and QoS requests [38], while [39] studies some synchronization protocols between single network devices and blockchain networks, and assesses the quality impact of the communication link and blocks chain parameters in the synchronization process. Result show that we should also consider communication parameters in the design of the chain service cycle and block device. This paper is divided into five sections. In the second section, system model is introduced. Simulation parameters and results have been showed in the third section. Finally, our conclusions come to the fourth section.

2 System Model

According to reference [39], exchange of model data expected by protocol P1 depends on the fact that device u is static or inactive to the implementation of protocol. Especially, when u wakes up, run the next sequence: firstly, u require new blocks from each of the BN nodes through the message of 1 block queue. After that, choose BN node to cast its new-block. The synchronization process can also inform u of the selection of BN to receive blocks. The Fig. 1 shows such a procession of requests and casts of blocks.

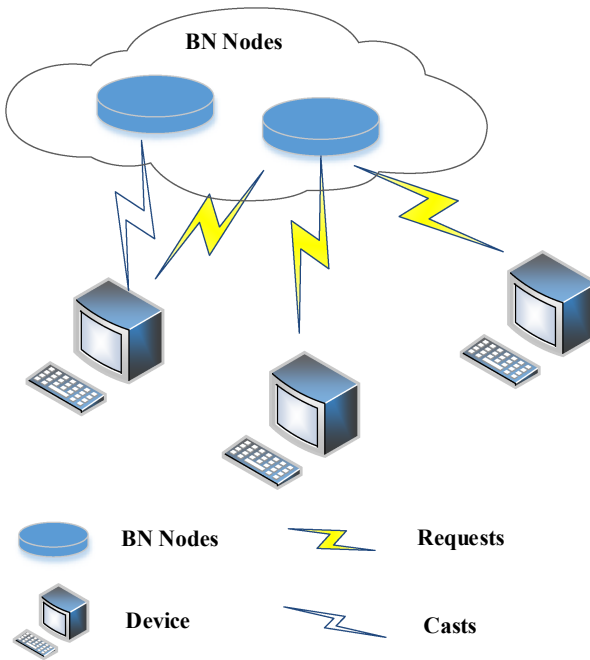


Fig. 1. Devices require new blocks from each of the BN nodes through the message of 1 block queue. After that, choose BN node to cast its new-block

The number of new blocks X_k is observed as an irreducible positive recursive Markov process. In order to analyze its likelihood of transition, we analyze the samples that

depend on the protocol used, derived from the following paper probability of the transition from state $X_k = n$ to $X_{k+1} = m$, where the state equals to amount of missing blocks in blockchain local copy, depending on whether u is inactive between X_k and X_{k+1} [39]:

$$P[X_{k+1} = m | X_k = n] = (1 - p_s) \cdot p_{s_0}(m|n) + p_s \cdot p_{s_1}(m|n) \quad (1)$$

Where $p_{s_0}(m|n)$ is the probability of the case that u stays active when implementing two protocols, which is the probability that blocks arrive during the protocol execution time t_p :

$$p_{s_0}(m|n) = \int_0^\infty p_{s_0}(t_p|n) \frac{(\lambda_B t_p)^m}{m!} e^{-\lambda_B t_p} dt_p \quad (2)$$

The λ_B is the parameter of P arriving, t_s is sleeping period. In other cases, u sleeps between X_k and X_{k+1} , the protocol execution time, depending on n and the number of blocks accumulated during inactive time, expressed by q .

$$\begin{aligned} p_{s_1}(m|n) &= \sum_{q=0}^{\infty} p(m|n, q) p(q) \\ &= \sum_{q=0}^{\infty} \left(\int_0^\infty p_{s_1}(t_p|n, q) \frac{(\lambda_B t_p)^m}{m!} e^{-\lambda_B t_p} dt_p \right) \frac{(\lambda_B t_s)^q}{q!} e^{-\lambda_B t_s} \end{aligned} \quad (3)$$

