Chat Stability and Scalability

By Chris Piro on Tuesday, February 17, 2009 at 9:43pm

Almost ten months ago we launched Facebook Chat to 70 million users. We ventured into a lot of new territories with this product: not only were there tricky web design and product issues, we needed to develop and launch a trio of new backend services to support all of Chat's functionality. Eugene wrote a great post detailing the inner workings of Chat, and recently we gave a talk (video: 1 2 3 4) about the product from front to back.

Since the product's launch last April Facebook has grown to over 175 million active users, and more than two-thirds of them have used Chat. It's been both an engineering and operational challenge to keep pace with Facebook's rate of growth. As we push our infrastructure closer and closer to its limit, some obvious (and not so obvious) bugs have expressed themselves. The individual servers work closer to their limits and it becomes more difficult to keep all the component pieces running in harmony.

The channel servers are the most intricate piece of the backend. They're responsible for queuing a given user's messages and pushing them to their web browser via HTTP. We made an early decision to write the channel servers in Erlang. The language itself has many pros and cons, but we chose Erlang to power Chat because its model lends itself well to concurrent, distributed, and robust programming. It's easy to model our millions of concurrent users with a few lightweight processes each, where the same tactic in, say, C++ would have been more daunting. Programming languages are always a tradeoff; Erlang makes some hard things easy but, unfortunately, some easy things hard.

One of the earliest challenges we faced was reducing the channel servers' memory footprint. High-level languages often provide rich data types and powerful abstractions for manipulating them. Erlang strings, for instance, are linked lists of characters, allowing programmers to use all the list-manipulation goodies that Erlang provides. In this case, however, it pays to control the representation a little closer and use arrays of characters like one might in C++. In this case we traded back some of Erlang's power in favor of CPU and memory usage. We also exploited the nature of our application to make another trade-off: just before a user's HTTP response process goes to sleep to wait for a new message to arrive, we force a pass of the garbage collector. We spend more cycles in that process than we usually would, but we ensure that it's using as little as memory as possible before it sleeps.

Working in high-level languages can be tricky, but that's not to say our C++ services have been without problem. The chatloggers store the state of Chat conversations between page loads. After launch these servers ran for many months without incident — we considered them the most stable of the trio of Chat services. However as more and more users began using Chat we started running the chatlogger machines closer to their capacity. We began to see that after several days of smooth operation the tier's CPU usage would increase dramatically and they would become unresponsive. We recompiled one of the daemons with OProfile support and observed that, after several days, most of the CPUs' time was being spent in malloc. The backtrace revealed that the use of lexical_cast within a loop was causing a lot of allocations, and after many days of operation the heap was so fragmented that the daemon spent most of its time trying to find free chunks of memory rather than servicing requests. We reorganized the code so that the allocations were done outside of the loop and CPU usage dropped back to its usual low hum.

Our difficulties haven't always been bugs in our programming. The presence servers are the simplest of the trio — in fact they're far simpler than even the example service bundled with Thrift. Their job is to receive periodic batched updates from the channel servers. Each cluster of channel servers keeps an array to record which users are available to chat. Building a list of a user's online friends might require knowledge from each of the many channel clusters, so we instead publish the channel servers' collective knowledge to one place — the presence servers — so that building a list of online friends requires only one

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query. These servers support two operations: reading a list of users' statuses from the array, and writing a chunk of information shipped from the channel servers. Each presence machine receives a tremendous amount of information: they regularly receive several bits *per Facebook user id*, whether the corresponding user is available or not. That volume of write traffic completely overshadows the read traffic, and pushes the limits of the both the servers' network adapters and the network infrastructure within our data centers. We therefore made a crucial CPU vs. bandwidth trade-off: the channel servers compress each chunk of data using zlib before shipping to the presence servers.

Our more serious challenges have been operational. A tremendous amount of data flows between our servers, devices, and networking infrastructure every minute. The millions of open browser windows and tabs on Facebook (both active and idle) hold an open connection to the channel servers. Internally we use load balancers to manage the sheer number of connections. Using many of their proprietary tricks we're able to connect many users with servers using only a few devices. At launch we had assumed the load balancers were a limitless resource, but in fact there is an upper bound on the number of simultaneous connections each can handle before they begin resetting connections. If that happens the web browsers on the other end try to reconnect by making a request to our web servers, who in turn send a flurry of requests to the channel servers. The connection is reestablished briefly and then the cycle continues, and all the while our users have sporadic or no access to Facebook Chat. At first the problem only affected users at peak Chat usage, but as weeks passed and our user base increased the outages became more frequent and began to affect the web and channel servers, as well as the infrastructure behind them. We explored (and fixed) several unrelated issues before we finally realized the root cause. We added more load balancers and the connection resets promptly stopped.

