

系统设计第六课

小憩一下，马上开课

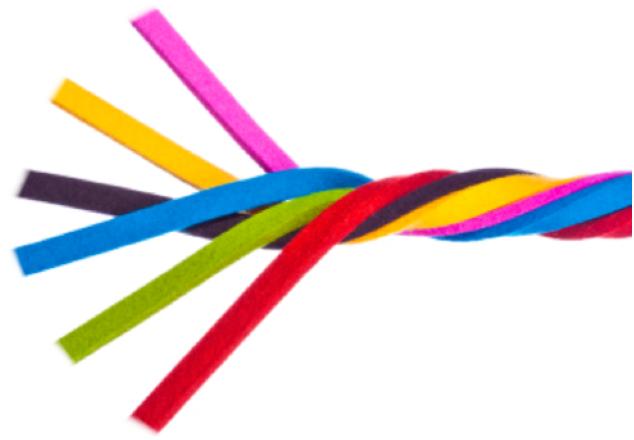


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System_Design_6

Feed & Chat

张无忌

2016-02-07

V4.00

After class_6, you can answer

- Design Twitter/Instagram/Facebook
 - Facebook, Uber, Shopkick, Bloomberg
- Design WhatsApp/Facebook Chat
 - Uber, Facebook, TubeMogul

Part 1, Feed

Read More

Novice, <http://url.cn/faa4ko>

Novice, <http://url.cn/1ob37A>

Novice/Expert, <http://url.cn/eKslaK>

Novice/Expert/Master, <http://url.cn/cinh36>

Expert, <http://url.cn/g4JSMc>

Expert, <http://url.cn/ayEgtO>

Expert, <http://url.cn/efdJnC>

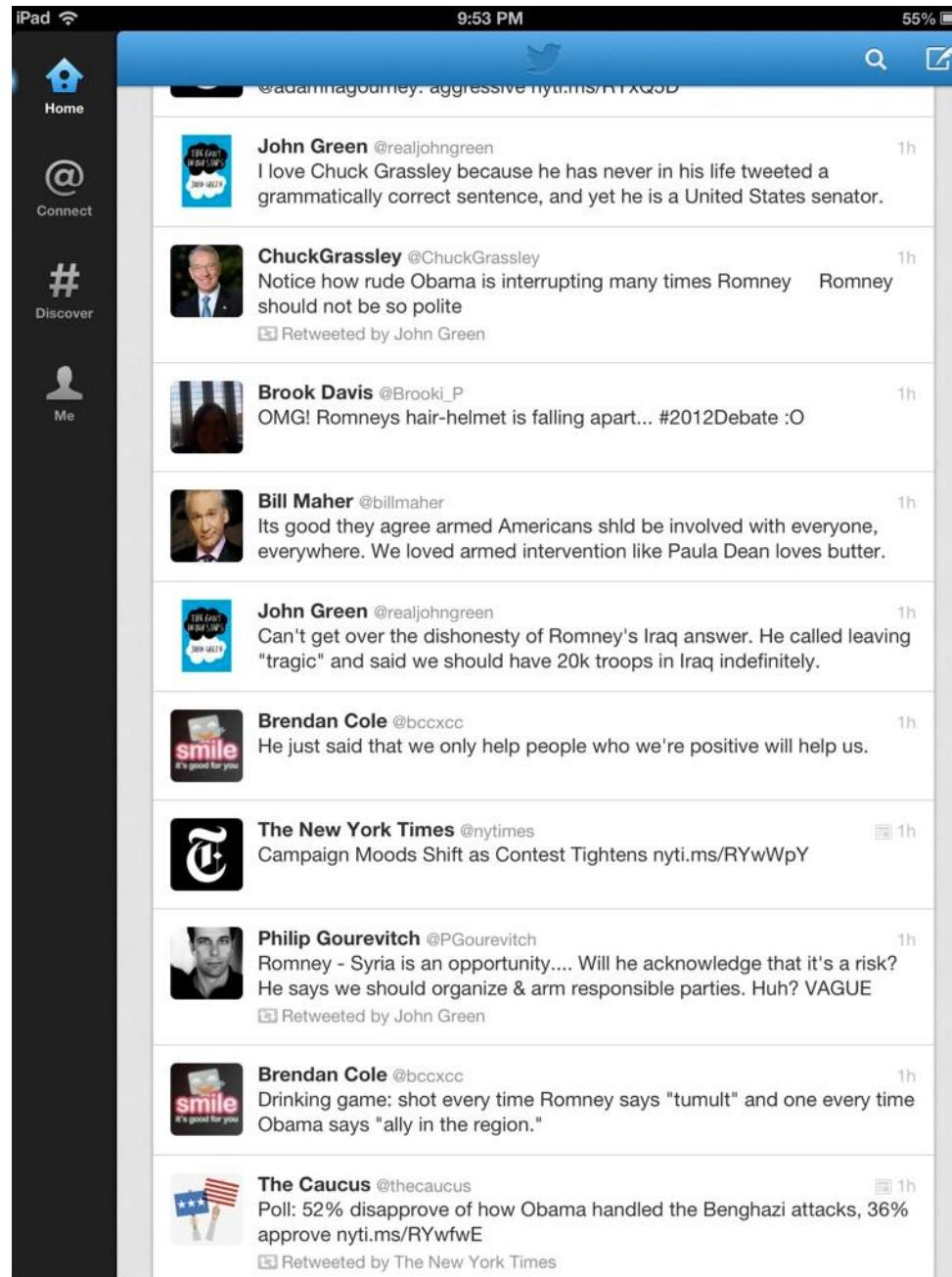
Expert/Master, <http://url.cn/fr44T4>

Expert/Master, <http://url.cn/H2CLaU>

Expert/Master, <http://url.cn/RXRa8P>

Expert/Master, <http://url.cn/hWVvmn>

Master, <http://url.cn/ULnxoG>



Interviewer: design Twitter

Scenario: three feed lists

<p>Nelson Minar @nelson That part of the hip hop record where there's a recording of someone urinating. Expand</p>	<p>36m</p>	<p>Tim O'Reilly @timoreilly "online messages that evoke feelings of unintentional joy!...a poetry of the Expand</p>	<p>Chris Matts @PapaChrisMatts Looking forward to #QCONNewYork on Monday. Talking about Lazy Learner. The other the "Agile Individuals track" speakers are most #awesome!  Expand</p>	<p>15 Jun</p>	
<p>Nelson Minar @nelson @kvox awesome photo, dapper man in vintage airplane? View conversation</p>	<p>on</p>	<p>Tim O'Reilly @timoreilly What's the craziest thing your dad ever did? Results from @make's homage to Father's Day. Expand</p>	<p>Con is coming to New York</p>	<p>QCon New York @qconnewyork "Spring Data - NoSQL, NoProblems" talk by @PeterBell at QCon New York. #springframework #nosql #mongodb #neo4j qconnewyork.com/qcon-nyc-2012/... Expand</p>	<p>14 Jun</p>
<p>Nelson Minar @nelson @bookscout oh bullshit, merlot is a terrible wine. Ch. Petrus, for instance. View conversation</p>	<p>on</p>	<p>Tim O'Reilly @timoreilly Potentially wonderful. Also very scary. A banker in Spain bit.ly/KExVdk Funded View media</p>	<p>Con is coming to New York</p>	<p>QCon New York @qconnewyork Want to learn how #APM can help you get the most out of your #bigdata application? See @mikopp's session at #qconnewyork qconnewyork.com/qcon-nyc-2012/... Expand</p>	<p>13 Jun</p>
<p>Nelson Minar @nelson Yesterday was South Park, today is Area startup tour? Go kart track? Sunburned from Woodside, CA </p>	<p>on</p>	<p>Tim O'Reilly @timoreilly Old friend selling beautiful cottage in Queens, NYC: bit.ly/KEvKqf Expand</p>	<p>Con is coming to New York</p>	<p>QCon New York @qconnewyork Creating maintainable, sustainable software can be hard but not impossible-Alexander von Zitzewitz #qconnewyork goo.gl/o3Dy7 Expand</p>	<p>12 Jun</p>
<p>Nelson Minar @nelson @skatterbean Harris Ranch is a fun place to go, but it's narrow. Don't count on the fuel world. View conversation</p>	<p>on Jun</p>	<p>Ivan Tarradellas @itarradellas @deepakmohoni @timoreilly @quixote "Go to the edge of the cliff and jump down"  View conversation  </p>	<p>Con is coming to New York</p>	<p>QCon New York @qconnewyork don't miss your chance to save \$200 for #qconnewyork! early bird expires Friday 6/15/2012! secure.trifork.com/qcon-nyc-2012/... Expand</p>	<p>11 Jun</p>

Scenario: one timeline

 **Tim O'Reilly** @timoreilly 31m
"online messages that evoke feelings of despair (and, often and unintentionally joy!)...a poetry of the New Aesthetic" bit.ly/NlePmd
[Expand](#)

 **Nelson Minar** @nelson 36m
That part of the hip hop record where they think it's funny to include a recording of someone urinating.
[Expand](#)

 **Tim O'Reilly** @timoreilly 2h
What's the craziest thing your dad ever made? bit.ly/KEln4D Some results from [@make](#)'s homage to Father's Day
[Expand](#)

 **Tim O'Reilly** @timoreilly 4h
Potentially wonderful, Also very scary: crowdfunded lawsuit against banker in Spain bit.ly/KExVdk Funded 24 hrs bit.ly/KExSOG
[View media](#)

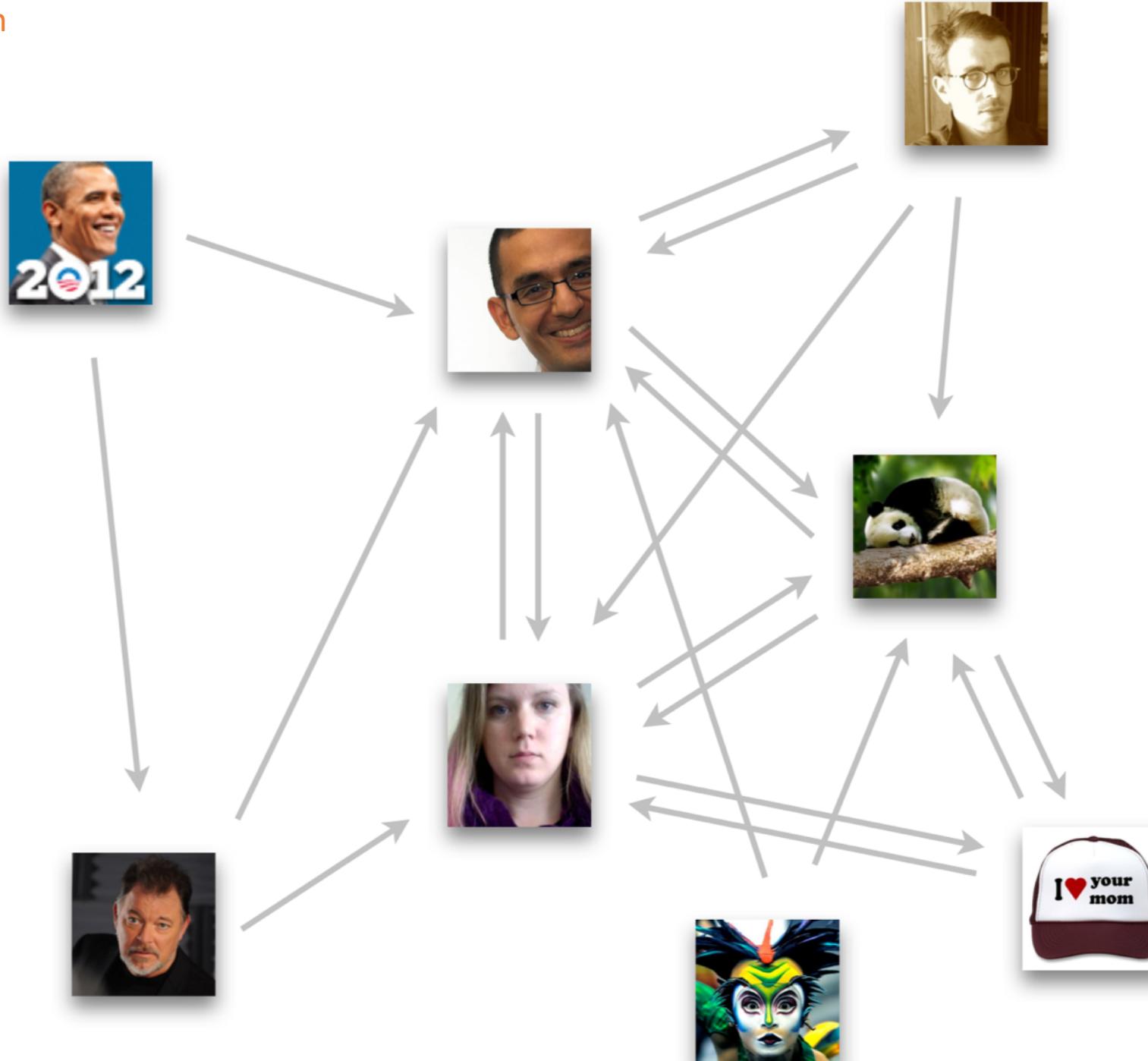
 **Tim O'Reilly** @timoreilly 4h
Old friend selling beautiful cottage on huge garden lot in Bayside, Queens, NYC: bit.ly/KEvKqf
[Expand](#)

 **Nelson Minar** @nelson 23h
Yesterday was South Park, today is Buck's. What's next on my Bay Area startup tour? Go kart track? Suburban garages?
 from Woodside, CA

 **Ivan Tarradellas** @itarradellas 16 Jun
@deepakmohoni @timoreilly @quixotic @dpatil Yes, Ray Bradbury "Go to the edge of the cliff and jump off. Build your wings on the way down"
 Retweeted by Tim O'Reilly
[View conversation](#)   

 **Chris Matts** @PapaChrisMatts 15 Jun
Looking forward to [#QCONNewYork](#) on Monday. Talking about Lazy Learner. The other the "Agile Individuals track" speakers are most [awesome!](#)
 from New York

