

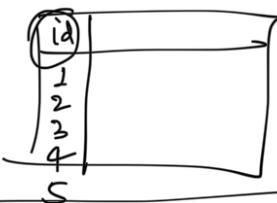
HLD : POPULAR INTERVIEW QUESTIONS

① ID Generator

② Rate limiting system

③ Bloom filter

id AUTO-INCREMENT



ID Generator



Clock is synced

$$\begin{aligned} t_1 &< t_2 \\ \text{id}(m_1) &< \text{id}(m_2) \end{aligned}$$

m₁ m₂ ID:

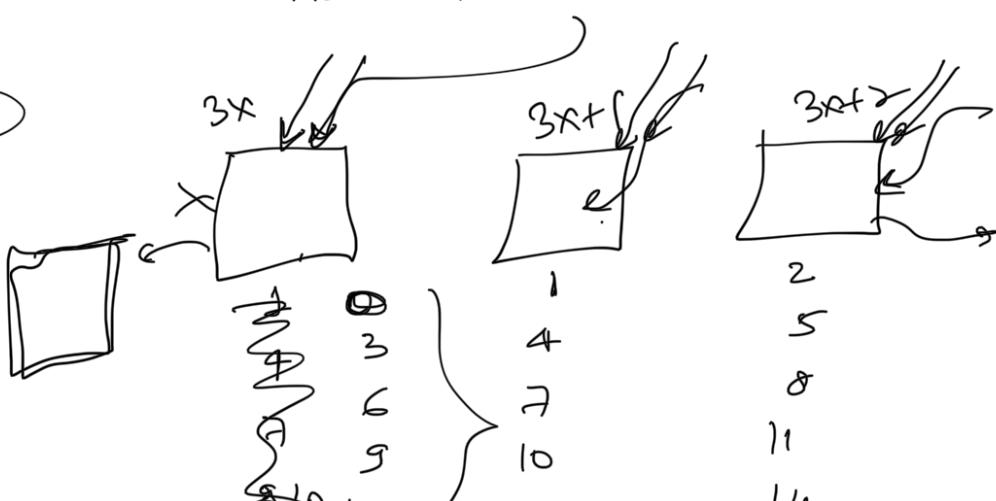
- ① Unique
- ② Incremental

① UUID | guid | ... - 'hash(...)'

