

Partitioning Caching: Reduction for Composable Web Services in Network Caching

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Abstract

Faced with the issue of substance circulation effectiveness in the host-driven engineering, ICN has developed as a promising system design as of late. In-arrange reserve as a center capacity in ICN can enormously improve the substance appropriation effectiveness and lessen repetitive system traffic. It is a test for ICN to configuration reserving procedures to expand the use of in-arrange store. The objective of ICN storing procedure lies in 2 focuses: first, duplicating mainstream substance to the edge of system to diminish the idleness of downloading well known substance; second, expanding reserve decent variety in the area to improve the hit proportion of reserve and accordingly lessening traffic to the separation and maintaining a strategic distance from high dormancy. Current ICN reserving techniques streamline execution on either side yet can't accomplish the two objectives simultaneously for their own weaknesses. So we propose a dividing storing methodology concentrating on the exchange off between the quantity of reserves for famous substance and substance reserve assorted variety. In parceling storing procedure, every hub has a different fame based reserve and a community store to catch both well known and assorted substance get to designs.

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1. Introduction

Information driven frameworks organization is proposed as a suitable future Internet configuration to address the issue of substance spread profitability in current framework structure. In-arrange store accept a critical activity in ICN. Switches in the sort out are outfitted with putting away abilities to hold content things. If a substance request is answered in one switch (i.e., the sales lands at the switch's store) before going to the source

server, the substance recuperation torpidity is reduced and the transmission limit of the upstream interface is saved. In spite of the way that web store has been totally explored, the in-organize save is for the most part not exactly equivalent to the store in web and cell frameworks. In any case, the standard framework building isn't organized considering framework save. Its accumulating workplaces, for instance, CDN are basically established on statically put holding estimation, which is

exorbitantly computationally raised and can't conform to the dynamic needs of customers and the quick changes in-mastermind putting away.

Spread all the substance transmission of the Internet and the traffic that should be reserved will far surpass the capacity limit of ICN in-organize store. Additionally, because of the point of confinement of line speed, the limit of the reserve in ICN system will be littler than the limit of the capacity in CDN. Along these lines, it is important to plan a straightforward and viable reserving procedure to sensibly assign the restricted store space in ICN.

We will likely exchange off the quantity of reserves for well known substance and substance store assorted variety under store limit requirements. In our methodology, switches arrange with both on-way hubs and one-jump neighborhood hubs to settle on storing choices. We assign reserve space for well known substance sensibly to locate the reasonable substance assorted variety and to accomplish a lower normal inertness. So as to plainly break down the procedure of the exchange off, we set up a store framework model to tackle the reserving income expansion issue in cooperative reserving for ICN, and propose our storing system. To assess the presentation of our methodology, we contrast it and the condition of craft of on-way reserving methodologies and territorial community procedures. Genuine topologies are utilized and different scenes are considered. The primary commitments of this paper are as per the following.

1) We propose a partitioning collaborative caching strategy for ICN trading off between the number of caches for popular contents and the content cache diversity to reduce content retrieval latency.

2) We formulate the caching revenue maximization problem as the average latency minimization problem in the cache system model we establish and compare the caching revenue of different caching placement strategies.

3) A new method to monitor the content popularity is designed for line speed processing requirement and dynamic popularity in ICN router. Local popularity is maintained online with low memory usage and operation time of $O(1)$. Overhead and feasibility are examined in our experiment.