Scenario: social graph



Necessaries

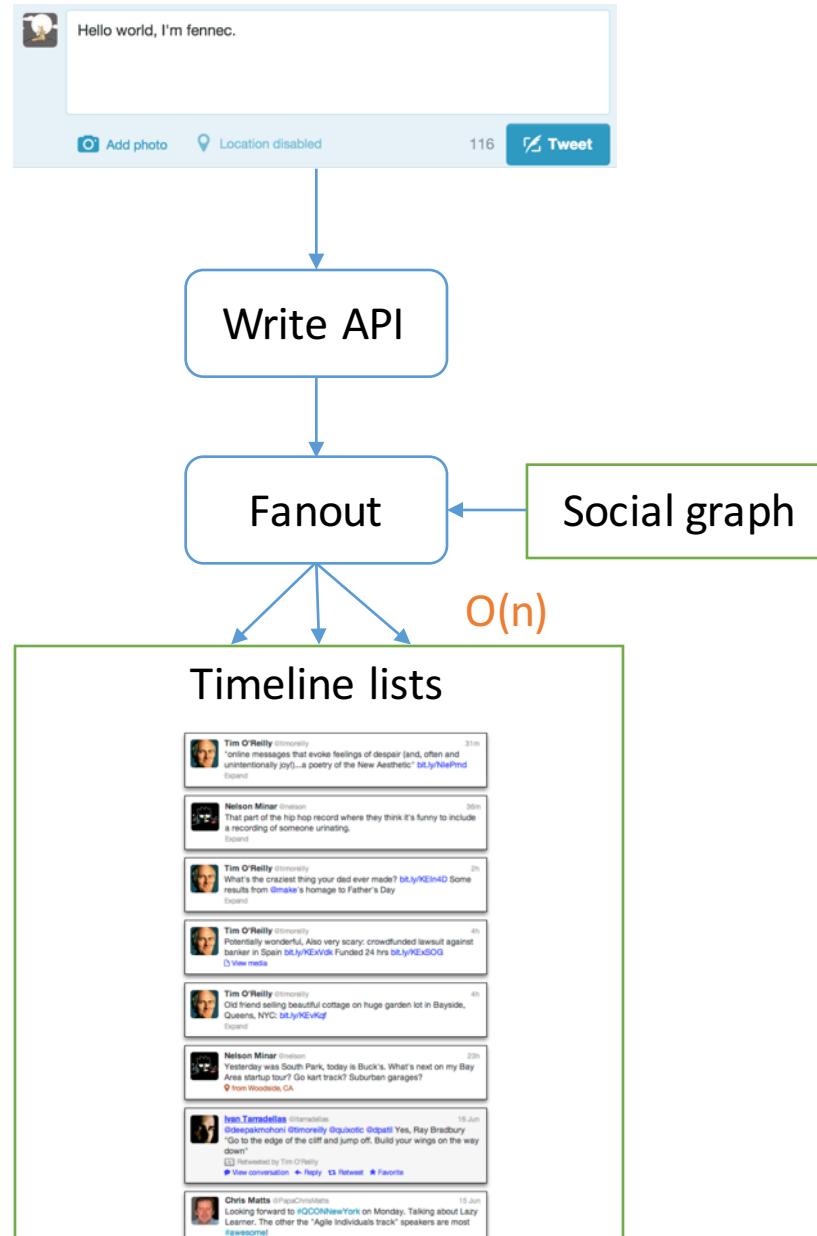
- Read timeline
QPS = 300K
- Write tweet
QPS = 5K
- Notify
 - 1million followers within 1s
- Concurrent users
= 15m
- Daily tweets
= 400m

PUSH MODEL



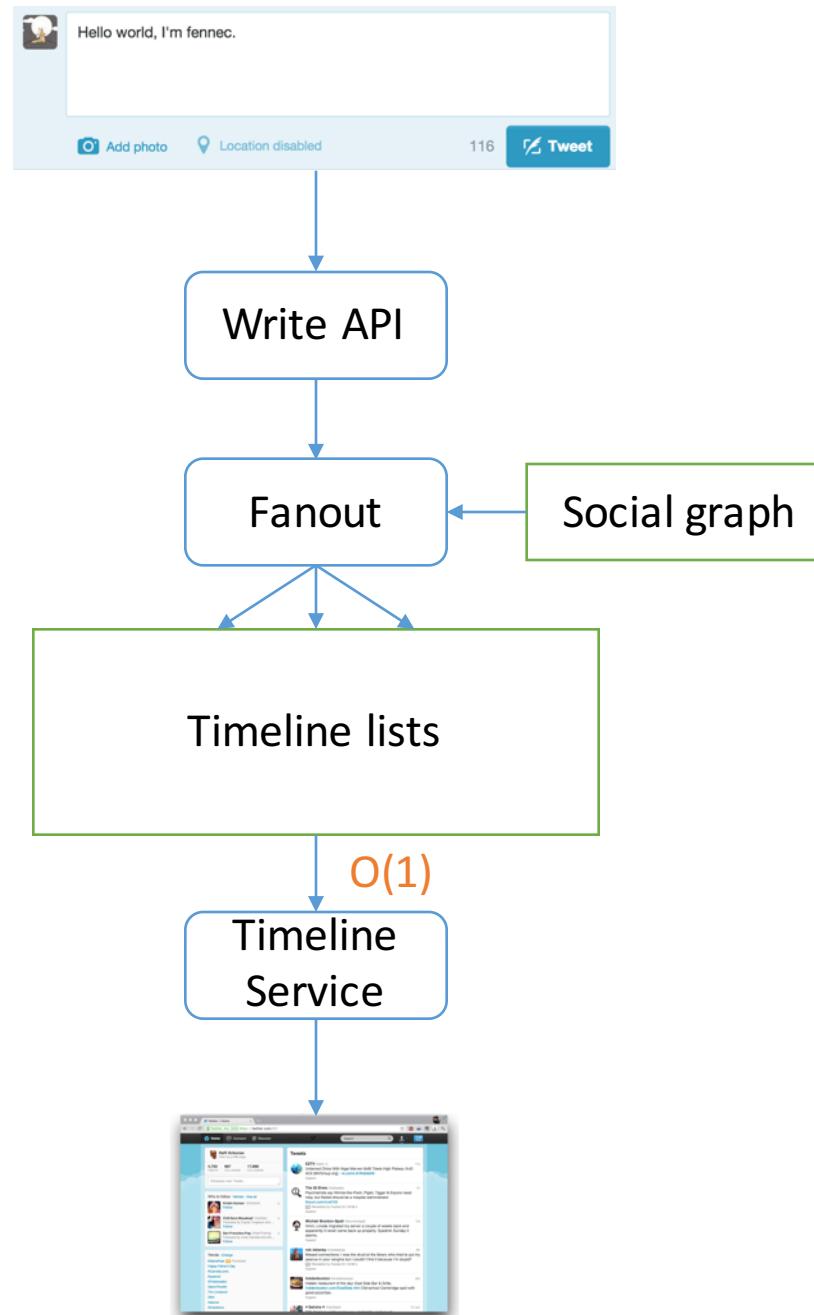
Interviewer: How to write a tweet?

Write a tweet with push



Interviewer: How to read timeline?

Read a timeline with push

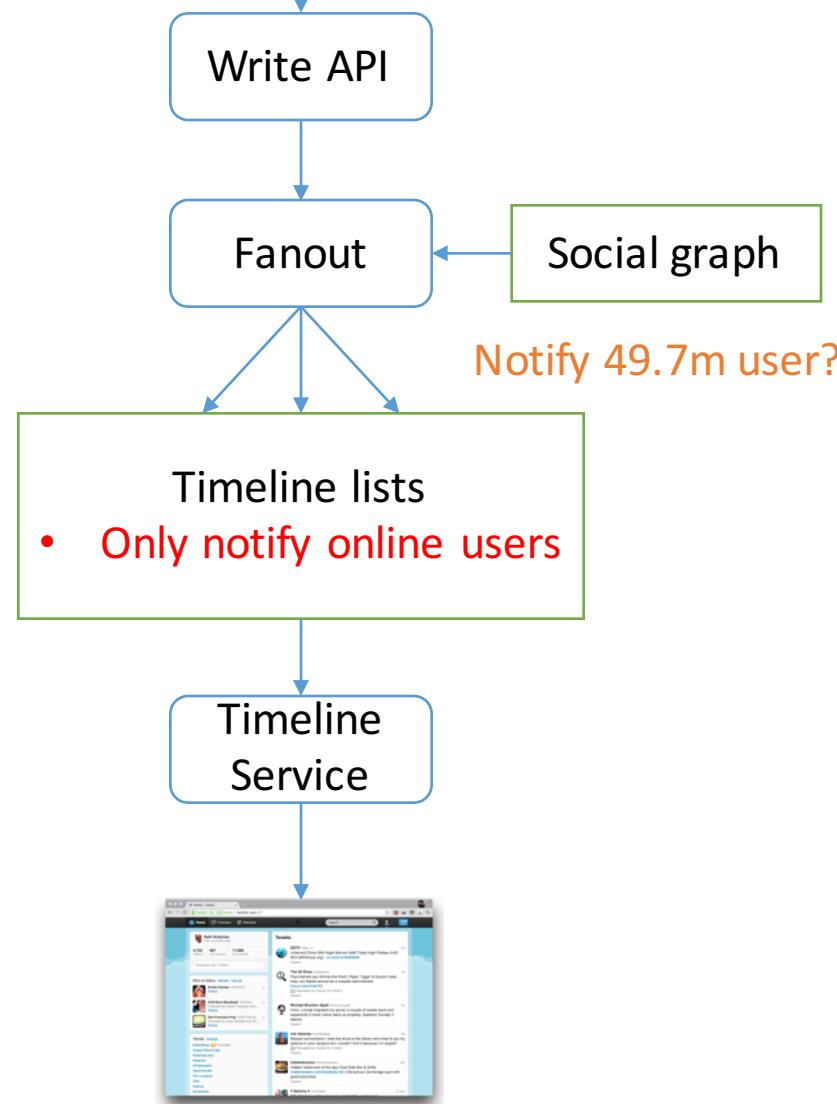


Interviewer: How to deal with the storm of Lady Gaga

The storm of lady gaga



FOLLOWERS
49.7M

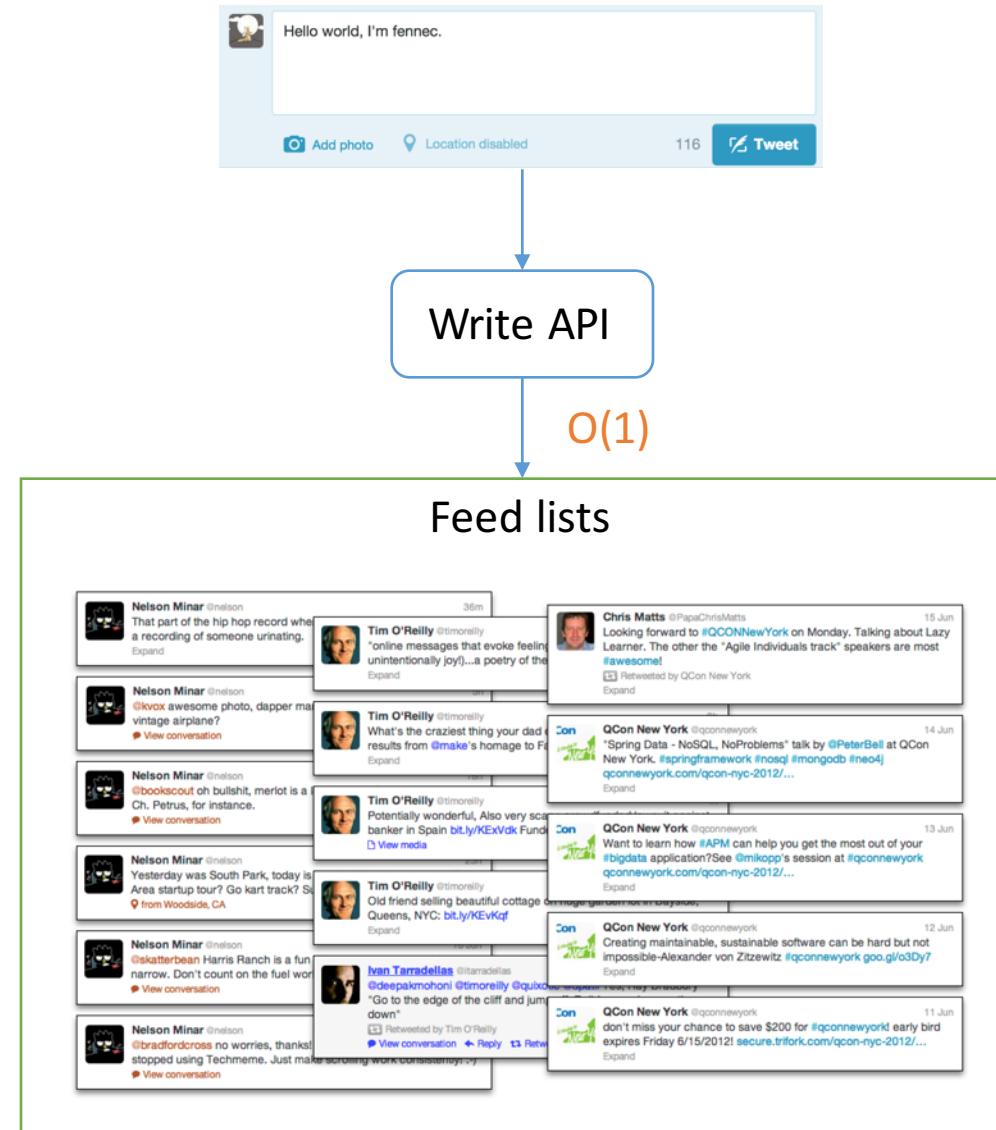


PULL MODEL



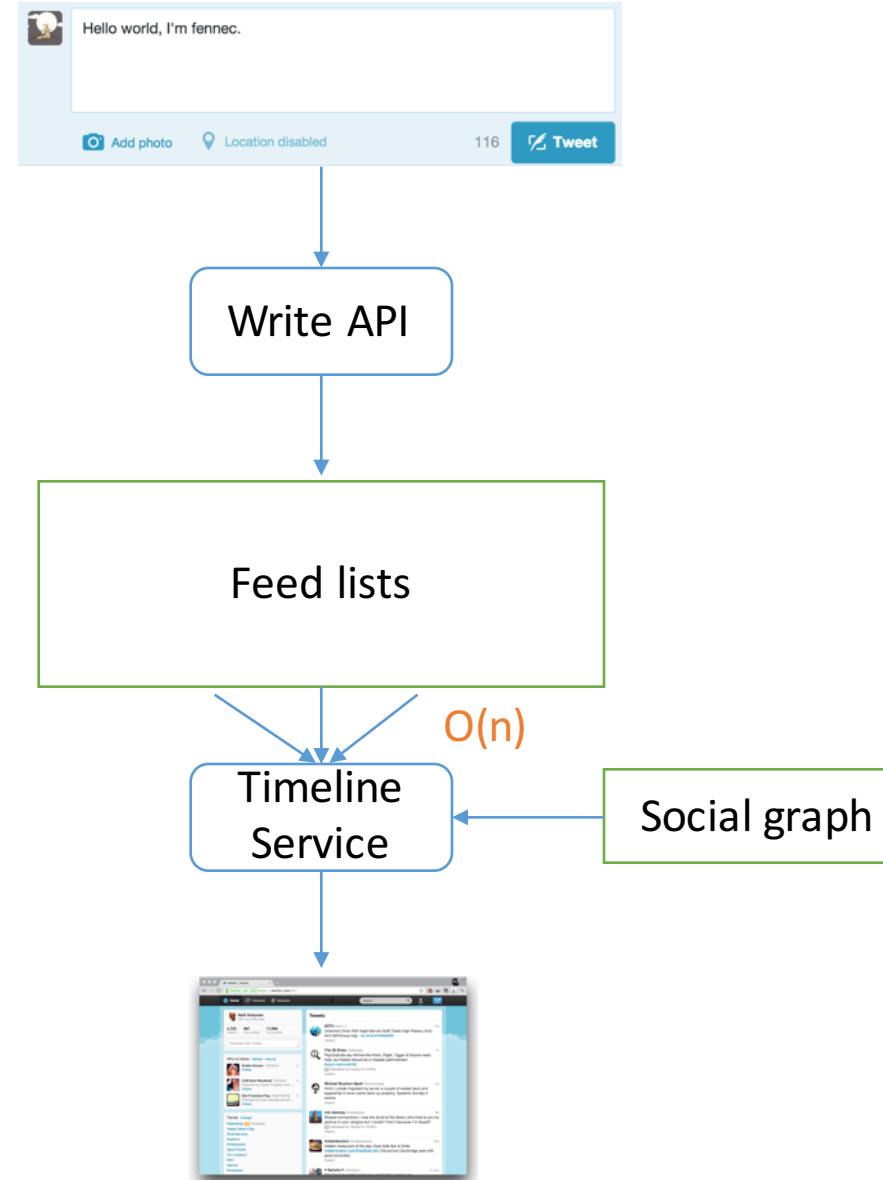
Interviewer: How to write a tweet?