unique ✓
increm X

→ string →
lexicographic
→ integer
↳ obvious

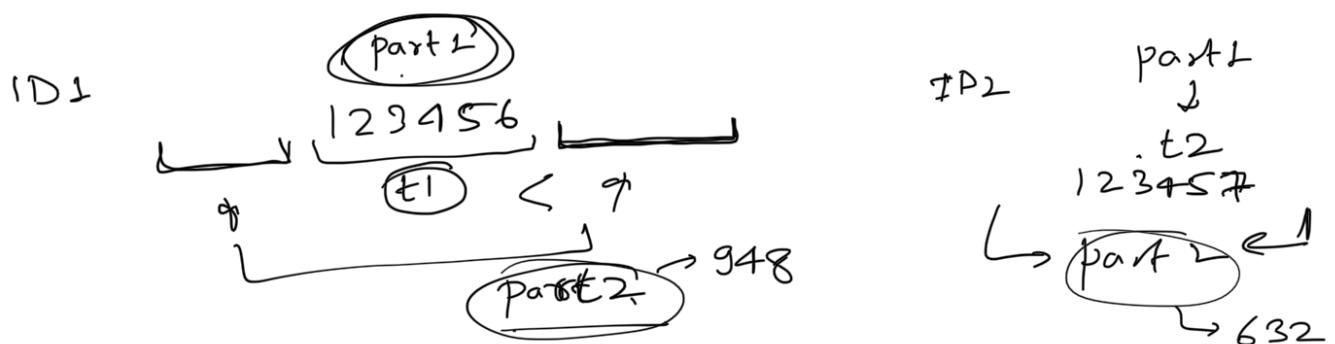
②



2 > 1
①
②

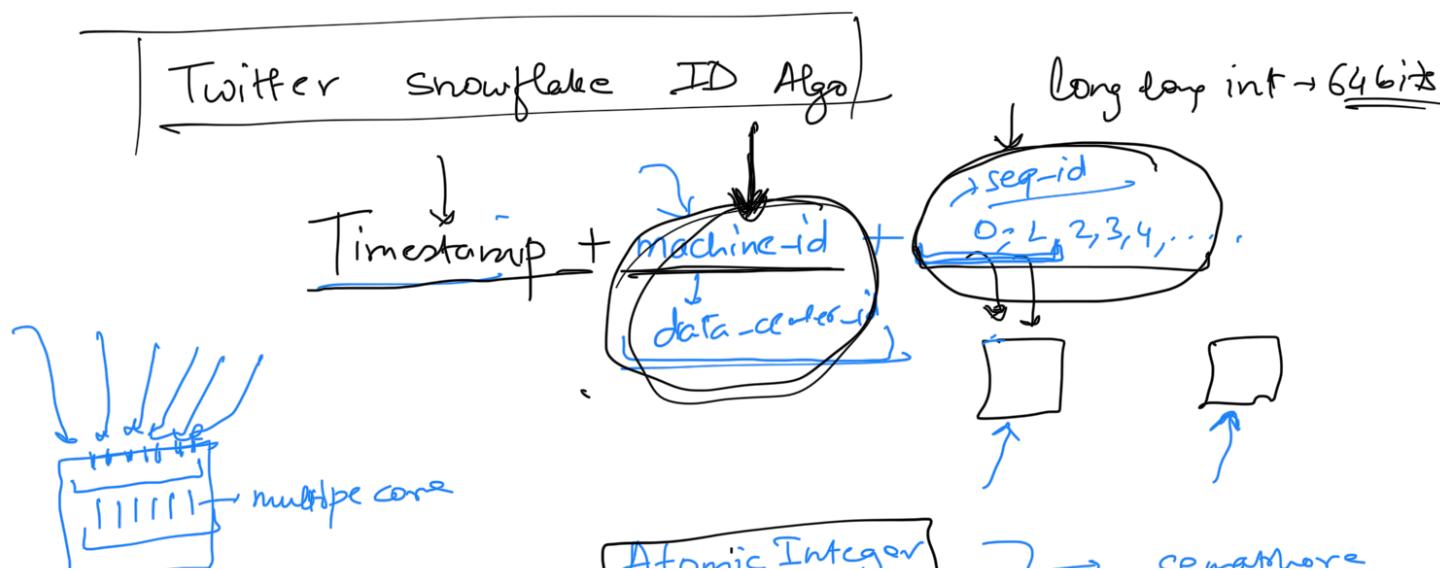
12 13
15 16
17
18

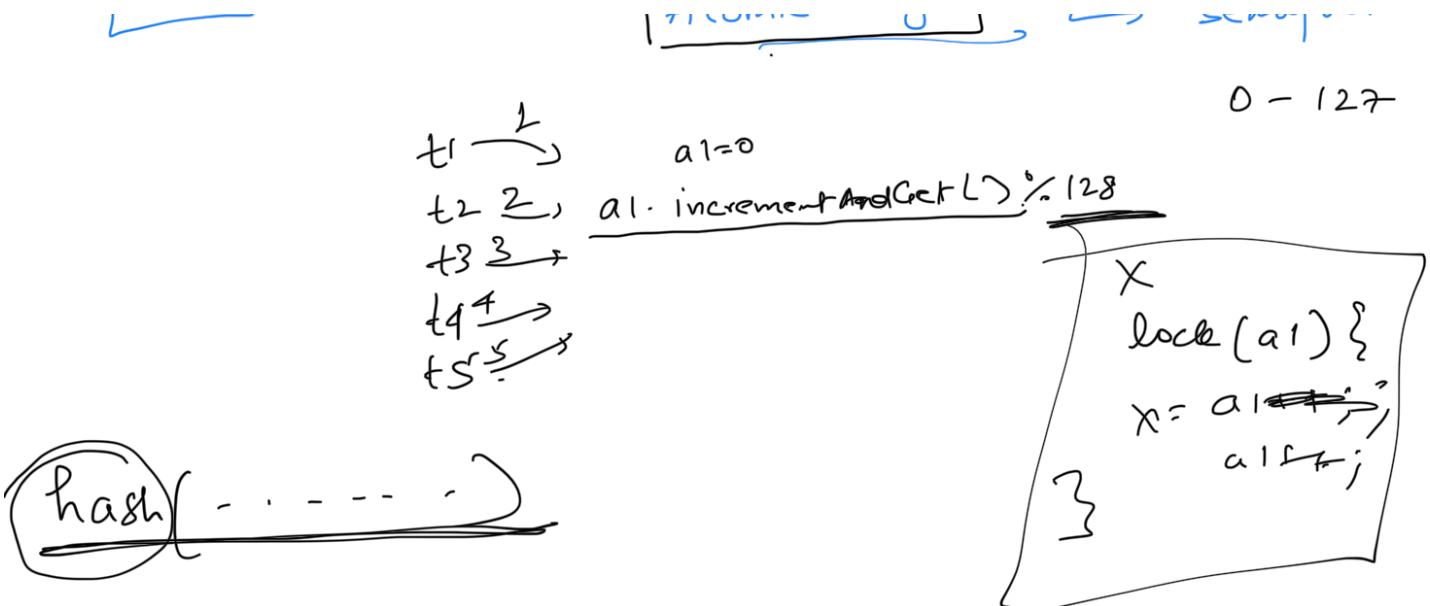
③ epoch timestamp
only timestamp → unique x