2. Related Works

The in-arrange storing procedures in ICN are chiefly ordered into three sorts: free reserving, on-way storing, and territorial communitarian storing. In the autonomous reserving, every hub freely makes a decision about the storing and sending of substance, which is straightforward and helpful yet needs data of different hubs unquestionably causing huge repetition and terrible showing. The ongoing looks into on storing procedures in ICN predominantly center around the on-way reserving and provincial synergistic reserving. Commonplace on-way reserving, for example, LCD, MCD can rapidly recreate substance to the edge of the system. Nonetheless, the issue is that as straightforward it seems to be, on-way reserving can produce a great deal of excess along the course and has a high pace of substitution. WAVE transforming the customary on-way hurting, can constrain the spread of the less well known substance reserves, and the mainstream substance with more demands can be transmitted to the edge in groups. In any case, more store excess starts to flood when the solicitation recurrence gets higher. Probcache is to progressively modify the store likelihood dependent on the separation between the reserving hub and the substance

source, and the substance will be reserved at the edge of the system instead of upstream with a higher likelihood. The above methodologies don't consider the substance prominence expressly in the reserve choice. Substance with high prominence are conceivable to be immediately supplanted by substance with low ubiquity whenever, possibly decreasing the hit proportion of reserve. Bernardini et al. decided whether a substance is well known by keeping up a substance notoriety table. A substance is viewed as famous just when the quantity of solicitations for it surpasses a given limit. In any case, it basically views the substance ubiquity as earlier information without thinking about how to screen it. Suksomboon et al. proposed a technique dependent on content notoriety and good ways from the requester. The most famous substance under the arrangement ought to be reserved on the switches nearest to the client, and the disagreeable substance ought to be stored in different switches. Be that as it may, this system just settles on reserving choices to dispense with storing repetition along the course. The cooperative range is constrained inside the course, inadequate with regards to thought of encompassing hubs even only one-bounce away. Under the store limit limitations, such pervasive reserving repetition between various courses will make it hard to viably use reserve assets or lessen organize traffic. In territorial communitarian storing, the reserve hubs exhaustively consider the condition of different hubs in a more extensive district than the course when settling on reserve choices. Lorenzo et al. proposed a hash steering based system in. At the point when the switches in the area get a substance demand, they hash content name and figure out which switch is liable for it and where to divert it. The fundamental thought of this methodology is that if the substance exists in the store inside an area, it will be in the

particular switch figured by the hash work. Heeyoung and Sunme followed the hashing directing based technique and did it along these lines.

3. Literature Survey

Administration structure permits mixed media administrations to be consequently made from nuclear assistance segments dependent on unique help prerequisites. Past work misses the mark for dispersed mixed media administration synthesis as far as adaptability, adaptability and nature of-administration (QoS) the board. Right now, present a completely decentralized help arrangement structure, called SpiderNet, to address the difficulties. SpiderNet gives factual multiconstrained QoS affirmations and burden adjusting for administration organization. In addition, SpiderNet bolsters coordinated non-cyclic chart synthesis topologies and replaceable creation orders. We have executed a model of SpiderNet and directed trials on both wide-zone systems and a recreation testbed. Our trial results show the attainability and proficiency of the SpiderNet administration creation system [1]. Distributed computing is regularly depicted as "assets got to by means of a program over the Internet." However, this definition has gotten progressively inadequate to portray the expansiveness of utilizations and use cases for the cloud, and the systems that must help them. A widening scope of endpoints are getting to the cloud: program free gadget applications, mixed media endpoints, for example, video and game consoles, sensor systems, servers, and capacity. The wireline and remote system prerequisites—e.g., jitter, idleness, bundle misfortune, convention support—for these utilizations fluctuate, and infer that an assortment of system capacities are in some cases important: e.g., MPLS for nature of administration through class of administration to help intuitive top quality video