Write a tweet with pull

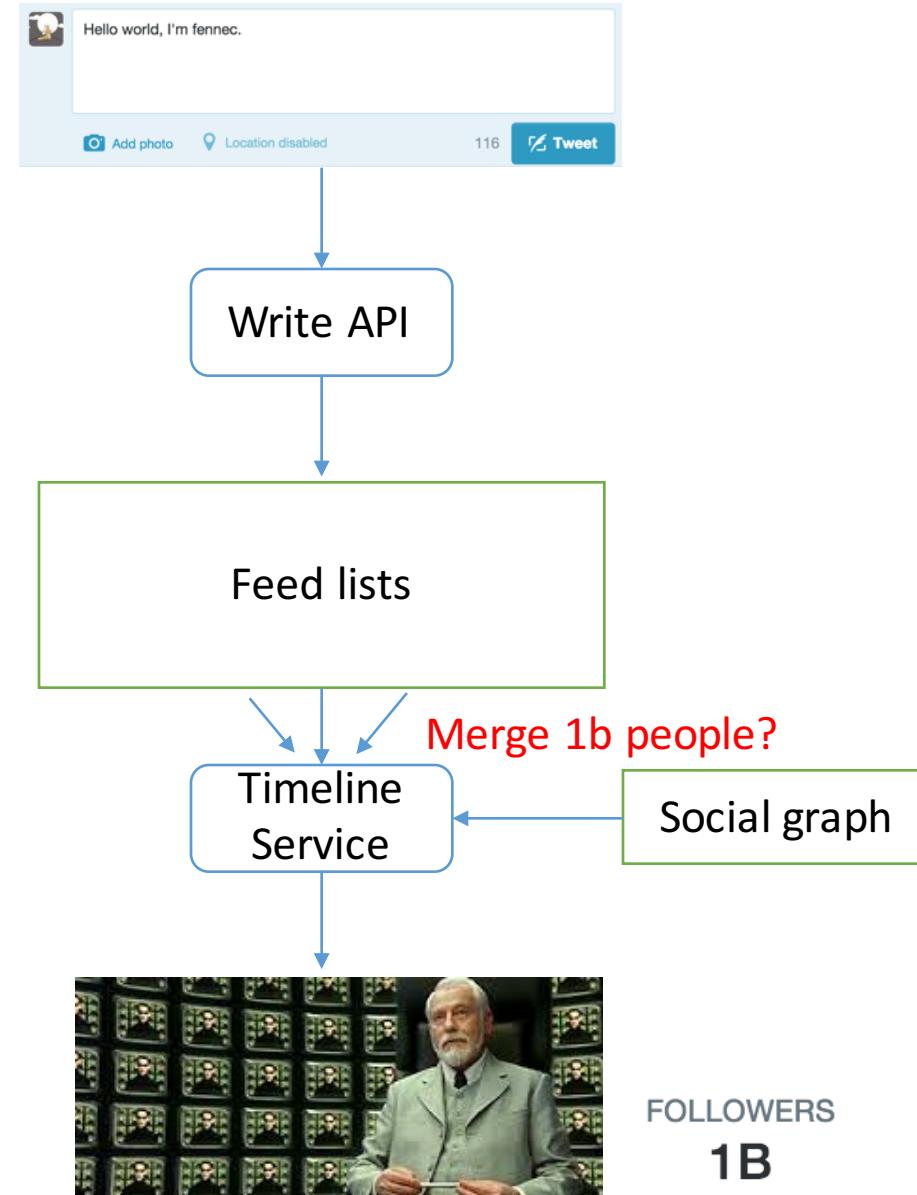


Interviewer: How to read timeline?

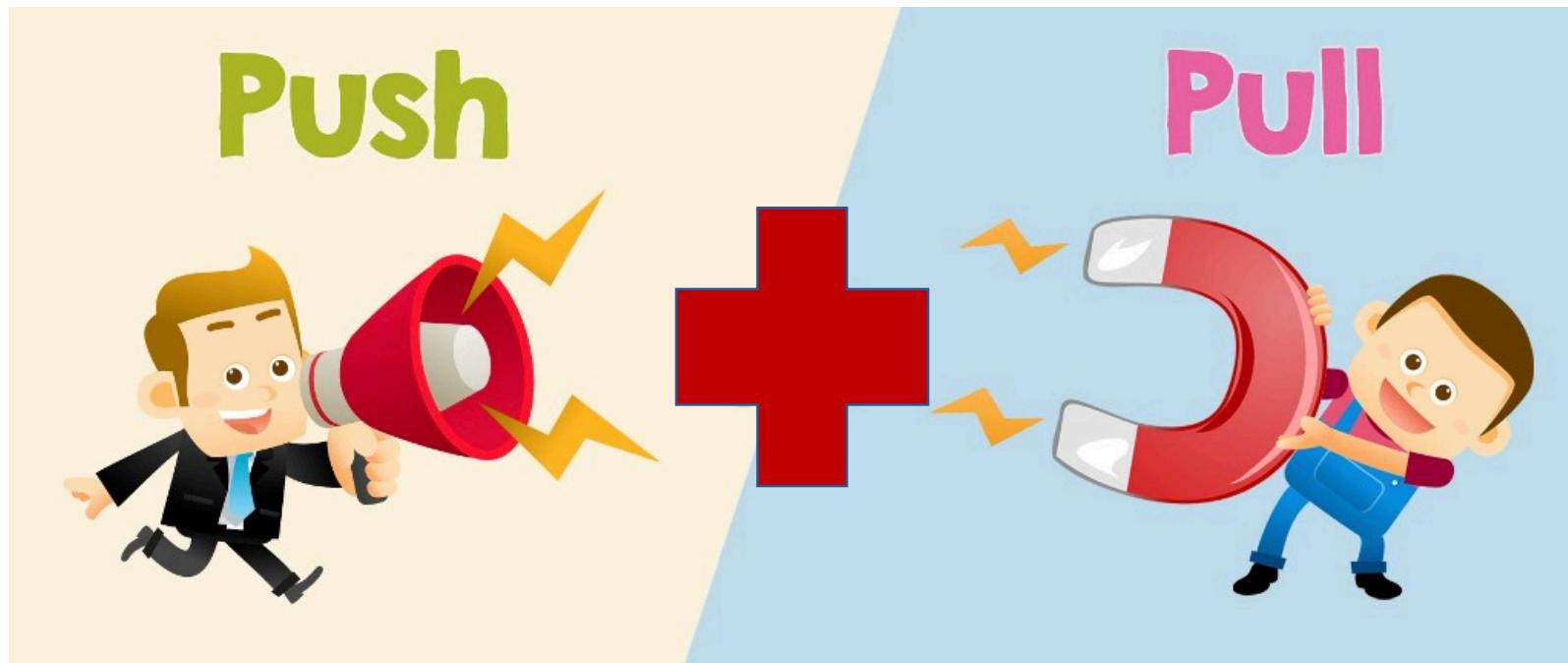
Read a timeline with pull



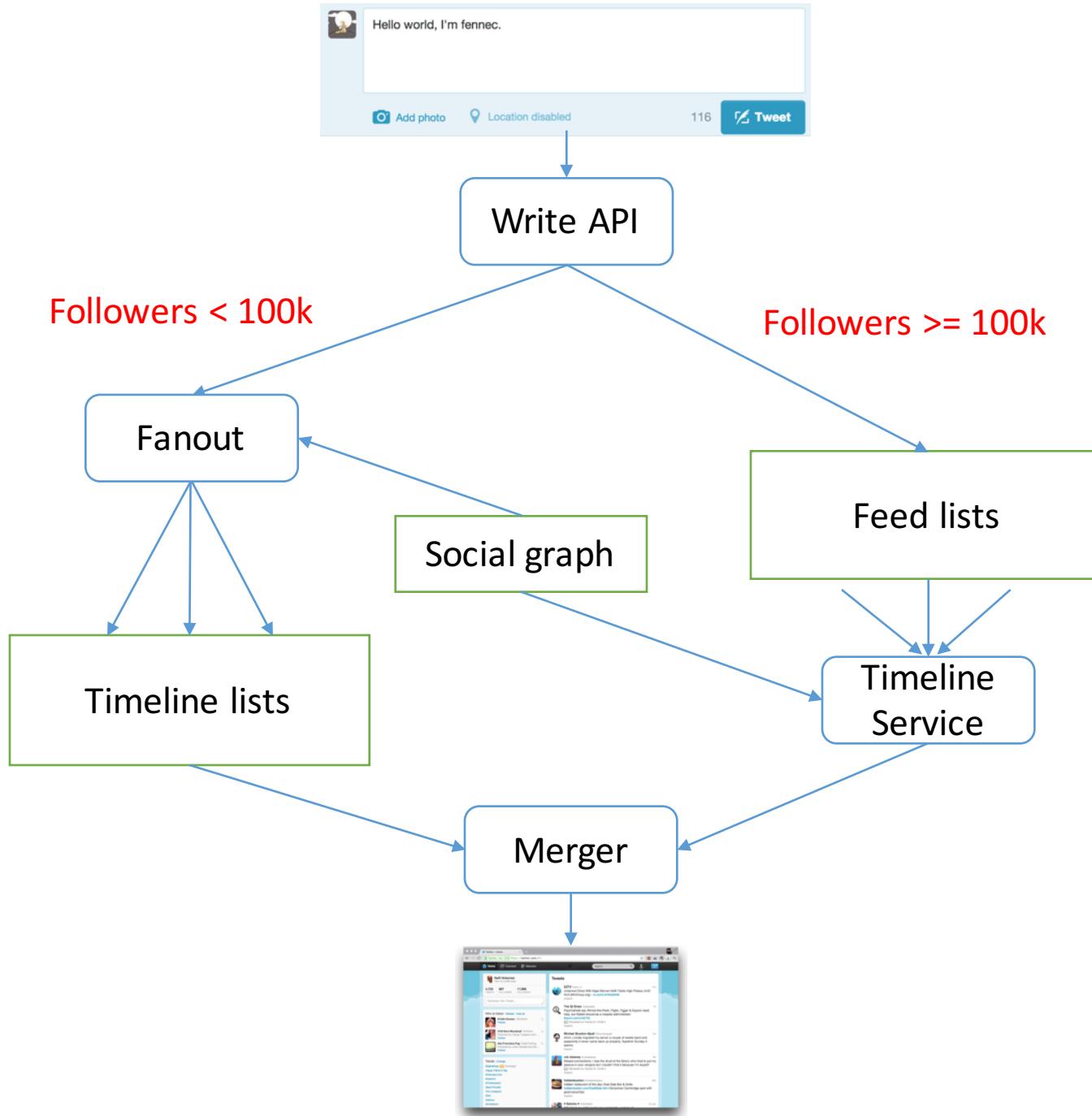
Interviewer: How to deal with the Architect of the MATRIX?



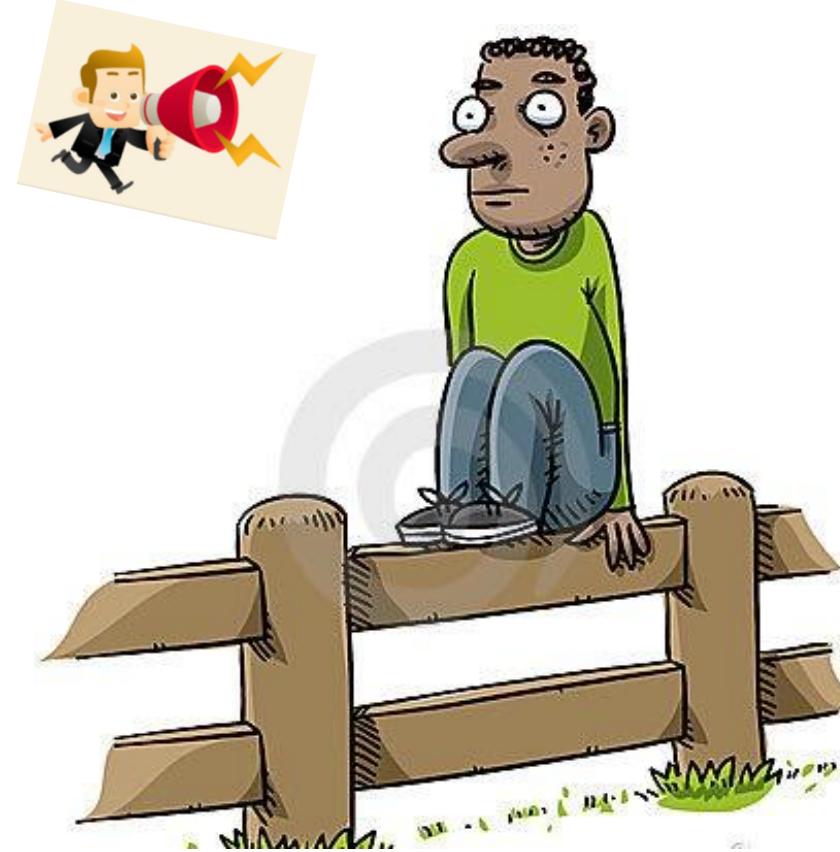
Push & Pull MODEL

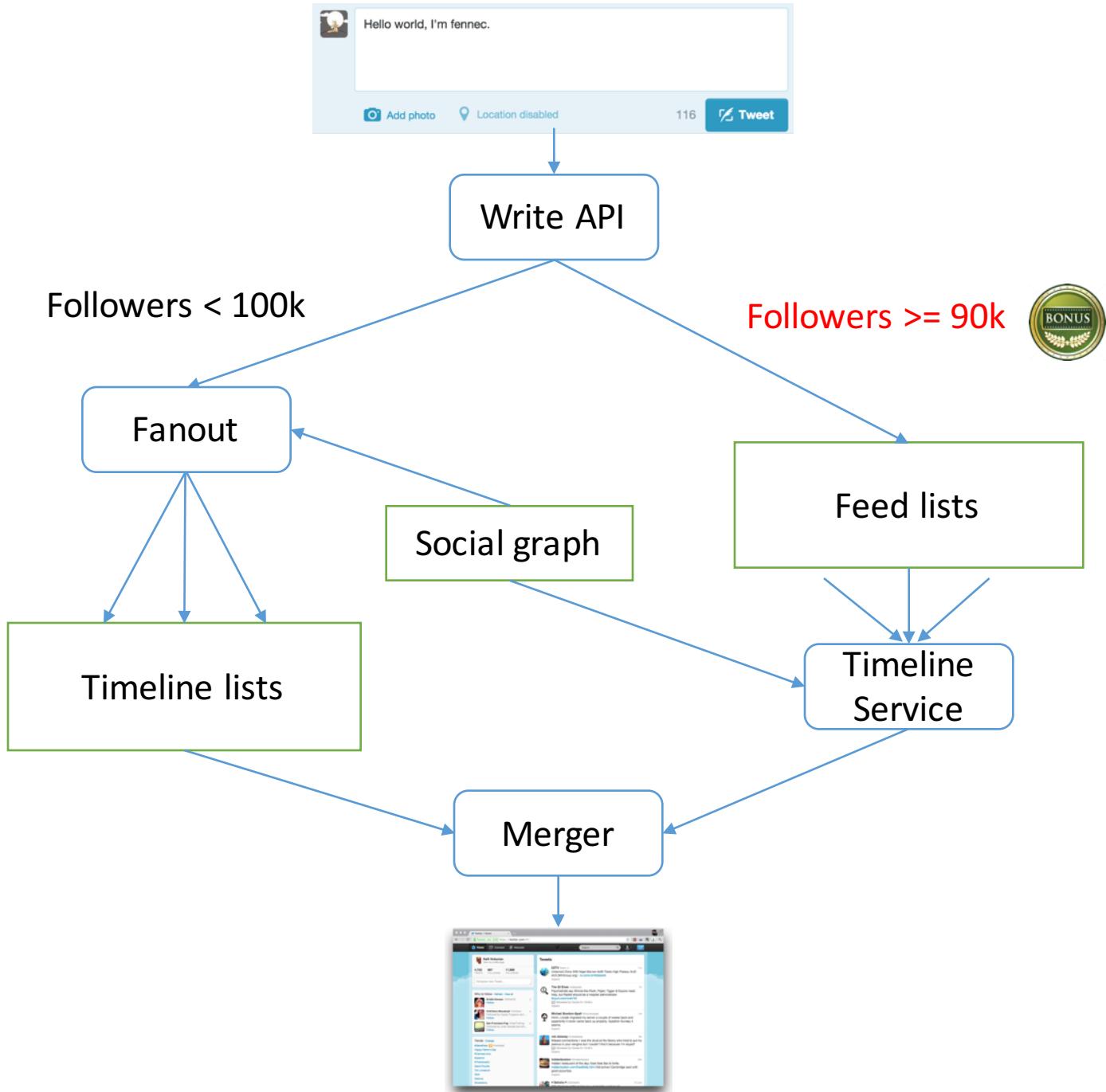


Push & pull



Interviewer: the challenge of vacillation?