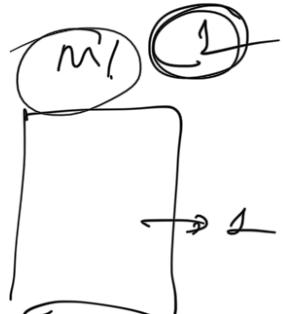
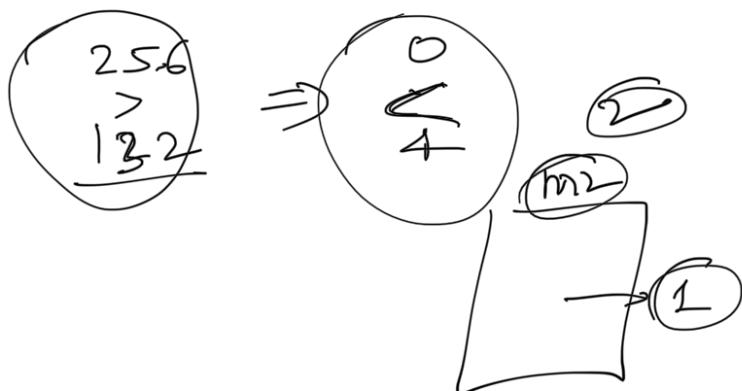
④ 48 123456 > 632 123457
 timestamp + --- → D D D D
 ↴ most significant bits/digits

m1 → 122
 m2 → 123
 $\frac{a_1 > b_1}{a_1 a_2 a_3 a_4 a_5} = \frac{b_1 b_2 b_3 b_4 b_5}{}$
 $\frac{12200}{12300} > \frac{12299}{12399}$