We've spent a great deal of effort building infrastructure to monitor all of Chat's parts and pieces. We're fortunate that Erlang allows us a look at the channel server's internals at runtime; we can attach a shell to a running service to find which processes are consuming what resources, to dump the state of particular data structures, and to load new code on the fly. We use Scribe to aggregate error logs across all three backend tiers, and we use fb303 to export statistics via Thrift to get a clear picture of the services' health both per-machine and in aggregate.

The news isn't all bad. We've spent a lot of time making all three services more robust and efficient, and Chat is more stable than ever. Having solved most of the scalability and stability problems in Chat (knock on wood), we're close to welcoming a new member to the family of backend services: Jabber. We've got a bunch of other cool stuff in the pipeline for the next few months, so stay tuned.

Ruairi Carroll Out of curiosity, what load balancers do you use? Do you use GSLB ?
February 18, 2009 at 10:29am

Justin Rosenstein Hey, Chris. +1 to Richard's question. If you were starting from scratch, would you still choose Erlang? Are there other fundamental design decisions you would make differently?
February 18, 2009 at 10:45am

Facebook Engineering We've had our ups and downs with Erlang, but I'm still glad we chose it. Like I mentioned above, the actor model (http://en.wikipedia.org/wiki/Actor_model) has worked really well for us, and we wouldn't have been able to pull that off in C++ or Java. ... See More
February 18, 2009 at 12:25pm · 2

Gilbert Leung Congrats on making it to Reddit Programming front page.
February 18, 2009 at 2:00pm

Jay Knight If you do allow federation with other xmpp servers, you should recognize users who have set xmpp addresses in their profile as "being" that person... that makes sense?
February 18, 2009 at 2:10pm

Frederik Seiffert For some reason there were no line-breaks in the article in the RSS feed for me. Any ideas?
February 19, 2009 at 12:29am

Gerard Sychay Out of curiosity, what load balancers were used? And about how many connections were reached before they started getting reset? I'm guessing around 65536.
February 19, 2009 at 4:42am

Justin Lintz With the memory fragmentations, was a dropin replacement for gnu malloc, such as google's tcmalloc considered? It's been shown to be a lot more optimal in allocations and reducing fragmentation
February 21, 2009 at 7:50pm

Jason DiOrio I've enjoyed reading this and I like your reasoning behind initial design decisions. I'm also quite interested in Facebook implementing Jabber, but I'm curious about the design for it; do you feel there's an intuitive means to make your current archite... See More
February 23, 2009 at 10:51am

Jason DiOrio Oh also, tcmalloc++, but I'm glad you looked at the core problem and fixed unnecessarily sub-optimal code, rather than blaming the underlying system. Still, you may find it to be helpful (pros and cons to everything I suppose).
February 23, 2009 at 10:53am

Mark Cummins I love these posts. Where else do you hear about coding on such a massive scale? Great stuff.
February 25, 2009 at 11:51am

Alessandro Borio ciao i'm italian maybe this it's not the space for write my disapprove, but i don't find a refer mail!!!! I don't happy!!!!!:(because is not possible meet the friends in a my list when i approve the friend!!!
March 10, 2009 at 7:11pm

Tj Mc Spice Kolarin my face book aint working is it becouse of the changes ur making to face book i keep getting this msg!!!!!!!!!!!Something went wrong. We're working on getting this fixed as soon as we can. You may be able to try again.pls let me know wats wrong thank you
March 12, 2009 at 12:35pm

Daniel Nathaniel CHANGE IT BACK!
March 12, 2009 at 11:16pm

Karen Van Hoof yè§§§è§§§è!!uuuii jin nn j
March 13, 2009 at 10:01am

Gary Seitz this new page sucks!!!!! PUT THE OLD FACEBOOK BACK!!! WHAT A DIRTY TRICK TO PLAY ON FRI THE 13th...VERY UPSET CUSTOMER !!! PLEASE PUT THE OLD FACEBOOK BACK DONT CHANGE WHAT WASNT BROKEN !!!!!!!!!!!!! PLEASE MAKE EVERYONE HAPPY AND WANT TO STAY A USER ~~~~~!!!!!!!!
March 13, 2009 at 10:16am