Interviewer: How to choose between push and pull?

How to choose pull and push



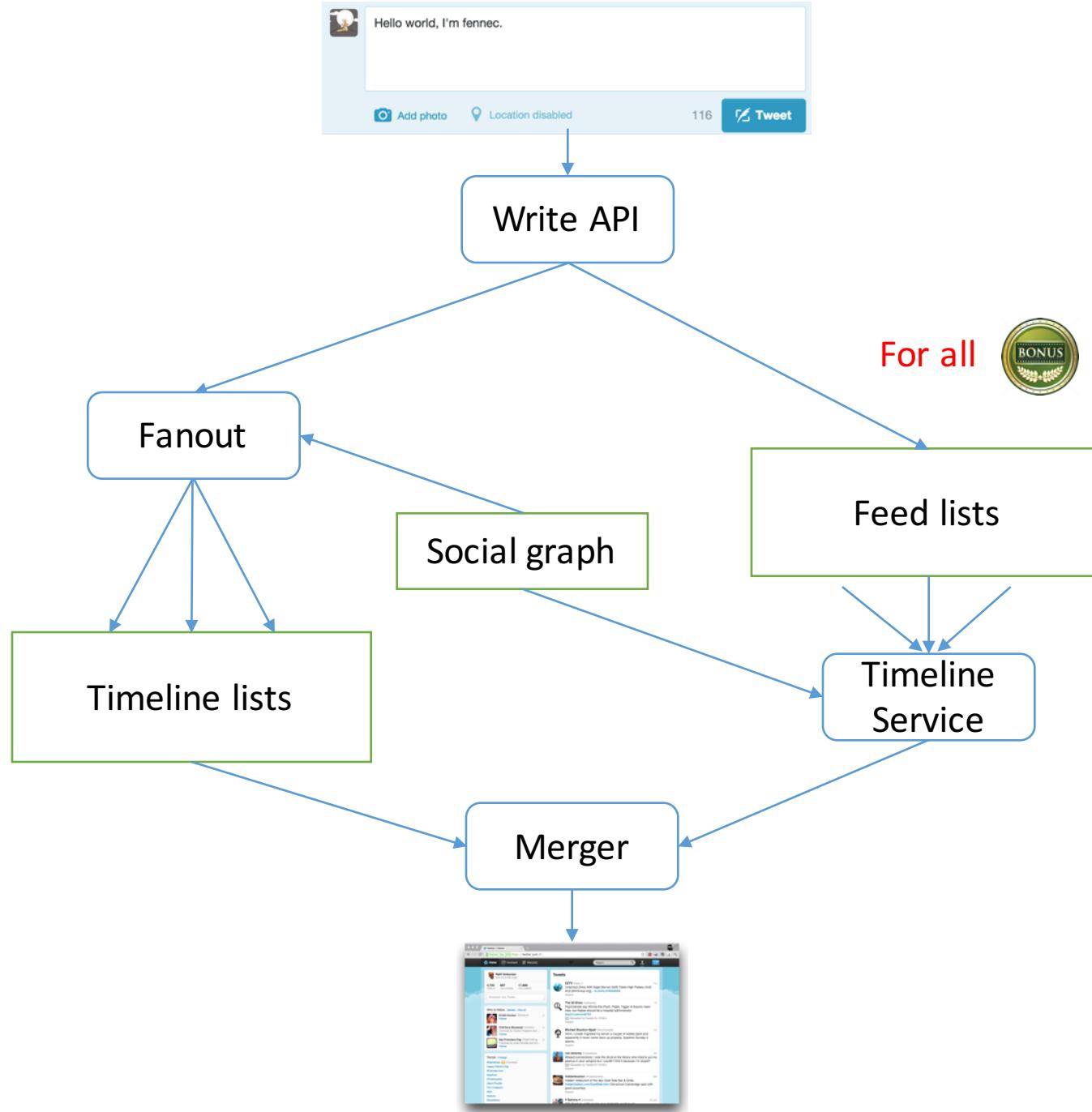
- Understand your specific scenario
- Balance between latency, computation & storage
- $O(n)$ is not workable
- Real time with terrible QPS needs pull
- **Simplicity asks for focusing on one**

Magic number you can know (2015)

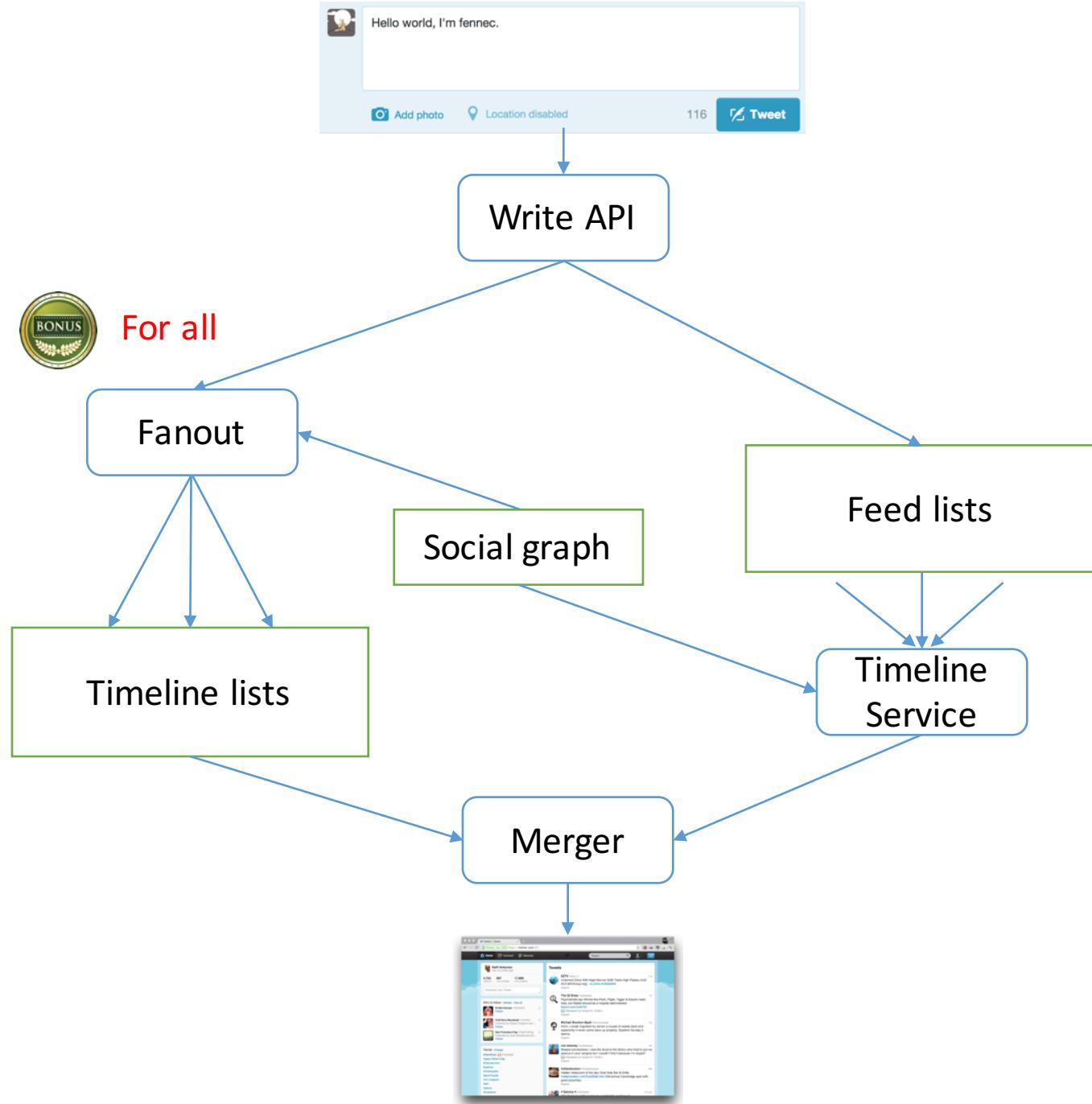
[Read More](#)

Novice/Expert, <http://url.cn/Do4CHm>

Facebook style



Instagram style



Interviewer: How to speed up?

Speed up with memory

Assumption

- 1billion users
- Average feed size: 50 tweets
- Average timeline size: 1000 tweets
- Tweet size: 200B
- Average followers = 30

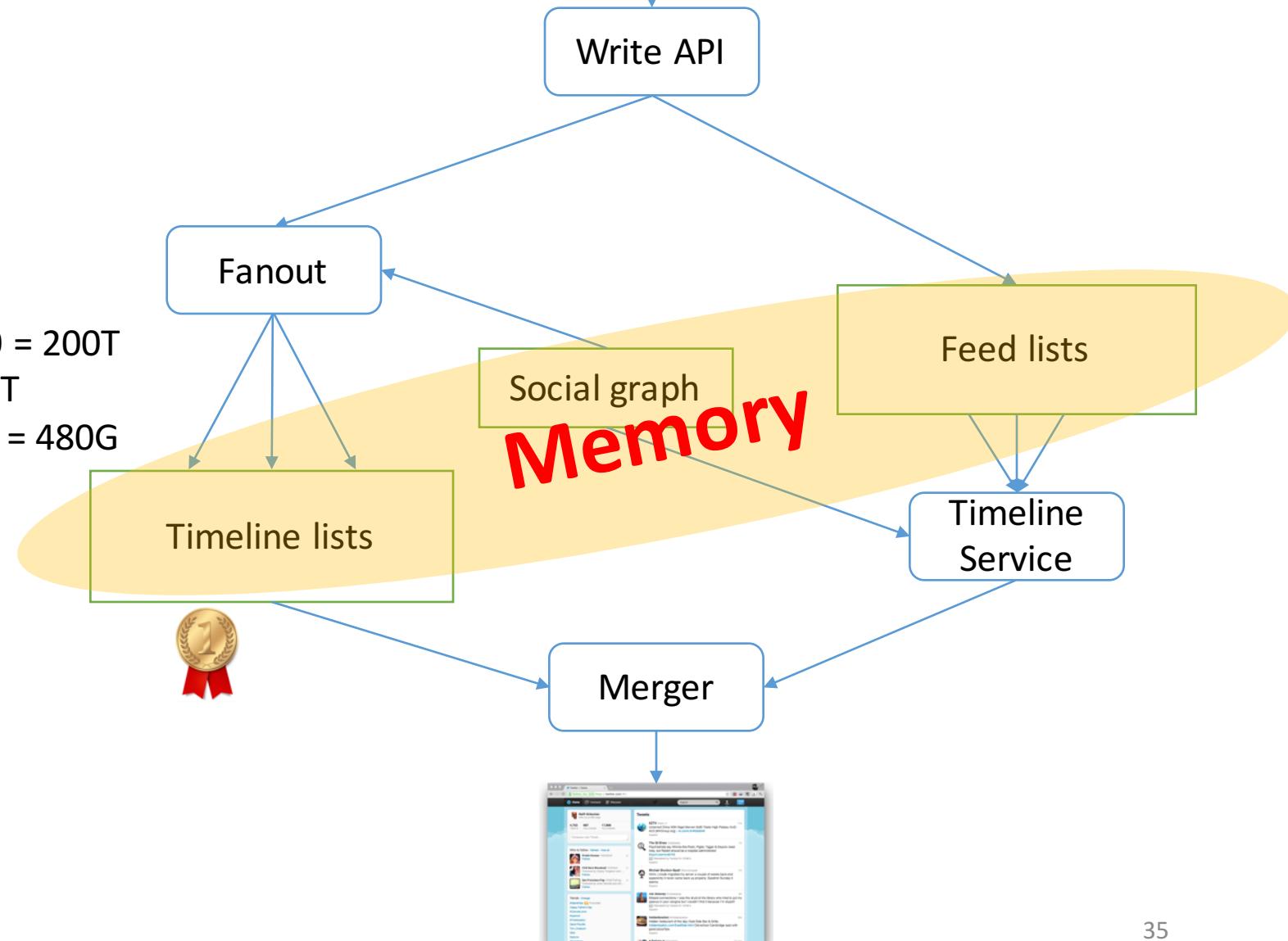
Memory needed

- Size of timeline lists = $1\text{billion} * 10^3 * 200 = 200\text{T}$
- Size of feed lists = $1\text{billion} * 50 * 200 = 10\text{T}$
- Size of social graph = $1\text{billion} * 30 * 2 * 8 = 480\text{G}$

Read More

Novice/Expert/Master, <http://url.cn/bZZASX>

Novice, <http://url.cn/1ob37A>



Interviewer: How to save space?

Save space with active user list

Active user list



- Only cache for the users who is active within 1 week
- Only cache the latest 800 tweets

Assumption

- Weekly active users: 100 million
- Average feed size: 80 tweets
- Average timeline size: 500 tweets
- Tweet size: 200B
- Average followers = 20

Memory need

- Size of timeline lists = $100\text{million} * 500 * 200 = 10\text{T}$
- Size of feed lists = $100\text{million} * 80 * 200 = 1.6\text{T}$
- Size of social graph = $100\text{million} * 20 * 2 * 8 = 32\text{G}$



Write API

Fanout

Social graph

Feed lists

Timeline lists

Timeline Service

Merger



Hello world, I'm fennec.