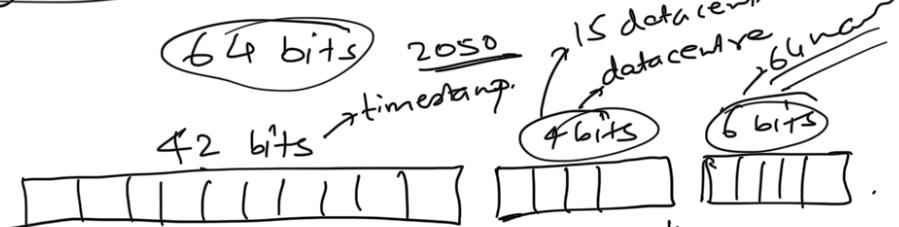
$\underline{\text{num}} \% 128$



1 2 3 4 2 1

22 bits

1 2 3 4 2 1



$t_1 > t_2$
 $\text{id}_1 > \text{id}_2$

$t_1 = t_2$
 $\text{id}_1 \neq \text{id}_2$

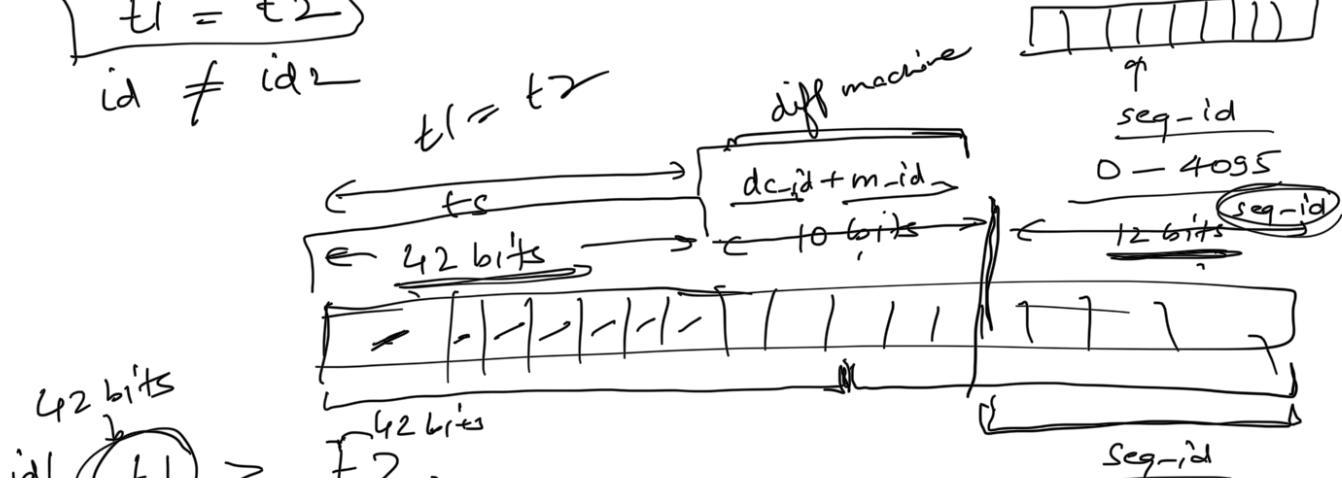
$t_1 = t_2$

diff machine

12 bits

seq-id

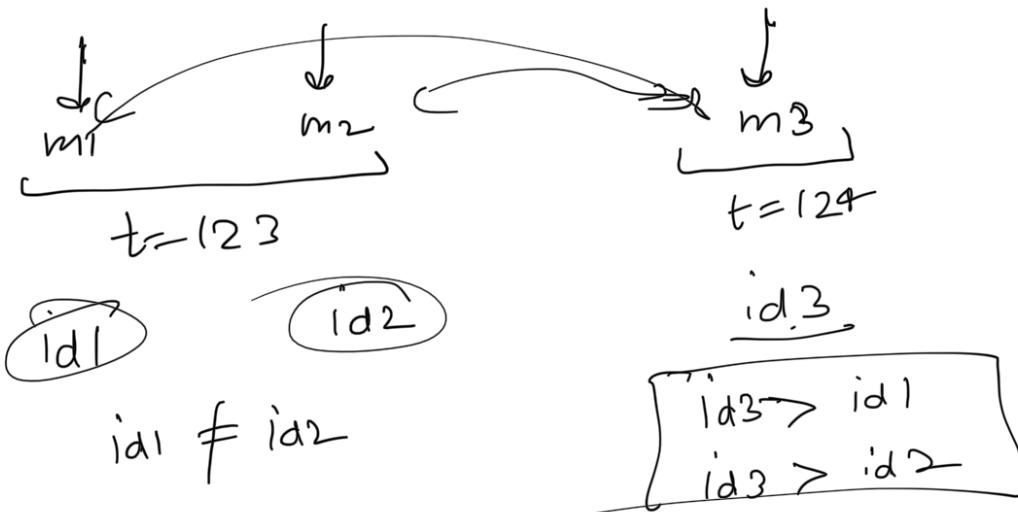
0 - 4095



1. (II) $\leftarrow \leftarrow$

$id_1 > id_2$

4095



CONSTANT $[d_{\text{id}}]$ $[m_{\text{id}}]$ Increment
timestamp \rightarrow int

(long long) $ts \leq 2^{12} + d_{\text{id}} \leq 17$
 $+ m_{\text{id}} \leq 12$
12 bits
 $+ \text{seq-id}$

