## Supplemental Material

In this supplemental material, we introduce the method to predict the transition probability for $G_N$. As mentioned in the paper, we make use of the analytical model proposed by Desnoyers [13], particularly, a non-uniform traffic case model. We can predict WAF of $G_N$ by setting variables of the model to reflect the characteristic of input workloads in $G_N$. The WAF value can be estimated by the following Eq. 1, where $\alpha$ is the ratio of valid blocks in the system (i.e., utilization), $r$ is the traffic ratio of hot blocks among all incoming requests, $f$ is a fraction of hot blocks in the entire logical space, and $A$ is the WAF.

$$A = 1 + \frac{r}{e^{\frac{r}{f}\frac{\alpha}{A}}} + \frac{1-r}{e^{\frac{1-r}{1-f}\frac{\alpha}{A}} - 1} \tag{1}$$

The values of $\alpha$, $f$, and $r$ can be easily obtained by referring to the system information and UID. First, $\alpha$ is obtained by dividing the number of valid data blocks in $G_N$ by the size of $G_N$. To get the value of $r$, we utilize UID again. In the Desnoyers' model, hot blocks are defined to be blocks that have update intervals shorter than the average update interval. Using UID, we can easily calculate the ratio of hot blocks. Finally, obtaining $f$ requires more thought. Consider that $p_j$ is a probability for update interval $j$ in UID. The total number of blocks updates to construct UID is equivalent to the length of an epoch, $L_e$. The number of blocks that have been updated at the update interval $j$ is $p_j \times L_e$. Suppose that only a single unique block is written over the epoch with the update interval $j$. $\frac{L_e}{j}$ represents how many times it has been written over the epoch. Data blocks arriving at $G_N$ are likely to have weak temporal locality with little skewness. Under this assumption, we can estimate the number of unique blocks as $\frac{p_j \times L_e}{\frac{L_e}{j}}$. Then, we can calculate $f$ by the number of unique blocks with $\alpha$. After calculating WAF, the transition probability for $G_N$ can be calculated as $TR_{V_{G_N} \to V_{G_N}} = 1 - \frac{1}{WAF}$.