Add photo

Location disabled

116

Tweet

Merger

Save space by separating tweet content



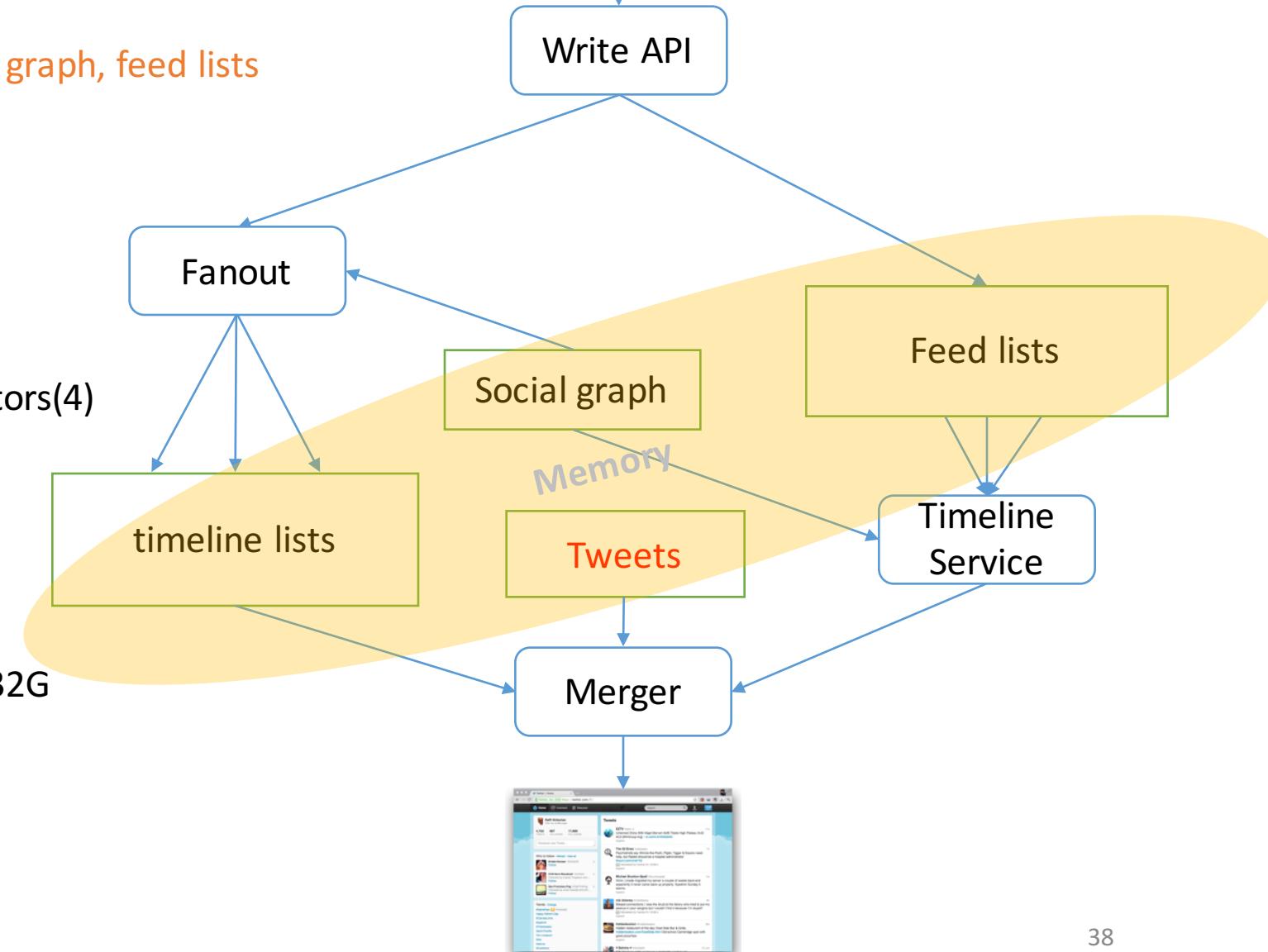
- Only TweetIDs are stored in timeline lists, social graph, feed lists
- Tweet contents are appended in merger

Assumption

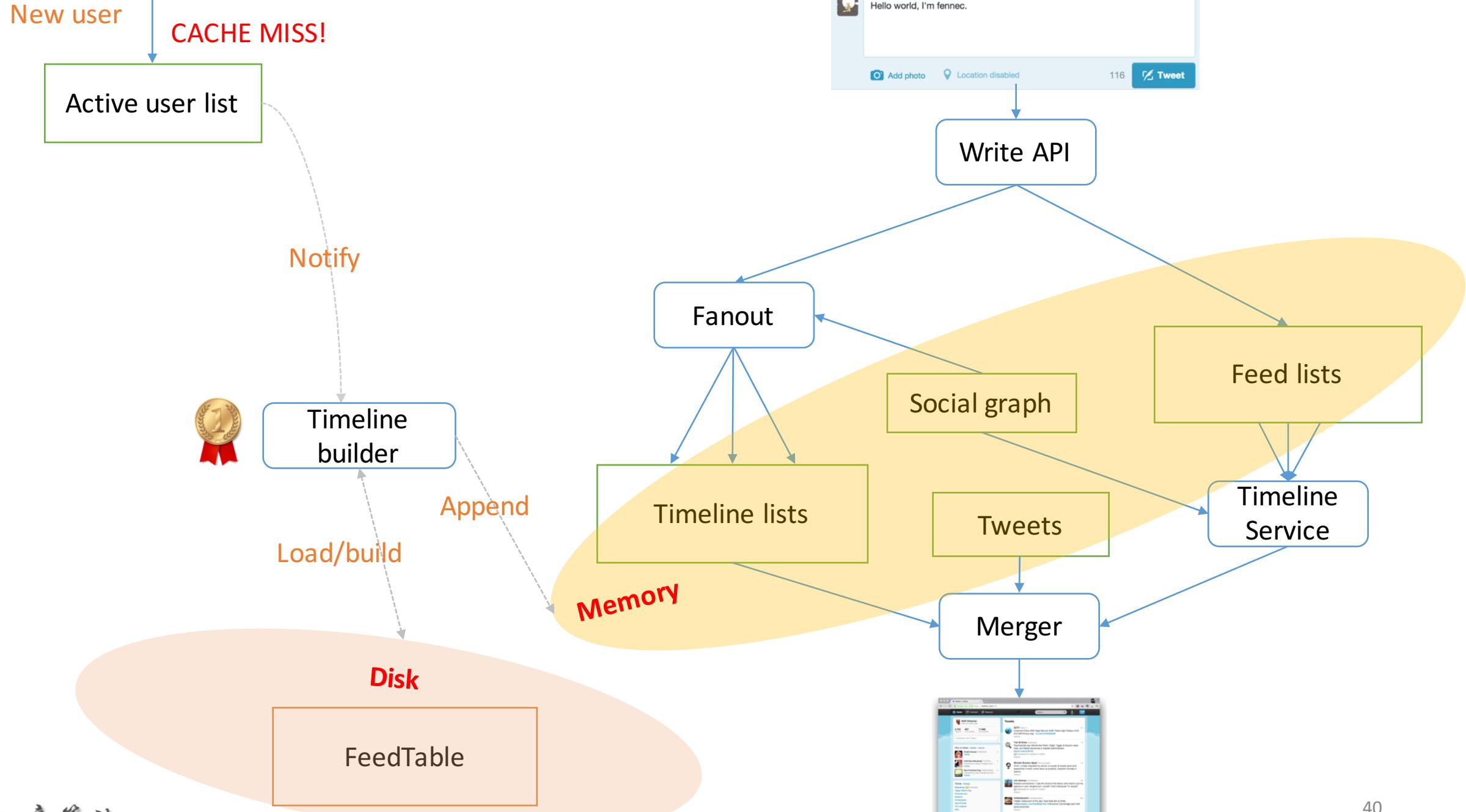
- Weekly active users: 100 million
- Average feed size: 80 tweets
- Average timeline size: 500 tweets
- Tweet size: $20B = \text{userID}(8) + \text{tweetID}(8) + \text{indicators}(4)$
- Average followers = 20

Memory needed

- Size of timeline lists = $100\text{million} * 500 * 20 = 1T$
- Size of feed lists = $100\text{million} * 80 * 20 = 160G$
- Size of social graph = $100\text{million} * 20 * 2 * 8 = 32G$



Interviewer: How to deal with
cache miss?



Interviewer: What is the interface
of timeline builder?

New user

Active user list

Notify

Timeline
builder

Load/build

Append

Disk

FeedTable



Write API

Fanout

Timeline lists

Social graph

Tweets

Feed lists

Timeline Service

Merger



Memory

Interface



- Get(userIDList)
- Get(userIDList, k)
- Get(userIDList, k, endTime)
- Get(userIDList, k, endTime, beginTime)



Interviewer: What is the data of timeline builder?

TweetListTable



TweetID	UserID	Time	Content	State
274	22	2015-08-14 19:35:13	I Love YOU	Verify
273	54	2015-08-14 19:34:00	Eat my food	Active
272	17	2015-08-14 19:33:33	f***	Ban
271	22	2015-08-14 19:32:31	I Miss YOU	Delete
270	19	2015-08-14 19:32:05	Whooooo	Active

TweetListTable



TweetID	UserID
274	22
273	54
272	17
271	22
270	19

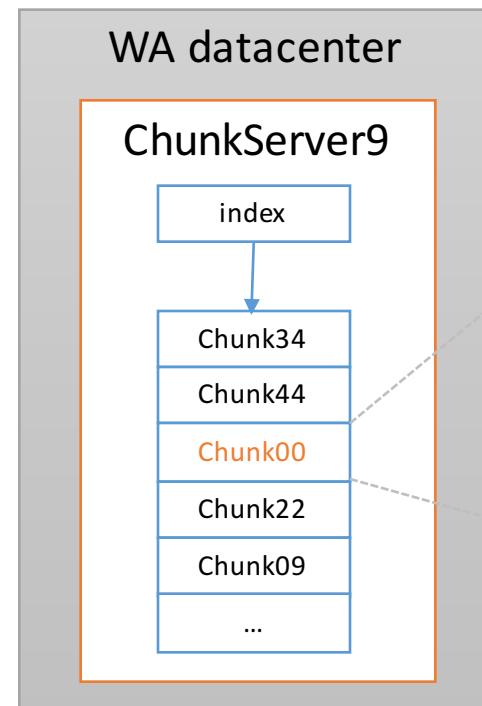
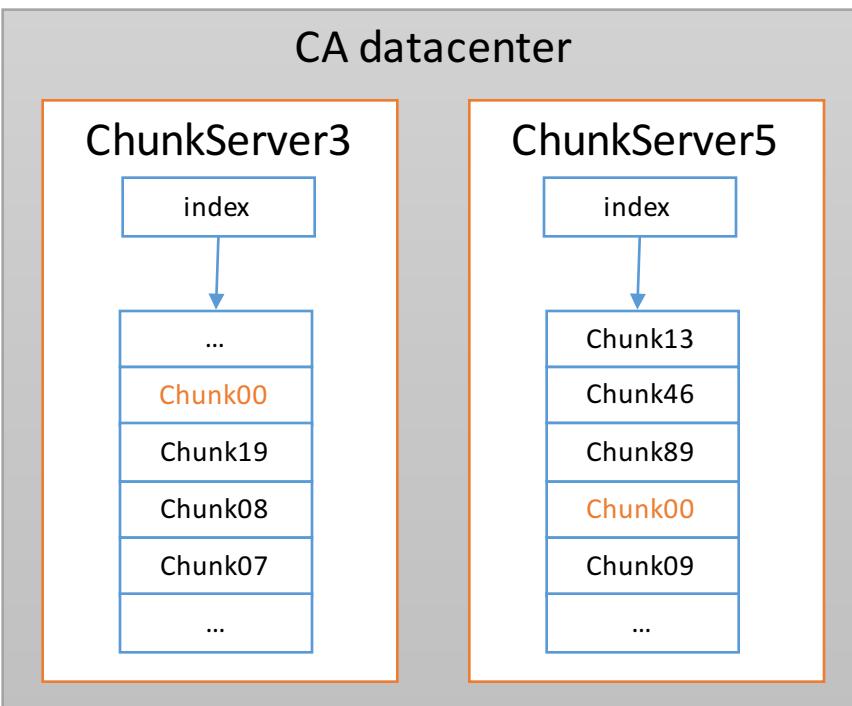
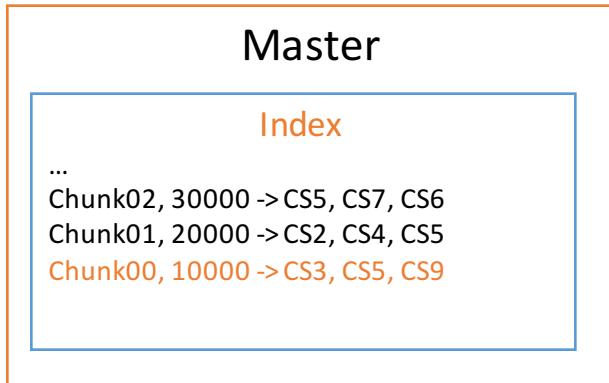
Quiz: have you reviewed
PPT after classes?



Interviewer: How to save the
TweetListTable on disk?

Save TweetListTable

- Each chunk is a 64MB of time capsule/chunk
 - Reversed TweetID to speedup lookup



TweetID	UserID
...	
274	2
273	54
272	17
271	22
270	19
...	
...	
...	

Interviewer: How to lookup on a
chunk of time capsule?

Get({2, 12, 22})



Time complexity: $O(n)$

time capsule

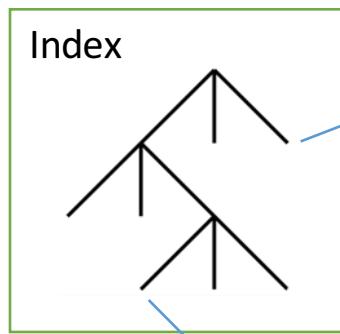
...	
274	2
273	54
272	17
271	22
270	19
269	22
268	33
267	22
266	19
265	5
264	2
263	7
...	

Interviewer: How to speed up?

Speed up: Get({2, 12, 22})



time capsule



(22)

(2)

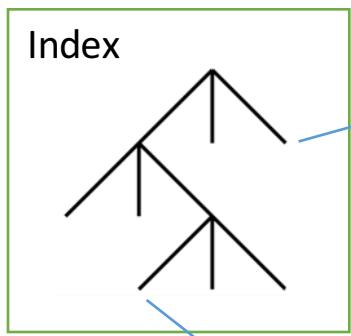
Time complexity: $O(q * \log(n) + k)$

...	54
273	54
...	33
268	33
...	22
271	22
269	22
267	22
...	19
270	19
266	19
...	17
272	17
...	7
263	7
...	5
265	5
...	2
274	2
264	2
...	

Interviewer: How to save space?

Save space: Get({2, 12, 22})

time capsule



(22, 3)

(2, 2)

...	
273	
...	
268	
...	
271	
269	
267	
...	
270	
266	
...	
272	
...	
263	
...	
265	
...	
274	
264	
...	

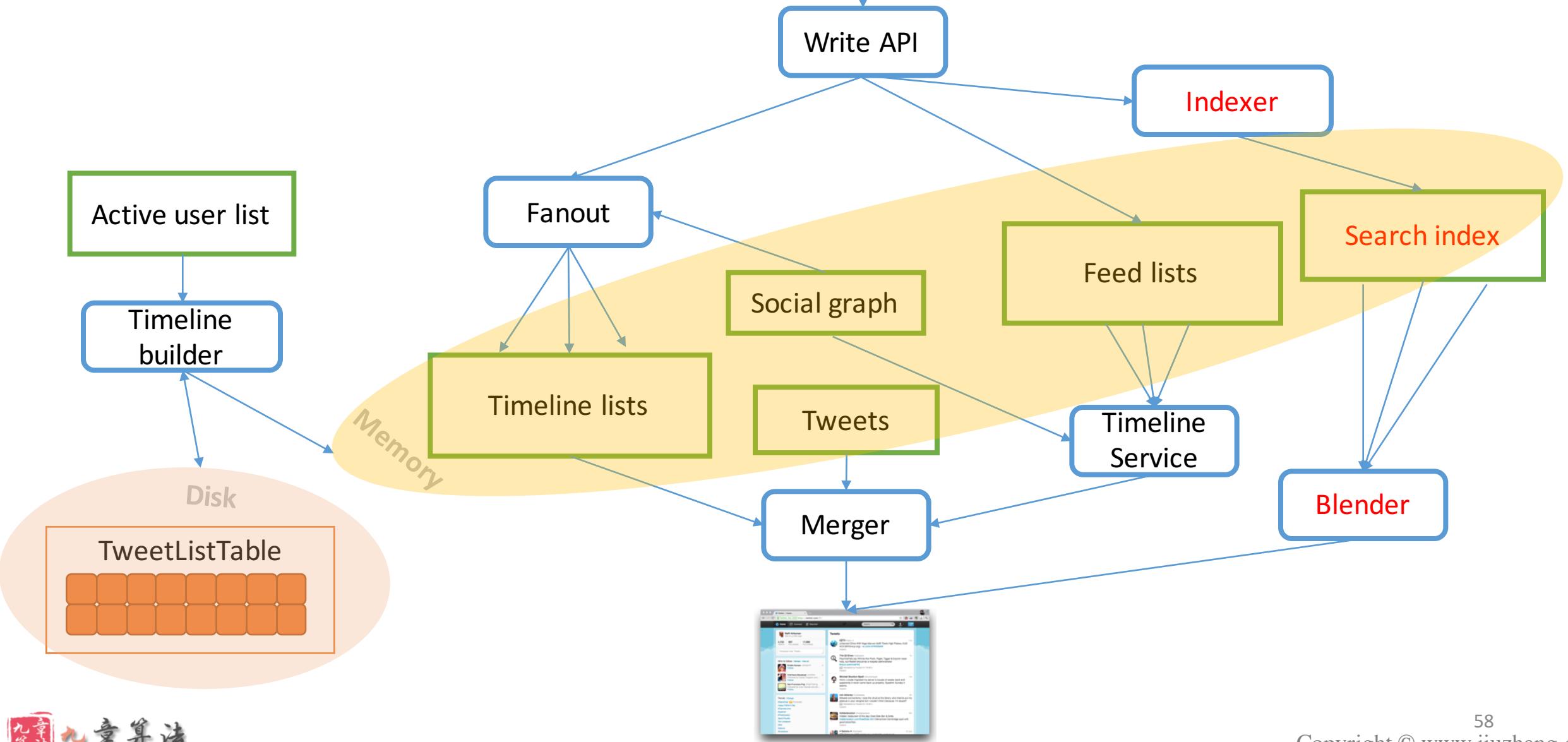


Compress

...	54
273	
...	33
268	
...	22
271	
269	
267	
...	22
270	19
266	19
...	
272	17
...	
263	7
...	
265	5
...	
274	2
264	2
...	