in the cloud; optical vehicle for local conventions, for example, Fiber Channel for information reconciliation in half and half cloud situations; course control for nation consistence issues. Likewise, appropriated topologies and streamlined steering are required because of utilization inertness imperatives. Additionally, remote sensor systems and half and half cloud situations, for example, cloud bursting that require an assortment of complex dispersed information approaches are driving new vehicle prerequisites: ensured data transmission, dynamic transfer speed on request, and utilization touchy valuing for fine-grained amounts and term of transmission capacity [2]. Estimating pulse can help screen an individual's wellness level; additionally, it can help spot creating medical issues. There are a few different ways that can be utilized to gauge pulse. Of late, picture based wellbeing observing frameworks have stood out because of the upside of being totally non-contact. In 2008, Verkryse et al., assessed pulse from a RGB video recorded utilizing a solitary customary computerized camera, by breaking down unpretentious changes in the skin shading brought about by blood course. A comparable methodology has been utilized by different examinations. Indeed, even cell phone applications have been proposed. Right now, creators present a picture based pulse estimating procedure that solitary uses profundity video. Profundity pictures are created by registering the per-pixel separation between the physical articles in the 3D scene and the detecting gadget. The upside of utilizing profundity pictures from a surface RGB signal is that the brightening variety isn't a factor. Past profundity pictures based frameworks have exhibited that specific biometrics, as respiratory rate, can be precisely evaluated. All things considered, because of confinements of the

present profundity detecting innovations, catch profundity recordings normally experience the ill effects of low piece profundity and procurement clamor. Therefore, it is hard to process obtained profundity pictures to appraise biometrics that require following of unobtrusive 3D movement of a human subject [3]. Estimating pulse can help screen an individual's wellness level; additionally, it can help spot creating medical issues. There are a few different ways that can be utilized to gauge pulse. Of late, picture based wellbeing observing frameworks have stood out because of the upside of being totally non-contact. In 2008, Verkryse et al., assessed pulse from a RGB video recorded utilizing a solitary customary computerized camera, by breaking down unpretentious changes in the skin shading brought about by blood course. A comparable methodology has been utilized by different examinations. Indeed, even cell phone applications have been proposed. Right now, creators present a picture based pulse estimating procedure that solitary uses profundity video. Profundity pictures are created by registering the per-pixel separation between the physical articles in the 3D scene and the detecting gadget. The upside of utilizing profundity pictures from a surface RGB signal is that the brightening variety isn't a factor. Past profundity pictures based frameworks have exhibited that specific biometrics, as respiratory rate, can be precisely evaluated. All things considered, because of confinements of the present profundity detecting innovations, catch profundity recordings normally experience the ill effects of low piece profundity and procurement clamor. Therefore, it is hard to process obtained profundity pictures to appraise biometrics that require following of unobtrusive 3D movement of a human subject [4].