$\asymp 2^{12}$

$ts = 998$, $\text{seq-id} = 2$

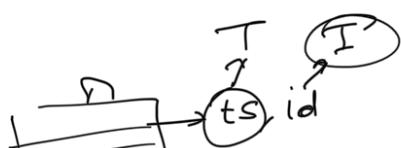
999 , $\text{seq-id} = 1$

9982

9991

~~99810001~~
~~99810002~~ X
99810003 ✓

index
 $\text{id} > x$
 $\text{id} > \text{id}_x$



Q1: $ts_x > T$

Q2: $\text{id} > I \leftarrow$ faster

① Rate Limiters

→ Distributed Denial of Service
DDoS attack.

9pm → critical



Rate Limiters

IP Address

Userid

=
=

1 code/sec

10 code/min

100 code/hour

Implement a rate limiter + where?

client → LB/API
server

~~Key → value~~

~~tft~~

IP Addr.

10 req/60 sec

Key → value ft

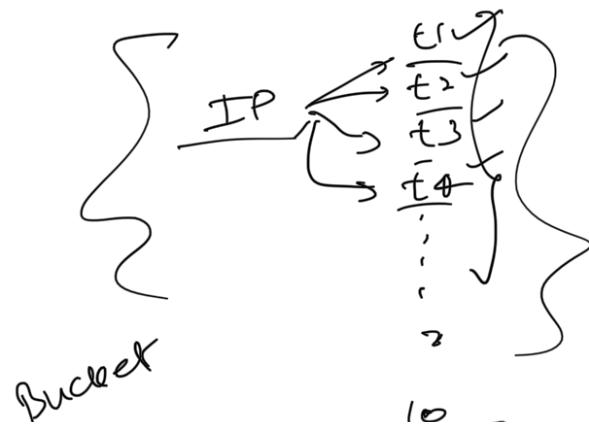
10.20.30.40 ..

10 req/60 sec.

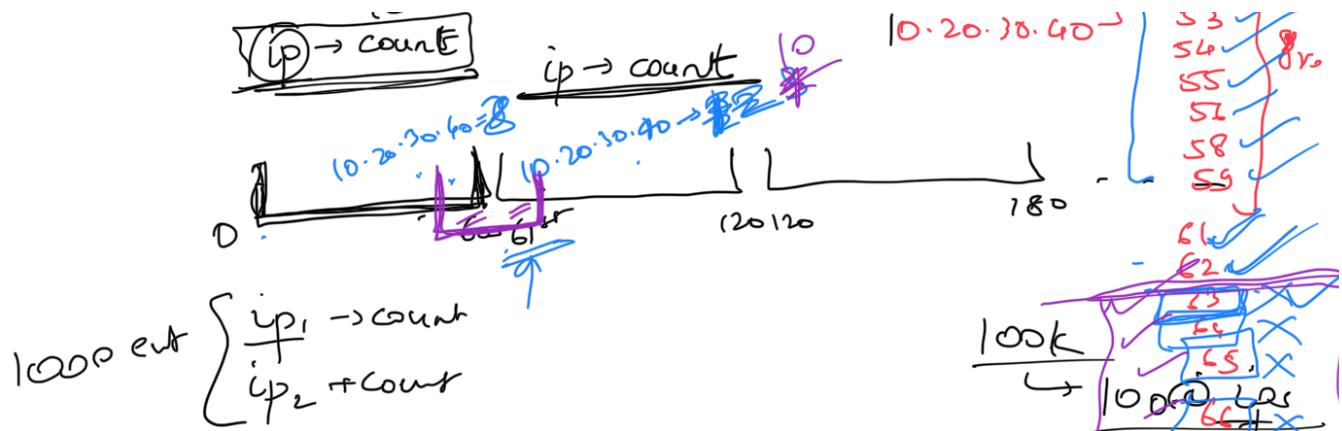
error code
429

> 10 ..