Interviewer: How to support search?

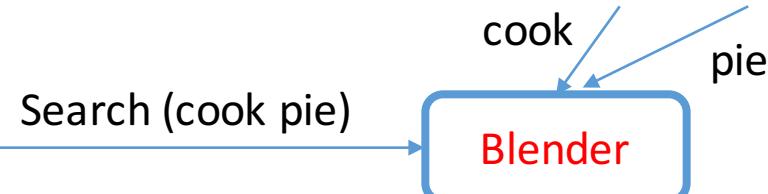
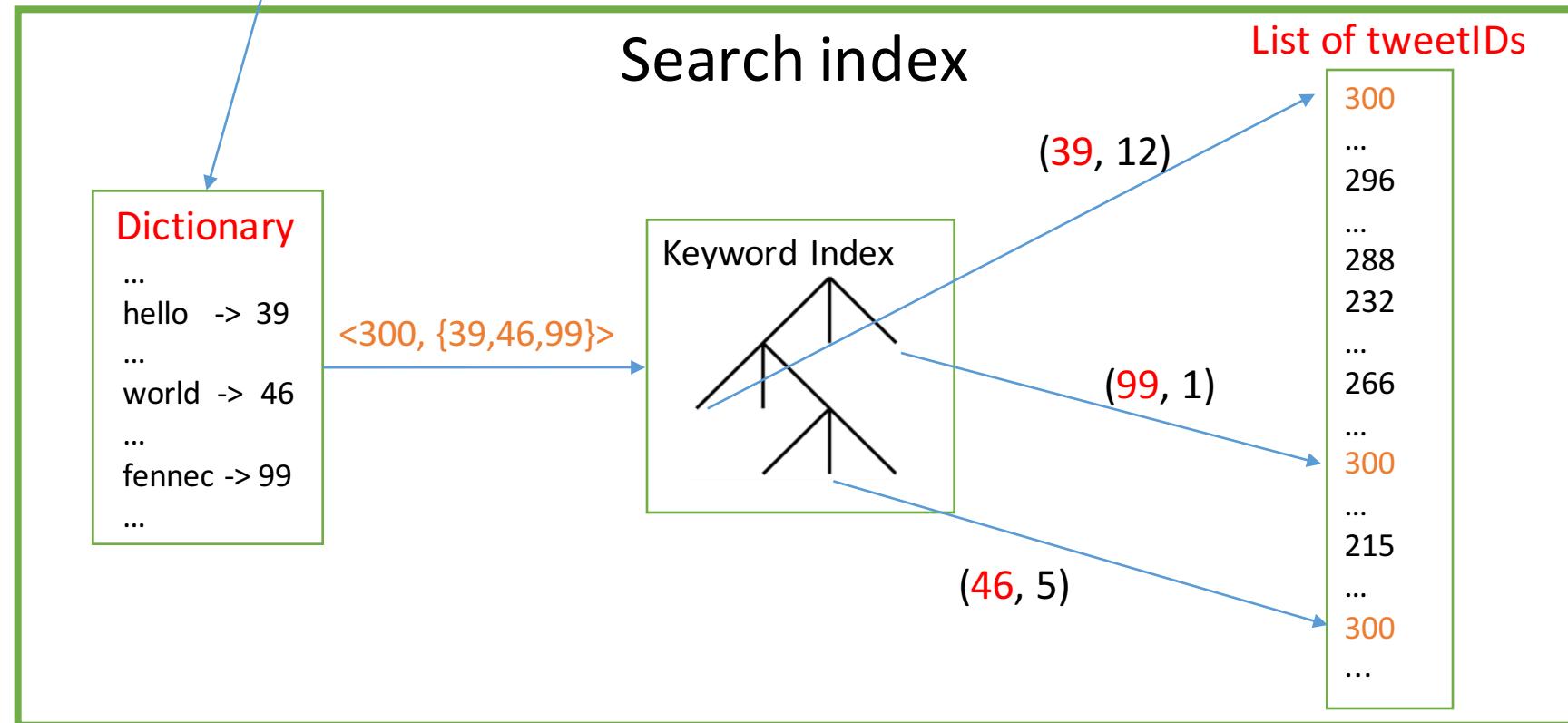
Support search



Search process



(tweetID=300, keyword = {hello, world, fennec})



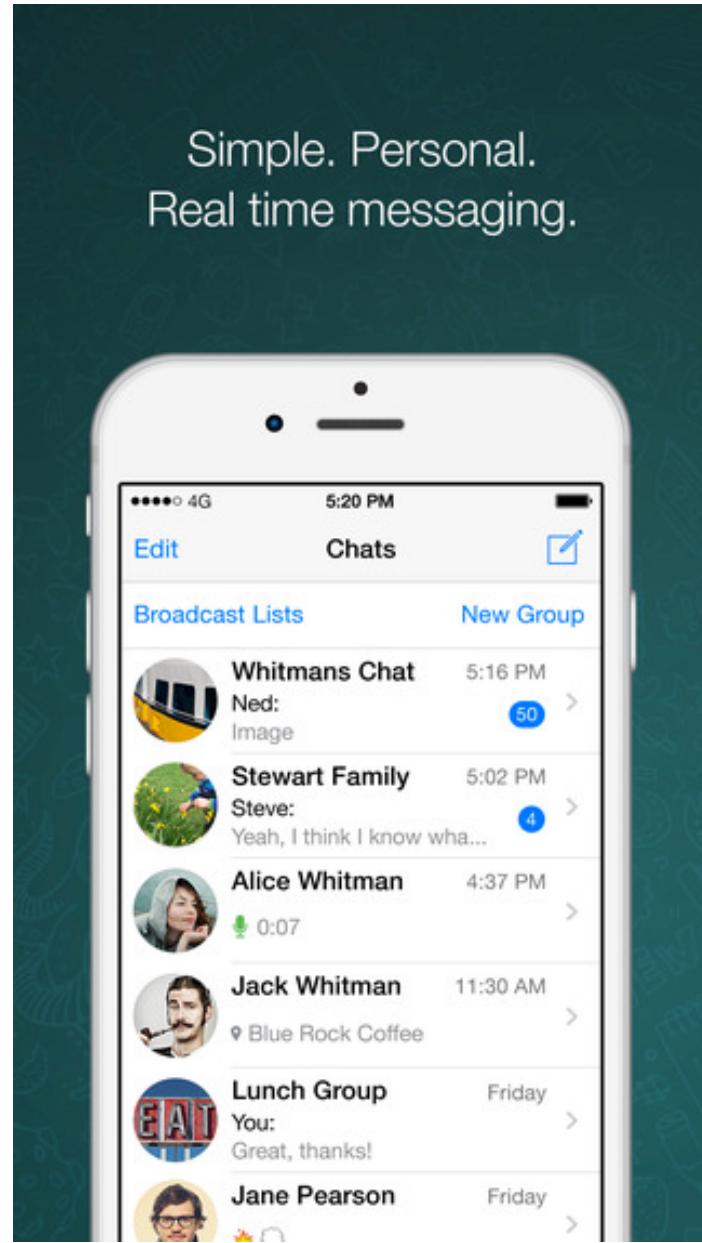
Part1 Summary (12+12)



Part 2, Chat

[Read More](#)

Expert, <http://url.cn/cNRIYQ>



Interviewer: Design data structure



UserTable

uid, parameters
uid, parameters

...

FriendTable

uidFrom, uidTo, state
uidFrom, uidTo, state

...

ChannelTable

cid, uid, state
cid, uid, state

...

MessageTable

mid, time, uid, cid, content
mid, time, uid, cid, content

...

Interviewer: How to choose the storage?

[Read More](#)

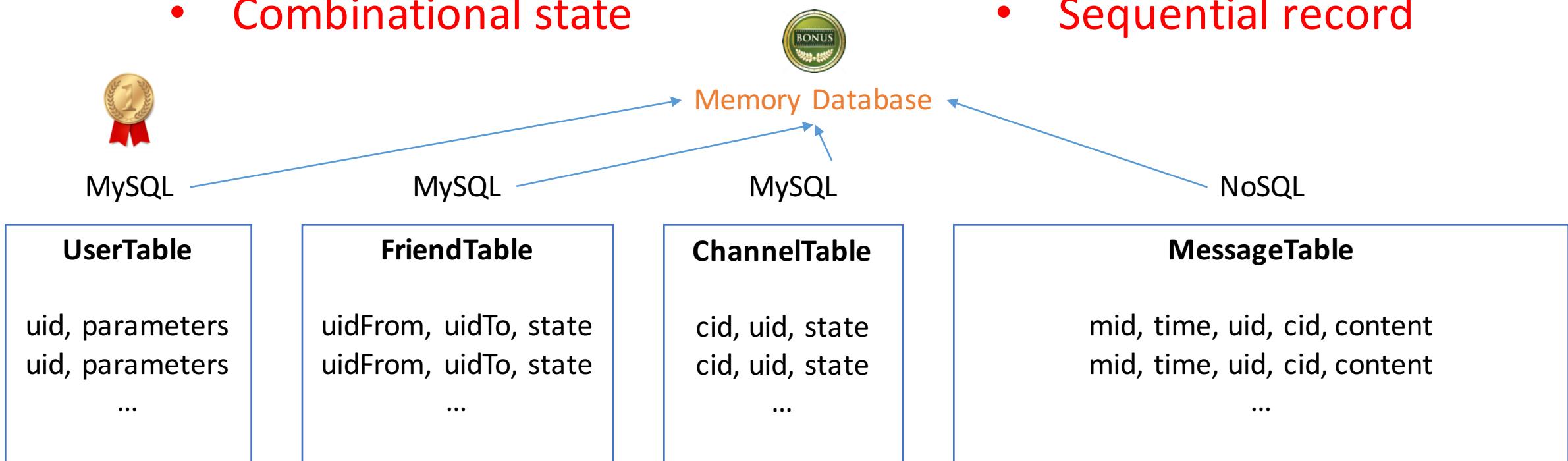
Expert/Master, <http://url.cn/Xv8Vm0>

SQL

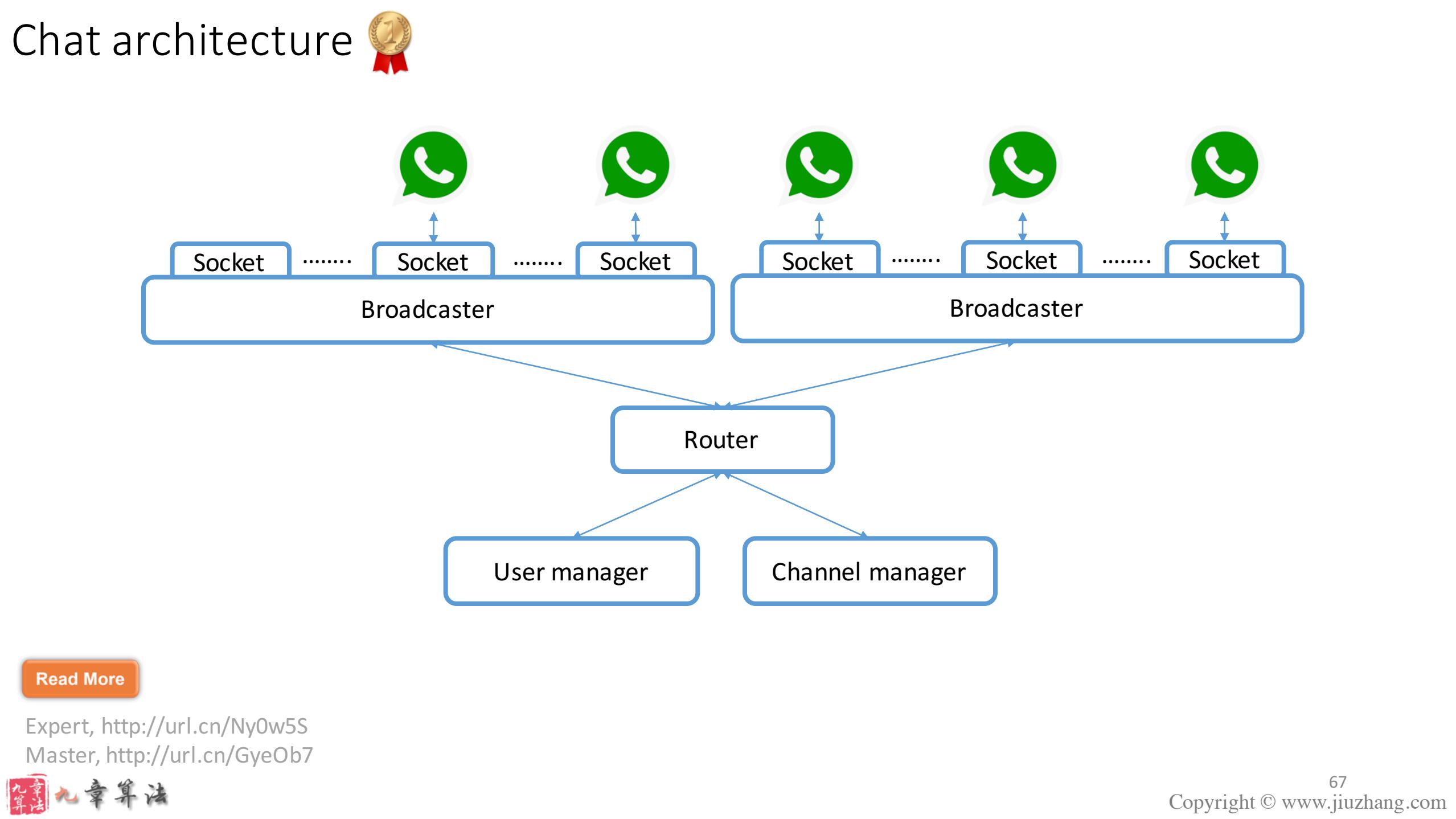
- Relationship
- Edit
- Correct
- Transaction
- Combinational state

NoSQL

- K/v pair
- Append
- Tolerant
- Performance
- Sequential record



Interviewer: What is the architecture?



Interviewer: How to support
chat group with 1 million users?

