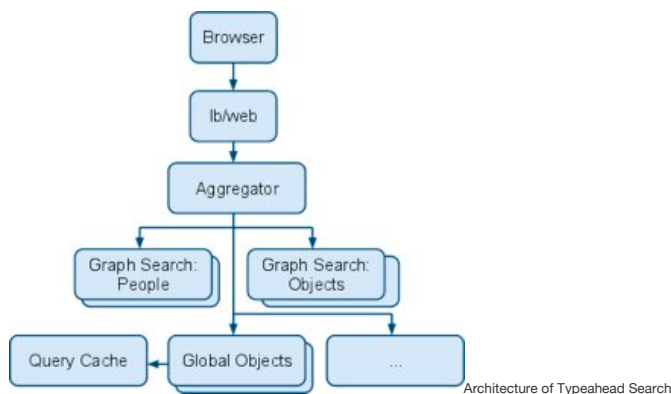# The Life of a Typeahead Query

By Keith Adams on Monday, May 17, 2010 at 12:36pm

In fall of 2009, some of us at Facebook imagined a more interactive search experience, where high quality results would appear as the user typed. We summarized the vision in a blog post introducing our new search box.

Making this system real for 400 million users has been challenging at every level of the software stack. On the front-end, code running in users' browsers must consume and render results quickly enough to not distract the user as they type. We set a strict goal for ourselves that the new typeahead can't be slower than the existing typeahead for finding your friends, so every millisecond delay matters. Despite these performance constraints, the UI cannot be too minimalist; each result needs enough contextual clues to convey its meaning and relevance. Because the new typeahead auto-selects the first result when you hit Enter in the search box, we need near-perfect relevance so that the first result is always the one you're looking for.

To satisfy all these constraints, we designed an architecture composed of several different backend services that were optimized for specific types of results. Let's follow a session as the request leaves a user's browser and becomes a set of navigable results.

Architecture of Typeahead Search

1. Bootstrapping Connections

As soon as the user focuses in the text box, we send off a request to retrieve all of the user's friends, pages, groups, applications, and upcoming events. We load these results into the browser's cache, so that the user can find these results immediately without sending another request. The old typeahead did this, but stopped here.

2. AJAX Request

If there are not enough results in the current browser cache, the browser sends an AJAX request containing the current query string and a list of results that are already being displayed due to browser cache. Our load balancer routes the request to an appropriate web machine.

3. Aggregator Service

The php AJAX endpoint is a thin wrapper around a Thrift service for handling typeahead queries. This service, called the "aggregator", is at the root of a tree of separate search services. Aggregators themselves are stateless and have no index of their own. They are instead responsible for delegating queries to multiple lower-level services in parallel and integrating their results.

4. Leaf Services

In parallel, several different backend search services scour their indices for results that prefix-match the contents of the search box. Each leaf service is designed to retrieve and rank results on only a few specific features. The architecture of the system allows us to add new services, too, as we discover important sources of results and features.

The *global* service maintains an index of all the pages and applications on the site. Unlike most of what we do at Facebook, these results are global because they contain no personalization. The signals that this service records are identical for all user on the site; for example, we might rank applications by the number of users who have interacted with them in the last month, and pages by the structure of the graph surrounding them. Since this service's results are independent of the querying user, we can save latency by storing recent results in a memcached-based query cache.

The *graph* service returns results by searching the user's neighborhood of the graph. For some types of queries, a user and her friend's graph connections are a powerful signal of expressed preferences, and thus relevance. Graphs are notoriously difficult mathematical objects for computers to come to terms with: they are large, and are a minefield of computationally hard problems that appear simple. Our graph contains 400 million active users, and many billions of connections, both among users and from users to objects of other types: pages, applications, events, open graph nodes, etc.

5. Merging Results

The aggregator merges the results and features returned from each leaf service and ranks the results according to our model. The top results are returned to the web tier.

6. Fetching Data and Validating Results

The results returned by the aggregator are simply a list of ids. The web tier needs to fetch all the data from memcache/MySQL to render the results and display information like the name, profile picture, link, shared networks, mutual friends, etc. The web tier also needs to do privacy checking here to make sure that the searcher is allowed to see each result.