4. Results

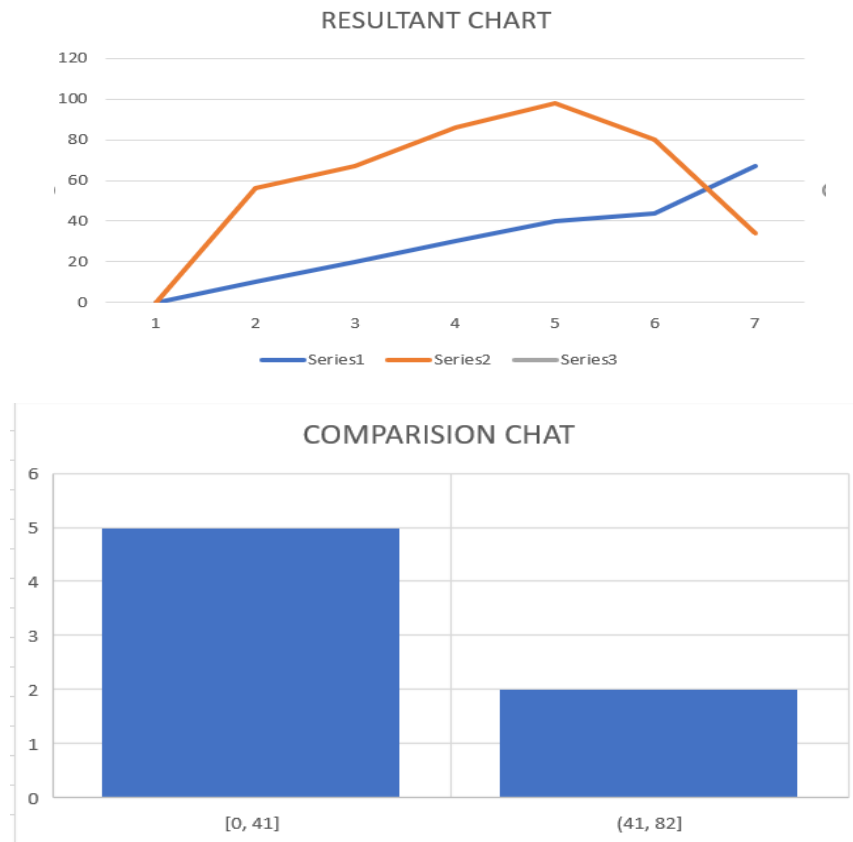


Figure 1: System Models

1) CDN Topology Model

We model the CDN foundation as an associated diagram $G=(V,E)$, where $V=\{d_0,d_1,\dots,d_N\}$, d_0 is the substance source, $\{d_1,d_2,\dots,d_N\}$ is the arrangement of CDN hubs, and N is the all out number of CDN hubs; E signifies the arrangement of system interfaces between those hubs, and (d_n,d_n') speaks to the connection between hubs d_n and d_n' . The substance source d_0 stores all the composable administrations and imitates a part of articles to the CDN hubs under a capacity requirement.

2) Composable Service Model

We model the CDN foundation as an associated diagram $G=(V,E)$, where $V=\{d_0,d_1,\dots,d_N\}$, d_0 is the substance source, $\{d_1,d_2,\dots,d_N\}$ is the

arrangement of CDN hubs, and N is the all out number of CDN hubs; E signifies the arrangement of system interfaces between those hubs, and (d_n,d_n') speaks to the connection between hubs d_n and d_n' . The substance source d_0 stores all the composable administrations and imitates a part of articles to the CDN hubs under a capacity requirement.

3) Request and Caching Model

Each CDN node also has a service entry point attached to an access network. We assume that user requests always arrive first at the geo-nearest node. In each slot t at node d_n , the average arrival rate to composable service G_m is denoted as $an_m(t)$. Because CDN nodes are constrained by limited storage capacity, they cannot store all the objects. For each CDN node

dn, the cached objects are denoted as $C_n(t) \in U_{M_n=1} V_m$. At each time slot, when a user associated with node d_n initiates a request for the composable service G_m , a set of requests for the different objects $c_{mi} \in G_m$ will be sent sequentially based on the dependencies defined in the service graph. In the request for object c_1 will be sent first. After receiving and executing c_1 , requests for objects c_2 , c_3 and c_4 will be sent. In this way, the request for object c_5 will be initiated after c_3 and c_4 . For each request for each specific object, the request will first arrive at the geo-closet CDN node. If the requested object is cached, it will be transmitted directly to the user; otherwise, the request will be redirected to other CDN nodes according to the routing policy (e.g., the layered architecture adopted by Akamai and cooperative caching) until it reaches the content source. The similar content routing policy is adopted by both industry products.

Problem Formulation

Utilizing the above models, we can determine the all out help inertness at schedule vacancy t as

$U(t) = \sum_{N_n=1} (\gamma \sum_{M_m=1} \lambda_{nm}(t) T_{nm}(t) + (1-\gamma) \sum_{M_m=1} \lambda_{nm}(t) T_{crnm}(t))$. U comprises of two terms. The principal term, $\sum_{M_m=1} \lambda_{nm}(t) T_{nm}(t)$, is the administration inertness for the whole help diagram, while the subsequent term, $\sum_{M_m=1} \lambda_{nm}(t) T_{crnm}(t)$, is the administration inactivity for the underlying rendering. Here, $\gamma \in [0,1]$ is a steady weight factor to adjust these two terms. Despite the fact that our attention is on diminishing the underlying rendering time (i.e., the subsequent term), we additionally present the nonexclusive weighted help dormancy, which can be changed over to various cases. When $\gamma=1$, the enhancement object is corrupted to lessen the underlying rendering time, and when $\gamma=0$, the improvement objective is to diminish the