Necessaries

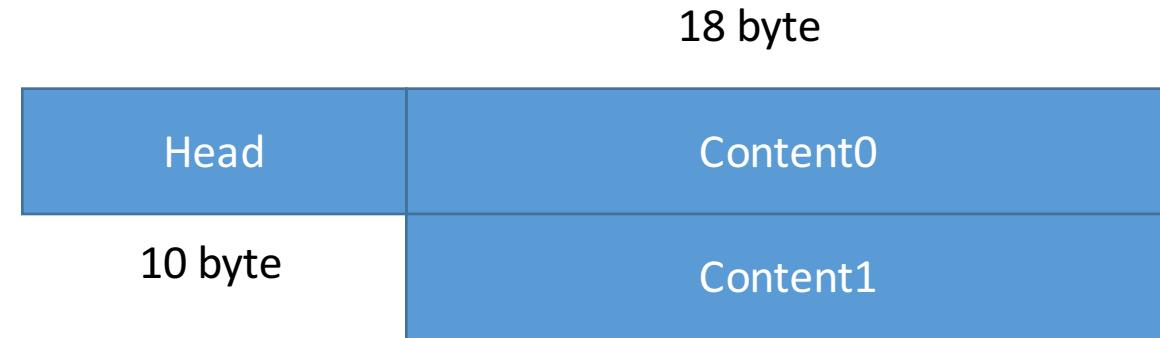


Head	Content	Tail
10 byte	18 byte	2 byte

- Assumption
 - 1 message/user/10min
 - Message = 30 Byte
- Message per second= $10^6/600 = 1,667$
- Traffic for one= $1,667 * 30 = 50\text{KB/s}$
- Traffic for all = $50 * 10^6 = \text{50GB/s}$

Interviewer: How to save the traffic?

Batch message



- Message per second = $10 * 6 / 600 = 1,667$

- Traffic for one = $1,667 * 18 = 30 \text{ KB/s}$

- Traffic for all = $30 * 10^6 = 30\text{GB/s}$



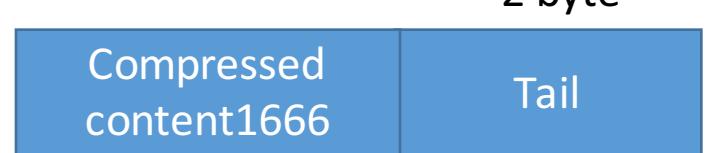
Compress content



- Message per second = $10 * 6 / 60 = 1,667$



- Traffic for one = $1,667 * 9 = 15$ KB/s



- Traffic for all = $15 * 10^6 = 15$ GB/s

Read More

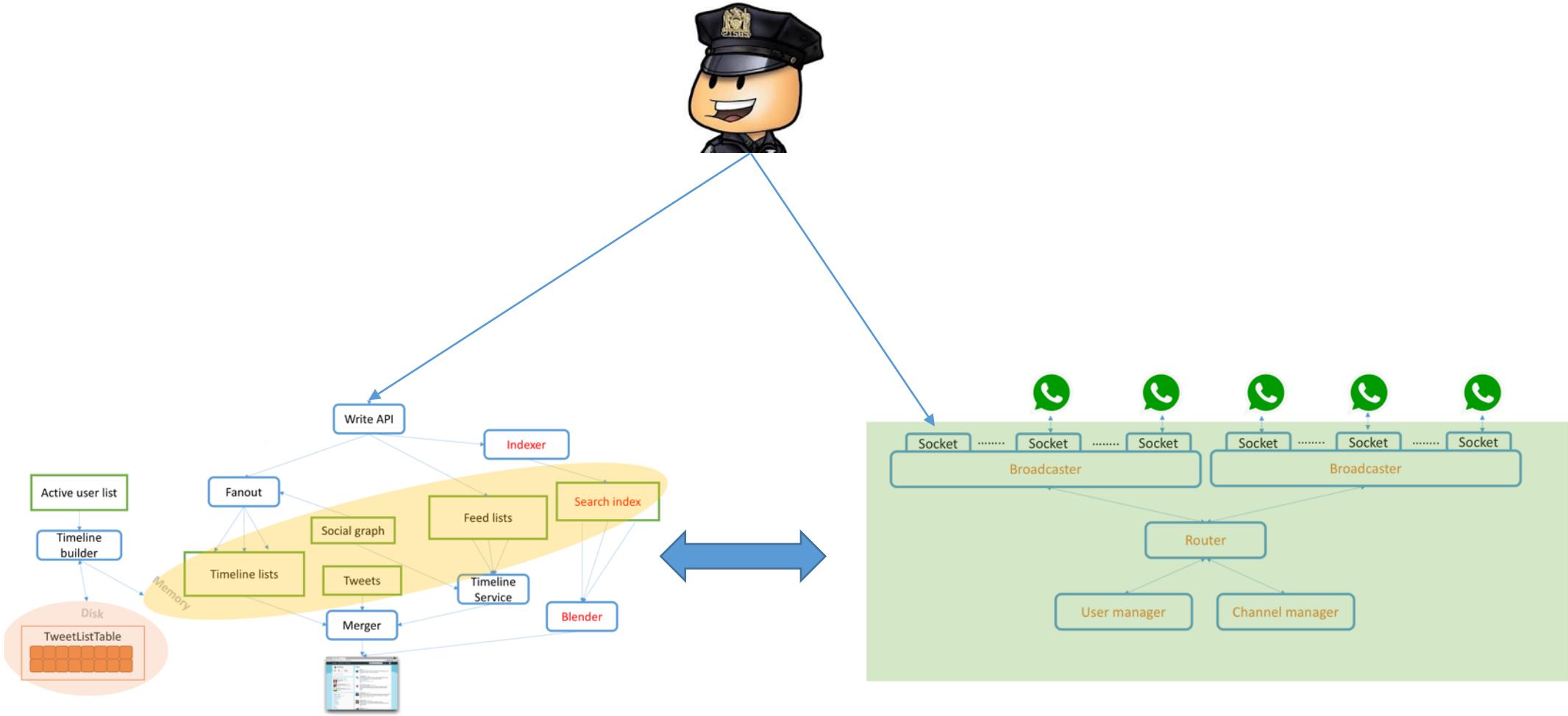
Expert, <http://url.cn/em8PuX>

Interviewer: How to save the message when a user is offline?

Interviewer: How to support
chat history?

Interviewer: How to support
search on chat history?

Combination of architectures



Interviewer: How to support
timeline notification in Twitter?

#apple

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Top 10 Movies @itmovierank · 1m

Australia 97. Nick & Norah's Infinite Playlist - Peter Sollett tinyurl.com/po0nmnk
#Movies #iTunes #iPhone #Apple



...



WordPress #4h2o @wordpress4h2o · 1m

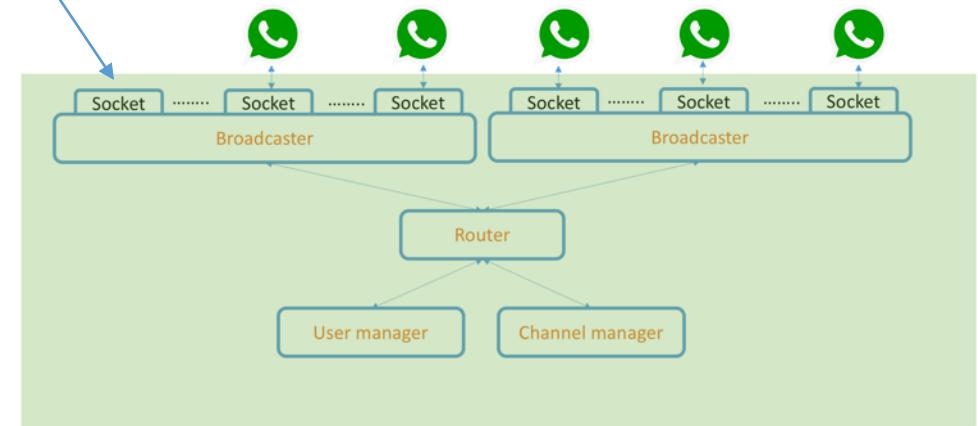
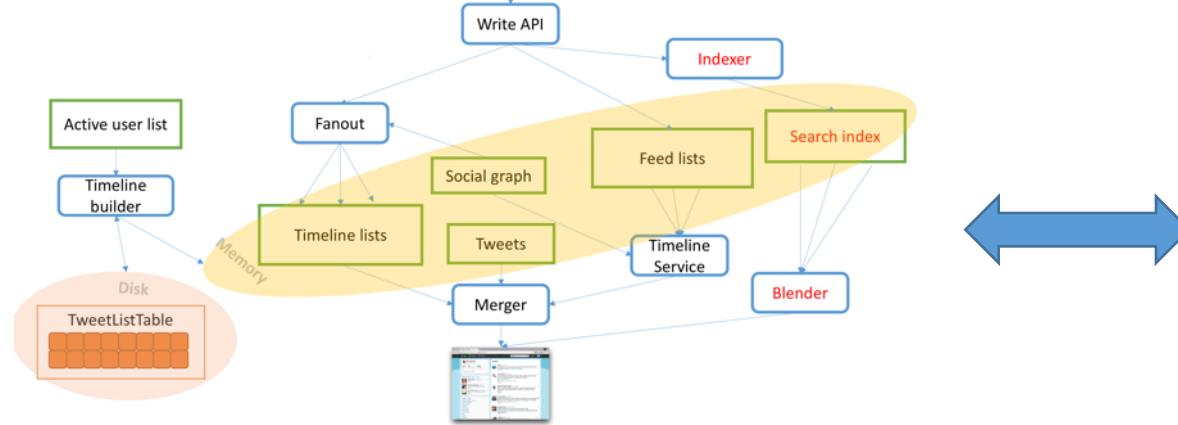
#Mac or #PC? A Brief History of #Apple & #Microsoft's Ad War dld.bz/d6A6r



...

[View summary](#)

Combination of architectures



Interviewer: How to update
online status of friends?

	Deepanker Verma	WEB ●
	Utsav Singh	WEB ●
	Chetan Khanna Sachinist	1h
	Anshuman Shukla	46m
	Mishra Avanish	MOBILE ●
	Rinku Mathur	WEB ●
	Varun Mishra	WEB ●
	Aamir Khan	MOBILE ●

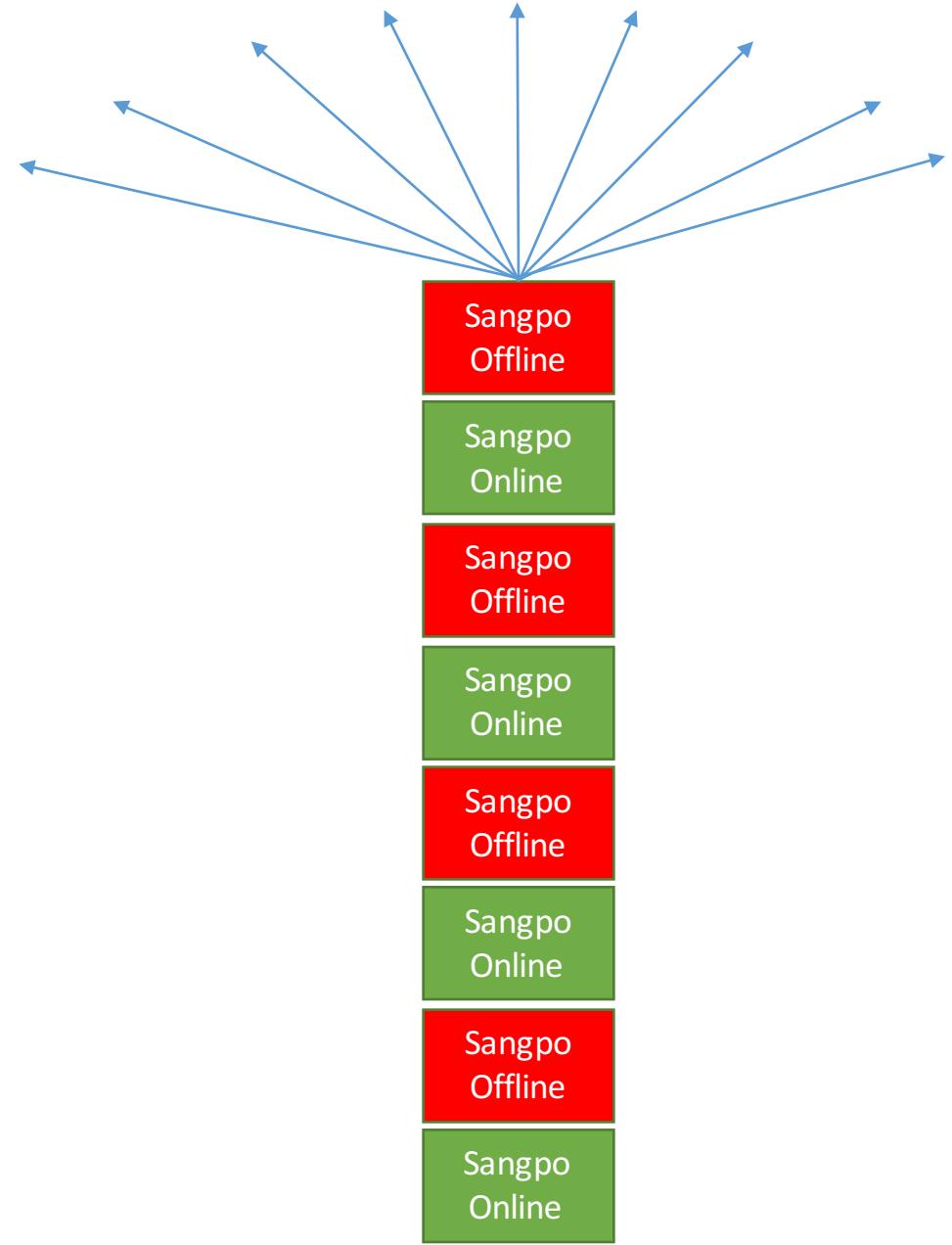
Search

Interviewer: the vacillation of status?