7. Displaying the Results

The results with all the relevant data are sent back to the browser to be displayed in the typeahead. These results are also added to the browser cache along with the bootstrapped connections so that similar subsequent queries don't need to hit the backend again.

Putting it all Together

Once the basic architecture was in place, we spent a lot of time getting everything to a production-ready state. We dark-tested by changing the old typeahead to send a query on every keystroke. We knew that usage patterns could dramatically shift once the new typeahead was fully launched, but this was a good first step to uncovering any scalability issues we might have. As a result of this testing, we discovered network limitations that caused us to adjust the topology of the architecture.

We also experimented with a large number of user interface variants using A/B testing and more qualitiative usability studies to help us make some thorny decisions.

- Number of results: We wanted to show enough entries so that you would serendipitously stumble upon fun results while typing, yet showing fewer results would be faster and be less distracting. Our ultimate design varies the number of results shown based on your browser window height.
- Searching: Even though we made the Enter key auto-select the first result, we wanted to ensure users who wanted to search still could. We experimented heavily with the placement, wording, and appearance of the "See More Results" link that takes you to our traditional search page.
- Mouse vs. keyboard: While Facebook employees are heavy keyboard users, we discovered most users prefer to use the mouse to select from the typeahead. This led us to focus on mouse use-cases more than we naturally would have.

Other experiments included different picture sizes, ways of distinguishing between different

result types like applications vs. people, highlighting the query string in results, and various ways of displaying mutual friends.

As with all interesting engineering projects, the trade-offs are where we had the most challenges, surprises, and fun. Many technical decisions in search boil down to a trilemma among performance, recall, and relevance. Our typeahead is perhaps unusual in our high prority on performance; spending more than 100 msec to retrieve a result will cause the typeahead to "stutter," leading to a bad user experience that is almost impossible to compensate for with quality. "Real-time search" is often used to mean chronologically ordered, up-to-date content search, but our typeahead search engine is "real-time" in the older sense of the term: late answers are wrong answers.

We have a lot of refinement ahead of us. Our result page is still there, and probably always will be: there will always be a "long tail" of queries that are too heavyweight for our typeahead. But we are excited to have shipped a first version, and look forward to seeing how far we can push our typeahead into the territory currently occupied by result pages.

Keith Adams is a Facebook engineer in search, in search of new Facebook engineers.

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John Moore I think the dropdown is one of facebook's best features. It is the quickest way to get to a friend's profile or an application. I don't see why the people above have problems with it. I would personally be more annoyed with having the wait for a new pa... See More
May 17, 2010 at 1:30pm

Christian Primozich I agree with Heather. As is, I've clicked/hit return/ended up on the wrong page more often than it has ever helped me. It's the opposite of useful. Is it for advanced users or newbs or everyone? Does that group find it useful?
May 17, 2010 at 1:40pm

Samuel Stair I agree with John it is very convenient now only if there was spell check built into new comments and messages.
May 17, 2010 at 1:43pm

Ed Slocombe I find it generally frustrating but when it gets it right, helpful...the thing I hate is the way that when I press escape I expect the drop box to disappear but my search term to REMAIN! Instead it clears the field. So if I want to search for what I ty... See More
May 17, 2010 at 1:49pm

Alden Gatto i think they should add a friends search to the friends page that at the moment just has an e-mail search. same for pages search. and make the search bar at the top of the home page specifically for searches for ppl and pages outside your added lists. ... See More
May 17, 2010 at 2:02pm

Sandie Smith am a blonde . . . i have no idea what this all means. . .but i love facebook !
May 17, 2010 at 2:07pm

Debra Andrews I can't find anyone on facebook.They always have to find me through there friends lists.They have to keep going through this one and that one and on and on till they luckily find me.I also can't find apps like I used to.I love Facebook but it's to hard... See More
May 17, 2010 at 2:26pm

Carsten Klouman I love the typeahead – and love the in–depth explanation and glimpse into your development process. This is great. Keep it up!
May 17, 2010 at 3:00pm