The device send message by Δt_x . In case that u is awake and synchronized, the protocol execution time is

$$\begin{aligned} t_{s,1} &= \Delta t_{s,1} + \Delta t_{s,2} + \Delta t_{s,3} \\ &= g_{DL}^{-1} l_r + t_w + g_{UL}^{-1} l_r + g_{DL}^{-1} l_b. \end{aligned} \quad (4)$$

If u is awake and not synchronized, the duration of the execution is a function of the number of missing blocks n :

$$\begin{aligned} t_{w,1}(n) &= \Delta t_{w1,1} + \Delta t_{w1,2} + \Delta t_{w1,3} + \Delta t_{w1,4} \\ &= g_{UL}^{-1} N l_n + g_{DL}^{-1} N l_r + g_{UL}^{-1} l_n + g_{DL}^{-1} n l_b. \end{aligned} \quad (5)$$

The distributions of the protocol execution time t_p are then

$$p_{s_0}(t_p|n) = \begin{cases} \delta(t_{s,1}) & n = 0 \\ \delta(t_{w,1}(n)) & \text{otherwise,} \end{cases} \quad (6)$$

$$p_{s_1}(t_p|n, q) = \delta(t_c + t_{w,1}(n + q)), \quad (7)$$

where $\delta(\cdot)$ is the Dirac. If u inactive for protocol execution, the connection time t_c should be included as well:

Define $t_a(k) = t_c + t_{w,1}(k)$, and the Eq. (2) and (3) can be rewritten as [39]:

$$p_{s_0}(m|n) = \begin{cases} \frac{(\lambda_B t_{s,1})^m}{m!} e^{-\lambda_B t_{s,1}} p_M, & n = 0 \\ \frac{(\lambda_B t_{w,1}(n))^m}{m!} e^{-\lambda_B t_{w,1}(n)}, & \text{otherwise} \end{cases} \quad (8)$$

$$p_{s_1}(m|n) = \sum_{q=0}^{\infty} \left(\frac{(\lambda_B t_a(n+q))^m}{m!} e^{-\lambda_B t_a(n+q)} \right) \frac{(\lambda_B t_s)^q}{q!} e^{-\lambda_B t_s} \tag{9}$$

In wire networks, the switches and routing devices often use the dampers when the arrival speed of the service source is greater than the EM transmission speed in a short period of time. Suppose these networks channels are stable, so the most important problem is that the characteristics of the arrival column. Therefore, the key problem is that the characteristics of the arrival columns indicate that the peak and medium speed analysis may change the rate of arrival. It described that QoS problem is generally considered as the relationship between the system envelope and the transmission capacity. In IoT blockchain networks, the arrival rate is time-varying, which is depended by the new blocks.

The QoS requirements are showed as [38]

$$P_r \left(\max_{1 \leq i \leq N} Q_i(0) > B \right) \leq \epsilon. \tag{10}$$

For a large buffer size B , given a QoS constraint ϵ and by choosing $\theta = -\log(\epsilon)/B$, the QoS requirement can be expressed as an EC problem:

$$\lambda \leq \min_{1 \leq j \leq N} C_k(\theta) \tag{11}$$

Where

$$C_k(\theta) = \frac{1}{\theta} \lim_{n \rightarrow \infty} \frac{-1}{n} \ln E \left(e^{-\theta \sum_{t=1}^n r_k(t)} \right) \tag{12}$$

and $r_k(t)$ is the rate allocated to user k in cell j at time t . Assuming these devices share a common channel, the number of devices receiving new blocks increases, and the opportunity for devices to acquire blocks decreases.

$$r_k(t) = \begin{cases} r & \text{W.P.1 - P}(X_{k+1} = 0 | X_k = 0) \\ 0 & \text{W.P. P}(X_{k+1} = 0 | X_k = 0) \end{cases} \tag{13}$$

In this case, the effective capacity can be written as:

$$C(\theta) = \frac{1}{\theta} \lim_{n \rightarrow \infty} \frac{-1}{n} \sum_{\tau=0}^n e^{-\theta \tau} P \left\{ \left(\sum_{t=1}^n r_k(t) \right) = \tau \right\} \tag{14}$$