administration idleness for the whole website page (i.e., the customary case). Our concern can be defined as follows:

$$P1: \min\{C(t)\} \text{ s.t. } \lim_{T \rightarrow \infty} \frac{1}{T} \sum_{t=1}^T U(t)$$

$$\lim_{T \rightarrow \infty} \frac{1}{T} \sum_{t=1}^T \sum_{n=1}^N \sum_{c_{mi} \in C_n(t)} s_{mi} \leq \beta_0, \sum_{c_{mi} \in C_n(t)}$$

$$s_{mi} \leq \beta_n, n=1,2,\dots,N, (3)(4)(5)$$

$$\{C(t): t=1,2,\dots,T\},$$

The constraint (4) indicates that the time-averaged cache capacity is below a predefined budget β_0 , and the constraint (5) is the cache capacity limit β_n of each CDN node. Note that our formulation does not consider the cost of cache adjustment, because the mainstream CDN providers, including Akamai, Azure and Amazon, charge only for outbound traffic.

Approximation Algorithm for One-Shot Optimization Problems

To solve problem P2, we first present the property of the object function and derive two approximation algorithms.

Definition 1:

For any set function $f: 2\Lambda \rightarrow \mathbb{R}$, $f(\cdot)$ is super-modular [30] if for any subset $\Psi \in V$, $i \in V, i \notin \Psi$, and $j \in V, j \notin \Psi$,

$$f(\Psi \cup \{i\}) + f(\Psi \cup \{j\}) \leq f(\Psi \cup \{i,j\}) + f(\Psi).$$

Lemma 2:

The administration dormancy capacity of a particular item $\tau_{nmi}(t) = g(d_n, c_{mi}, s_{mi}, C(t), B(t))$ is super-secluded and monotonic. The stacking idleness of a website page relies upon the execution and download time of the comparing objects just as on the page structure. Given all these site page factors, the heap time is equivalent to the greatest inertness everything being equal (from any root item to leaf object in the administration chart). As showed in Fig. 6,

we can produce three ways, i.e., c1-c2, c1-c3-c5-c6, c1-c4-c5-c6. As indicated by the store appropriation, download and execution time, the idleness is: $\max \{50 + 10 + 70, 50 + 10 + 70 + 30 + 120 + 120, 50 + 10 + 100 + 120 + 120\} = 400$. Practically speaking, notwithstanding the reserve dispersion, the inertness of article ways will be influenced by client associations and other complex conditions; subsequently, it is difficult to figure out which way will be the bottleneck [22]. In this way, we present an estimate structure dependent on the instinct that ways with more items, bigger total of article sizes and execution time are well on the way to turn into the page load-time bottlenecks. On the off chance that we can upgrade the stacking time of these ways, the website page load time can be diminished. For each assistance chart m , we can rank every one of the ways and select the top L ways that have more items, more prominent article sizes and, in this manner, longer execution times. Every way $O_{ml}, l=1,2,\dots,L$ comprises of an arranged rundown of articles. The idleness along every way can be inferred by $\sum_{c_{mi} \in O_{ml}} (\tau_{nmi} + e_{mi})$. We characterize the estimate dormancy of a website page as follows:

$$T_{nm}(t) = f(E, T_m(t)) \approx \sum_{l=1}^L \omega_l \sum_{c_{mi} \in O_{ml}} (\tau_{nmi}(t) + e_{mi}), \quad (8)$$

where ω_l is the heaviness of various ways, and $\omega_l \geq 0$ and $\sum_{l=1}^L \omega_l = 1$. When all is said in done, the way with the most hubs and the biggest item sizes will have a bigger ω_l . For the underlying rendering time, we can characterize a capacity along these lines.