Cheryl Blackmon King I HAVE TO AGREE!!!! THIS NEW FORMAT FOR OUR PAGE IS AAAAWWWWFFFFFUUUULLLL!!!!! There was absolutely nothing wrong with the old page! If it ain't broke, don't fix it!!!!!
March 13, 2009 at 10:25am

Ben Wolff Why the FUCK did you change facebook? i was getting to like the old one. I hate the person who has designed the new facebook. at least give us a chance to use the old one.
March 13, 2009 at 10:47am

Marika Dye I use Digsby to chat on Facebook because it's really hard to on the page itself. It gets stuck... you get offline...
March 14, 2009 at 8:18am

Laura Natalia you guys are great..
March 14, 2009 at 10:19pm

Salman Saleem hmm
March 15, 2009 at 3:41am

Edray Bromani Adding chat was a great idea but consider expanding the options that we have with it. I end up ignoring a lot of friends if I'm away from the computer and my chat is open. So something like an away status would really help. Something else to consider f... See More
March 22, 2009 at 10:58am

Matthew Sinclair fix the chat ASAP!!!!!
April 11, 2009 at 2:32pm

David Leflett I'm not sure, but the way chat is acting, you might need to add more load balancers.... lol
August 26, 2009 at 4:33pm

Nindita Giwangkara it freezes my pc to death.. feels like im using 486...
December 31, 2009 at 12:15pm

Florian Frotzler yes it is eating my CPU, please fix this soon!!!
January 18, 2010 at 3:37am

Rick Usifer My chat has not worked for the past 3 months. When I log on, it says there are 4 or 5 friends online, but when I click, it ALWAYS 100% of the time says no one is available to chat. Makes me feel inadequate - they all run away when I want to chat with them.
February 4, 2010 at 3:21pm

Itai Roded i have this no one is available to chat problem as you.. any ideas what to do?
February 6, 2010 at 5:14am

Akande Olajide Kayode Hello Facebook Great Team,
I really like what you are doing infact your operation make the world more smaller and you have construct a bridge that link everyone and to make far away relatives, friends and family feel more closer. You doing good well do... See More
February 9, 2010 at 4:26am

Nathan Lawrence Did Facebook actually write their own jabber server in erlang, or did Facebook just deploy a modified ejabberd?
February 10, 2010 at 4:33pm

Wani Salim how can i talk in italino can any 1 know plz tell me
April 6, 2011 at 5:59am

Victor Vorski Sadly the videos linked at the end of the first paragraph are said to be "removed", anywhere else they can be watched?
June 15, 2011 at 1:36am

John A. Fries yeah, same comment as Wiktor, the video links are gone, anyone know where we can see them again?
November 4, 2011 at 6:37pm

José Eduardo Braga my facebook chat doesn't work. it says no connection stablished most of times.When I'm online in the chat the connection is always going down, and I can't maintain a conversation in real time. to see the answers I have to refresh the page and sometimes they are in the chat windows and other times they go to the messages. What can I do to fix this problem? Thanks for the help!
January 18, 2012 at 5:45am

Mahesh Reddy hi i am unable to connect to the chat when i sigin the chat list only 5 seconds after that it will goes to unable to connect please help me as much as possible
January 29, 2012 at 6:49am

Libby Birchfield regardless of how i access it (web browsers firefox or ie, mobile site, or android app) it consistently tells me no one is available to chat.
February 4, 2012 at 3:52pm

Ankit Kharola i willl deactivate my fb account as it shows chat disconnected realyy its disgusting
February 10, 2012 at 3:05am

Grace Chuppa-Matuska I still cannot get into my chat it has been loading for 4 days what is wrong with it.....
April 2, 2012 at 11:48am · 1

Md Aquib Alam i can't see the chat option on my a/c when i log in
November 1, 2012 at 2:01pm

WebTwo Gain /** C++ code to find the private key of RSA... See More
December 11, 2012 at 6:14am · 1

Jiahao Wang Amazing story, hope I can take a look at your code sometime.
May 19, 2013 at 1:02am

Jeremy Girard my group chat is saying it has to many participants in it but there dis only about 61 when online it says i can have 250, any ideas why it is doing this?
November 25, 2013 at 8:01pm

Craig Lukey load of shite
January 27, 2014 at 2:36pm

Ravinder Kumar hai give me ur whats app no.
October 22, 2014 at 11:07am