①

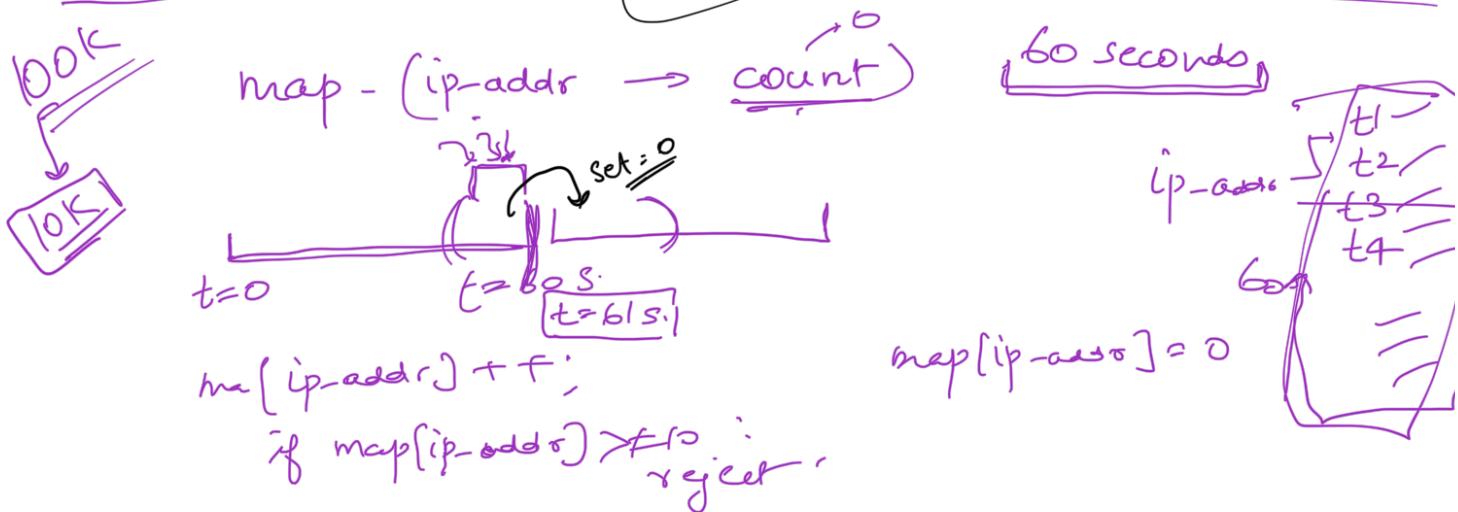


2

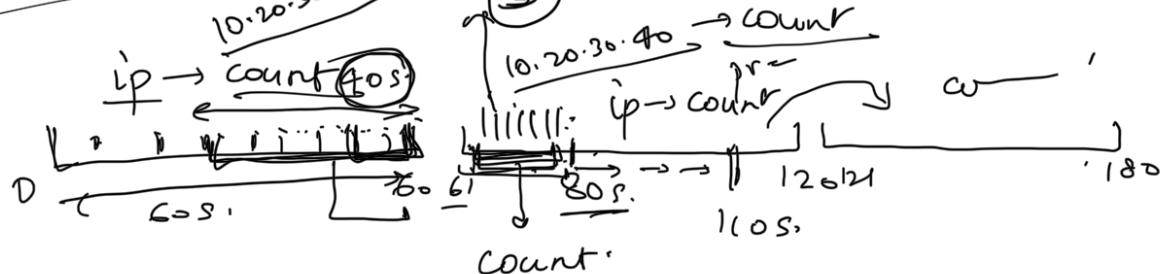


$\{$ deleted (H_1);
 H_2 ^{new} map <string, int>();
 \downarrow sleep (60s)

```
    t[ip-addr] ++;  
    if (t[ip-addr] >= 10) {  
        // object  
    }  
}
```