Mike Hoy can it find my car keys
May 17, 2010 at 4:15pm

Gemma Goode Waaaaaay over my head =z
May 17, 2010 at 4:32pm

Stephen Fadem T
Th
Thi... See More
May 17, 2010 at 8:50pm

Cañoneo Aljun nice.....
May 17, 2010 at 8:59pm

Imran Shaikh kewl...
May 17, 2010 at 11:10pm

Santosh Halpati good...
May 18, 2010 at 12:09am

Zynep Hzt shrew and nice;)))))
May 18, 2010 at 1:44am

Siddharth Prakash Singh Good one!
May 18, 2010 at 3:52am

Oladejo Olasunkanmi Dahood this is nice to go with.
May 18, 2010 at 8:51am

Samrendra Kaushal and and and....i think there should be regular updates and all...administrator should be more active!!!!!!!!!
May 18, 2010 at 11:28am

Matthew Manuel The only bad thing about it is that hitting Enter goes to the first result object instead of going to the search results page... sooo annoying! Don't break interface conventions like that! The first search result should be accessed by pressing DownArrow,Enter
May 18, 2010 at 2:51pm

Vince Pale I find them to be correct most of the time, however, as Matthew stated, it should be down, enter to select the first result, especially when there are numerous results which agree with the currently entered chars.
May 18, 2010 at 2:57pm

Rg Enzon is putnam the putnam icon on the facebook chat?!
May 18, 2010 at 4:42pm

Firas Hamtini Guys please i need help .... ineed someone who works in facebook to contact me i need HELP ... something wrong with my facebook thanks
May 19, 2010 at 6:28am

Liz Scully Please fix the bug that is pushing down all my news feed content and the status update form when I have any events populated in the events component – I'm using mozilla 3.5.9 for Mac and all I see everytime I log on to facebook when there are any event... See More
May 20, 2010 at 4:03am

Chamodh Abeysekera i have a problem with my chat...can u pleae check on it..
May 20, 2010 at 8:24am

Hassan Ali Al Ssadi you are Ultra engineers
May 20, 2010 at 2:26pm

Vivek Singh FB engineers really rox......
May 20, 2010 at 3:06pm

Ron N Amy thanks guys!!!
May 21, 2010 at 2:37pm

Aymen Mami there is some web sites that do spam on facebook actuality page ......like a page with a nammmeeeee soooo loooonnnnnggggg that your actuality page is messed up... See More
May 21, 2010 at 3:25pm

Abd Rahim good
May 22, 2010 at 9:57pm

Meganathan Gk Face book engineers are keep on moving forward !!!!! u guy's always rocks !!
May 22, 2010 at 11:52pm

Teshe Tadesse it is very interesting field so continuou ....
May 24, 2010 at 11:31am

Afimani Deogratious good idea
May 28, 2010 at 12:06am

Sukru Batar http://groups.google.com.tr/group/makinamuhendisigrup
May 28, 2010 at 4:53am

Aslan Ege Please help me make a mistake, I'm sorry but my other address has been canceled for this very upset and we apologize to our other address, activate the I beg the people making the same mistakes I promise to help the thanks
June 8, 2010 at 12:42pm

Woody Turner You people are MORONS...do you hear me? MORONS How do you run a website that connects people WHEN YOU CAN'T KEEP THE CONNECTION GOING ? 'Friends drop off for days and weeks at a time...do your programmers no nothing about 'refreshing'?

And speakin... See More
June 11, 2010 at 9:22am

Hilmi Erden facebook sohbet hizmetim çalışmıyor. Hiç kimseyi açık göremiyorum.çok kötü durumdayım lütfen yardım edin..
June 13, 2010 at 7:34am

Hilmi Erden facebook sohbet hizmetim çalışmıyor. Hiç kimseyi açık göremiyorum.çok kötü durumdayım lütfen yardım edin..
June 13, 2010 at 7:34am

Chris Cinelli Love it and I agree with Matthew Manuel. Enter should go to the search results not to the first result!
June 15, 2010 at 2:34am

Poppy Shaco Mundo hahahahh
October 18, 2010 at 10:06am

Jo Torr does anyone know how to delete the history on the typeahead. i appreciate some people find it helpful but i find it so annoying!
October 25, 2011 at 1:41pm ·   7

Wade Liang where the local cache be stored?
January 20, 2012 at 11:32pm ·   1

Russel Schwartz how do i remove whats in the typehead
April 22, 2013 at 8:54am ·   2

Ahmad M We have the same question...
June 23, 2014 at 6:12pm ·   2

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