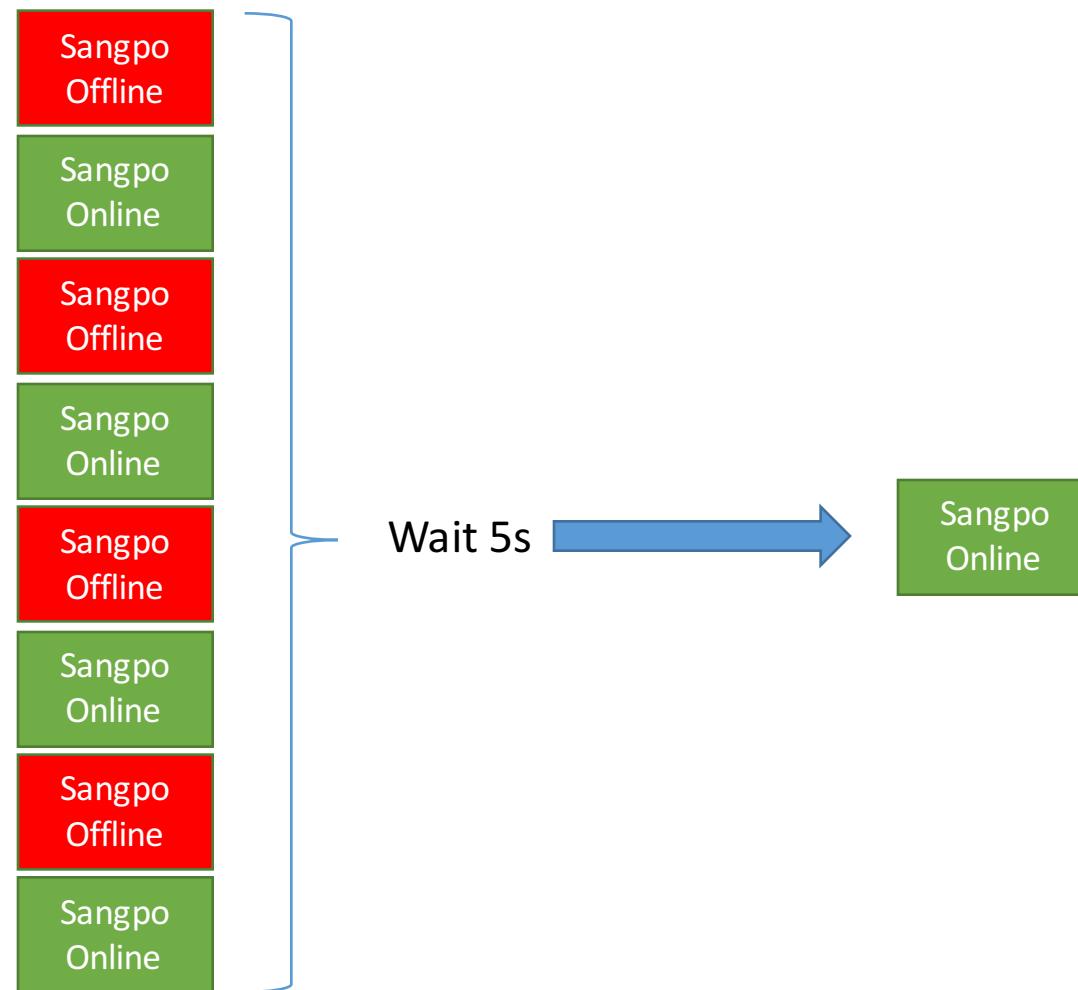
Online



Offline



Delayed change of status

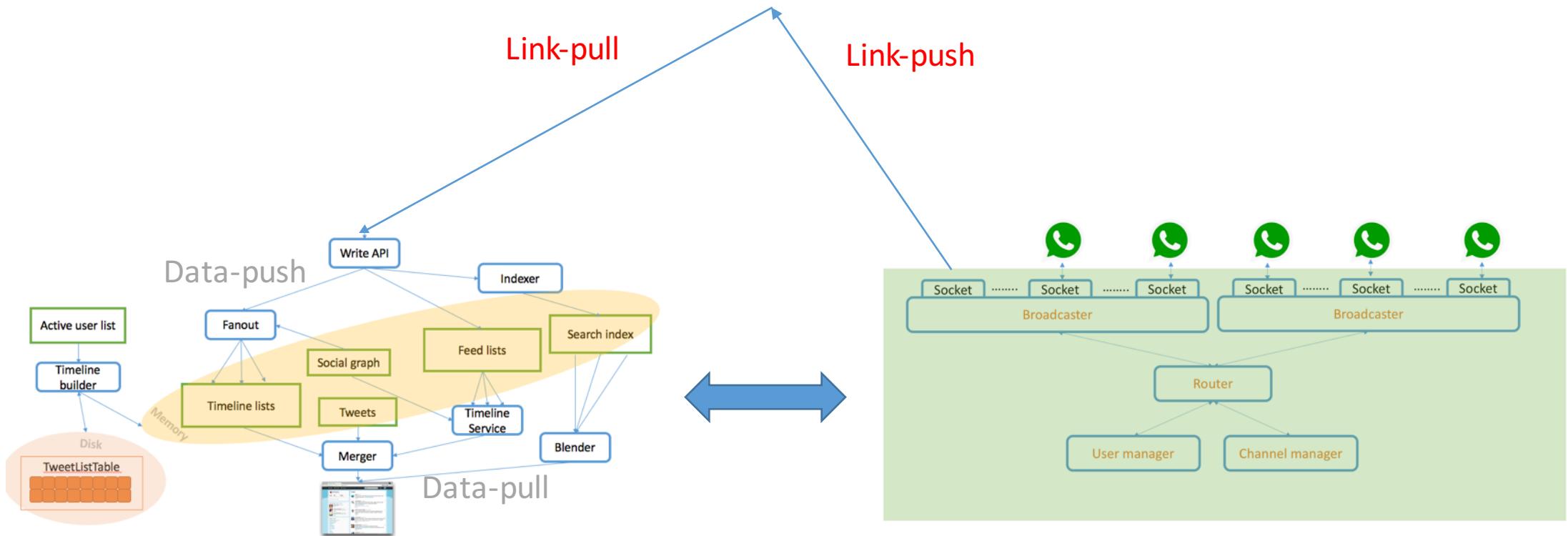


Two kinds of push/pull



Read More

Novice/Expert/Master, <http://url.cn/PdXMO6>
Expert, <http://url.cn/YLC49j>



Data-pull: build a user's timeline by pulling data from his followings

Data-push: build a user's timeline by pushing data from his followings

Link-pull: a user pulls the notification from the user every k seconds

Link-push: the server pushes the notification to the user with WebSocket as soon as it appears

Interviewer: How to choose between pull and push?

Link-push



- Fast
- Waste for users seldom check
- Need more connections

Link-pull

- Delayed
- Waste for users with less news
- Need more bandwidth



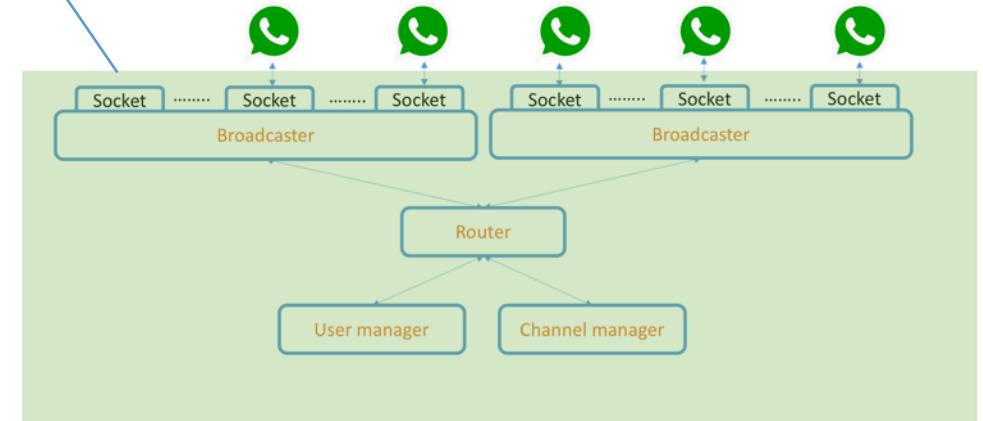
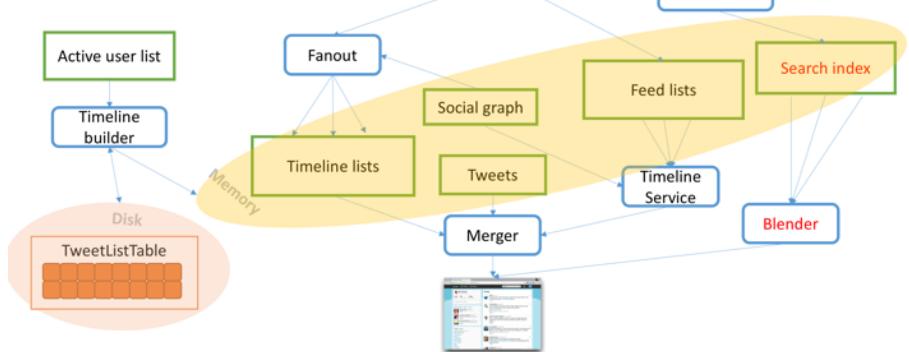
Interviewer: How to combine
pull and push?

Combine link push/pull

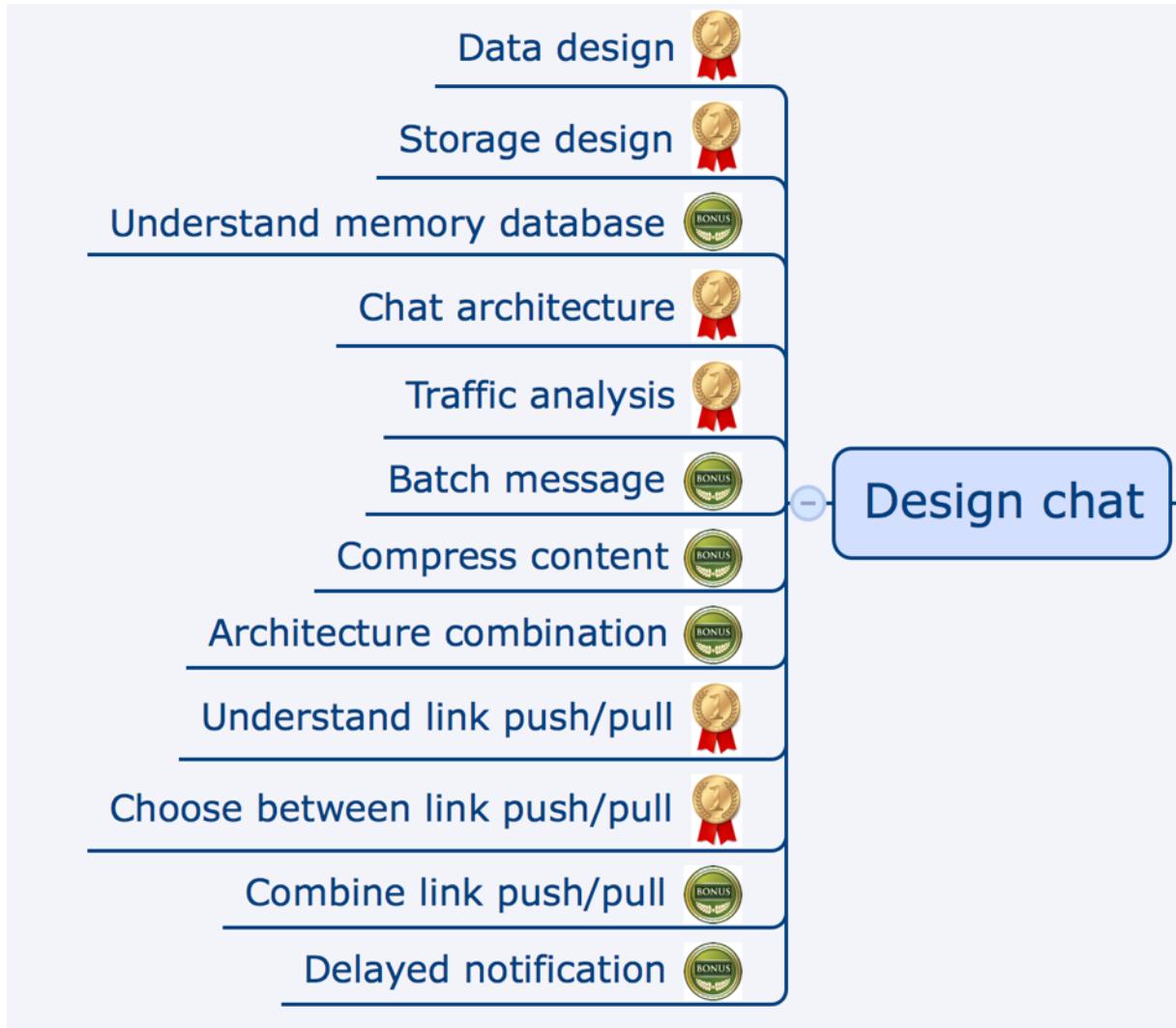


1. Push number of notifications

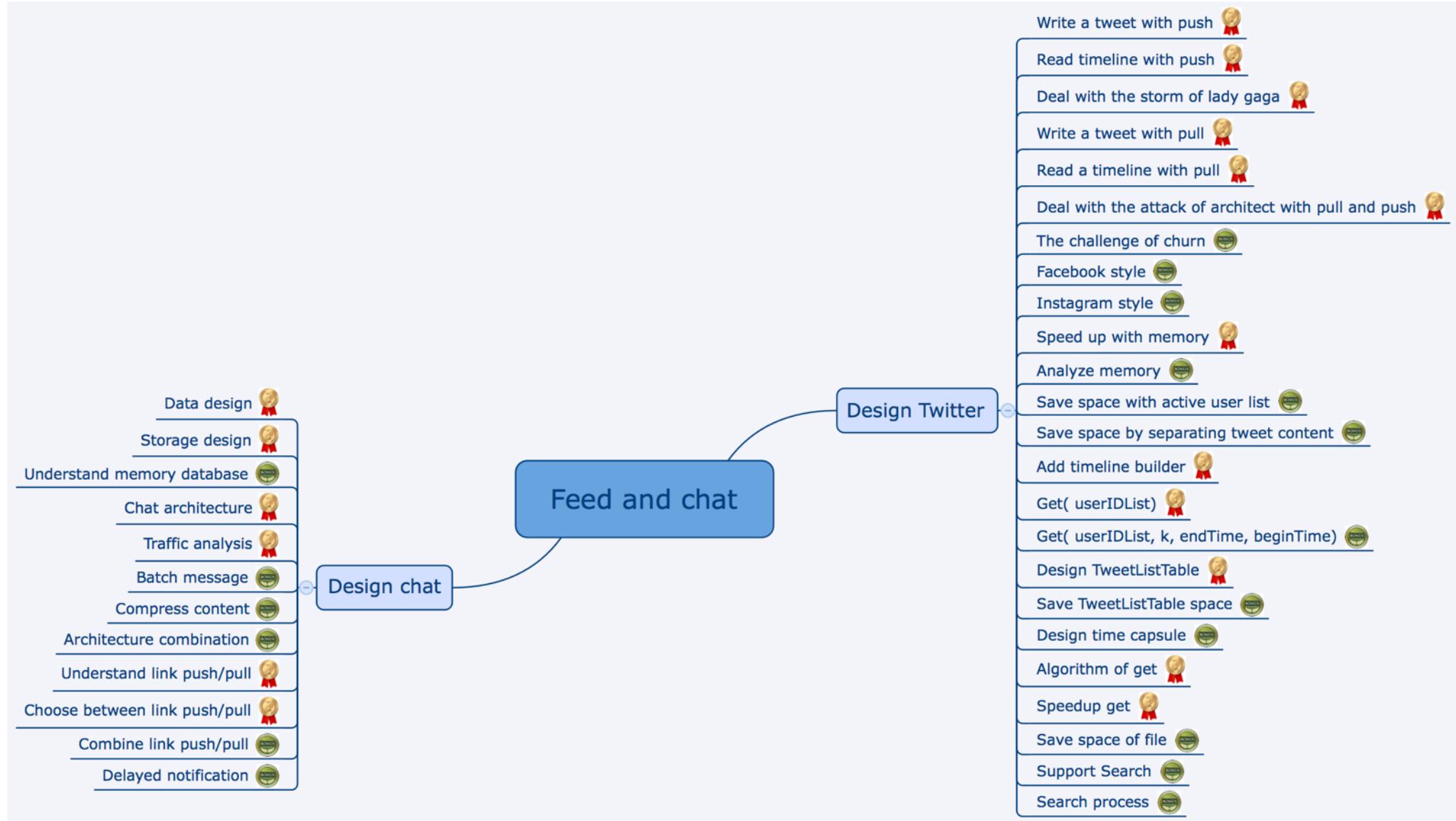
2. Pull details of notifications



Part2 Summary (6+6)



Summary of Class6



Keyword

- Feed
- Pull
- Push
- Search
- Chat
- SQL
- NoSQL
- Memory database
- Broadcast
- Batch
- Compression
- Delay

Homework

- Design WeChat

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QA



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Change

Kunga Lodro

Change is upon us
Confusion on its tail
Seeing this is what we practice for

Fertile ground for new beginnings
A luminous vast array of possibilities
Yet still we cling to the past

So drink from the bittersweet cup
And share in this feast among friends
There is no outlet but the present