Lemma 3:

The administration inertness work characterized in (8) is super-measured and monotonic. Therefore, the target work characterized in issue P2 is additionally super-measured and

monotonic. Using the super-particularity of the goal work, we find that:

Theorem 1:

The one-shot streamlining issue P2 is NP-hard. To decrease the computational unpredictability of taking care of issue P2, we structure two estimation calculations. To rearrange the inference, let $R(C) = Q(t) (\sum_{n=1}^N \sum_{c_{mi} \in C_n(t)} s_{mi} - \beta_0) + VU(t)$.

1) General Greedy Algorithm

The key thought of the general eager Algorithm 1 is that in every emphasis, we plan to discover a tuple (object, CDN hub) (i.e., reserving an item at a CDN hub), that gives the biggest help inactivity decrease or unit decrease. Without causing equivocalness, in Algorithm 1, $(c_{mi}, n) \in UM_m = 1V_m \times V$ alludes to $c_{mi} \in UM_m = 1V_m$ and $dn \in V$, $UM_m = 1V_m \times V \setminus C = UM_m = 1V_m \times V \setminus \bigcup_{n=1}^N C_n$, and $CU(c_{mi}, n) = \{\dots, C_n \cup \{c_{mi}\}, \dots\}$. In every emphasis (line 3), our calculation needs to find out whether at any rate one tuple exists that can be added to the reserve set. The physical significance of recipe in line 3 is that we will discover all the staying conceivable tuples (i.e., item and CDN hub), which meet the condition that the article size is not exactly the rest of the reserve spending plan. All these tuples (c_{mi}, n) are assembled to a brief set S (line 4). We at that point discover the tuple that brings the biggest inactivity decrease when added to the reserve set (line 5–8). It ought to be noticed that our calculation embraces two principles to ascertain the minor advantage, outright addition (line 6) or unit gain (line 8). Utilizing one of the guidelines, we can locate a heuristic arrangement. The arrangement with the more noteworthy advantage is the result of our calculation (line 13). Expect C^* is the ideal arrangement and C is an achievable arrangement, we characterize the serious

proportion as $R(C)R(C^*)$ to measure the exhibition of the estimation calculation, as expressed as follow:

Theorem 2:

Algorithm 1 can discover an answer with a serious proportion under $\eta=1+12(1+1e)R(\emptyset)R(C^*)$, where $R(\emptyset)$ is the administration inactivity without caching. Complexity Analysis: In every cycle, we have to decide all the conceivable tuples to store them and figure the negligible advantage. The time intricacy of Algorithm 1 is $O(\sum_{Nn=1}^N \beta_n E[smi] | \cup Mm=1 Vm | |V|)$, where $E[smi]$ is the normal article size and $\sum_{Nn=1}^N \beta_n Esmi$ signifies the mean number of stored objects. Clearly, there are an excessive number of peripheral advantage computations and examinations.

5. Conclusion

Persuaded by the perception that clients care increasingly about the underlying rendering time of site pages, this paper explored the basic article mindful storing plan to diminish the administration dormancy. From the genuine estimation on the biggest CDN supplier, we found that not all reserved items were basic and just a little part of basic articles was stored. We exhibited a few models to portray the basic article mindful reserving plan, and detailed it as a compelled advancement issue. Utilizing the stochastic enhancement structure, we disintegrated the issue into a lot of the one-shot streamlining issues. In the wake of inferring two estimate calculations for the one-shot improvement issues, we built up an online calculation with execution bound. Through genuine follow driven reproductions, we confirmed that our proposed calculation could diminish the underlying rendering time of website pages, improve the reserve hit proportion and decrease the system traffic. With

respect to our future work, we will broaden the proposed system and calculation to the portable edge figuring worldview. The portable edge figuring worldview in 5G standard imagines an IT administration condition and distributed computing capacities at the edge of versatile system, inside the radio access organize and in nearness to portable supporters. Edge storing and community oriented reserving will assume a basic job in the MEC. The point is to lessen inactivity, guarantee exceptionally proficient system activity and administration conveyance. We will together use the need based reserving procedure just as range portion technique to lessen the administration dormancy.

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