SLIDING WINDOW APPROACH



cur-map
prev-map }

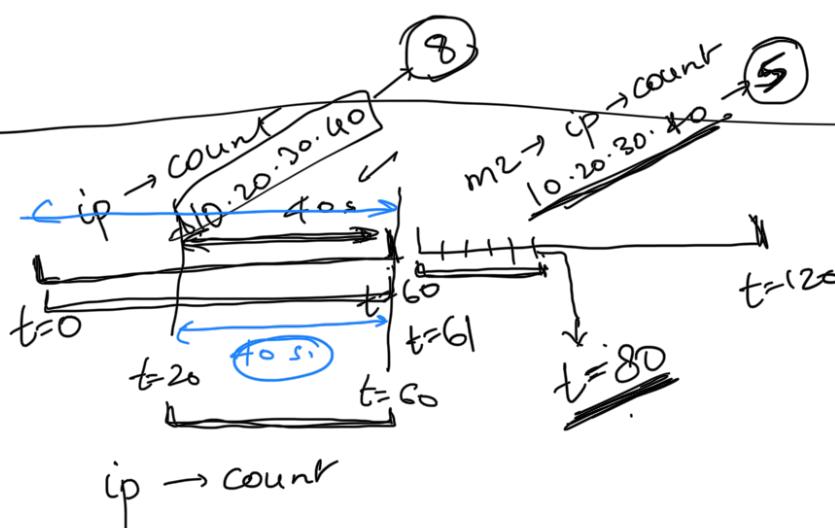
$$5 + \frac{40}{60} * 8$$

$$60 \text{ sec} \rightarrow \text{Drof-map} = \text{Cur-map}$$

$$= 5 + \frac{16}{3} = \underline{10 \dots \text{xxx}}$$

$\text{curr_mapp} = \text{new mapp}$

$$\begin{aligned}
 60 &\rightarrow 8 \\
 1 &\rightarrow \frac{8}{60} \\
 40 &\rightarrow \frac{8}{60} * 40 \\
 &= \frac{8}{60} \frac{15}{3} = 5.33
 \end{aligned}$$



approximate algorithm
20 seconds → 5
40 seconds → $\frac{5.33}{10.33}$

$$t=0 \rightarrow t=60 \rightarrow 8$$

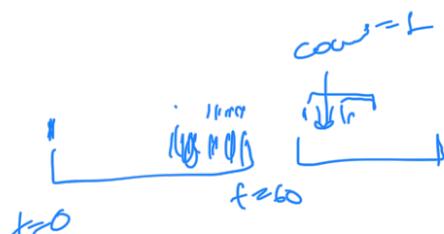
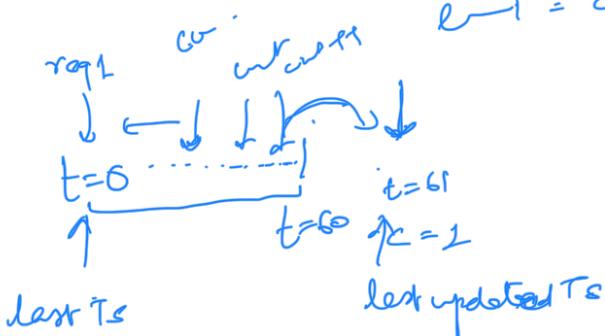
$$t=0 \quad | \quad t=30 \quad | \quad t=60$$

$$\begin{aligned}
 60s &\rightarrow 8 \\
 1s &\rightarrow \frac{8}{60} \text{ req.} \\
 40s &\rightarrow \frac{8}{60} * \frac{2}{3} = \frac{16}{60} = \frac{16}{7} = 5.33
 \end{aligned}$$

if $\text{currTs} - \text{lastUpdate} < 60s \dots$
count ++

else

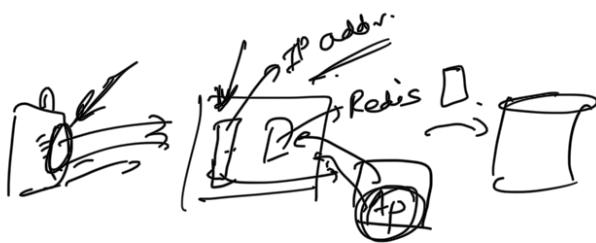
$$\frac{\text{Count} = 1}{\text{last} = \text{currTs}}$$



Approach:

Sliding window approach

Where:



URL Shortener

8/10

4/10