Finally, the EC of device can be formulated as:

$$C(\theta) = \frac{-1}{\theta} \ln \left(1 - \frac{1 - e^{-\theta r}}{K(1 - P(X_{k+1} = 0 | X_k = 0))} \right) \tag{15}$$

3 Simulation and Results

This article studies the relationship between QoS requirements, as well as the sleep time of blockchain devices in IoT networks. We use the BN for simulating simple scenes. The sleep interval is [10, 2000], and the QoS parameters vary from 0.1 to 0.9. The channel capacity is stable with a value of 100.

The results of the simulation are shown in the Fig. 2. Increasing sleep time is a powerful first step in reducing EC experience, which means building new ones blocks collections. The high value of θ means QoS strict of request. EC get reduced as increasing the quality of QoS requests (Fig. 3).

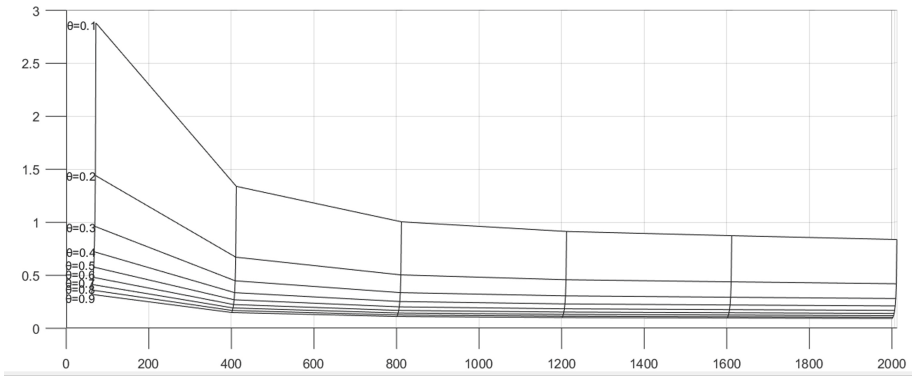


Fig. 2. Effective capacity Vs. sleeping period with fixed QoS request.

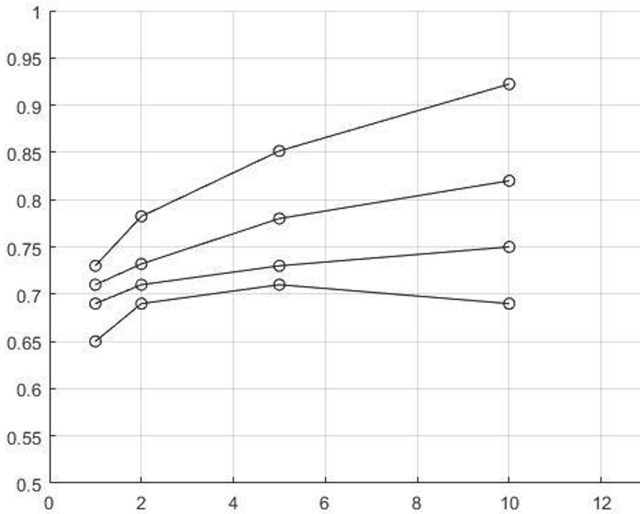


Fig. 3. QoS varies and increases quickly as sleeping period increases.

4 Conclusion

In recent years, the blockchain protocol has sparked great interest from researchers and industry. It seems a promising technology, but it is immature. This protocol family of bitcoin specification proposes a password-based solution that tries to replicate several parameters in a block chain synchronization protocol consistent database distributed by a network not licensed. The device sleep time, energy efficiency and reaction time of the new equipment are affected, either. Using our effective capability model on the street, the results of the summary sleep time simulation and the study of the QoS requirement ratio show that the emergence of the TEM sleep time has a significant impact on the requirements of the QoS. This is useful for designing network synchronization strategy from the block chain.

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