War Stories from Azeroth

15 Years of Server Engineering on a Successful MMO

War Stories from Azeroth

~~15~~ 16 Years of Server Engineering on a Successful MMO

Who Are We?

Joseph Cochran

- Over 20 years working in games
- 16 years on World of Warcraft, and has contributed code to every WoW expansion
- Co-Chair of Blizzard's LGBT+ Network
- Specializes in interactions with data, both static and persistent
- Started Alliance, moved to Horde

Kurtis McCathern

- Over 20 years in programming
- 8 years on World of Warcraft, and has contributed code to every WoW release since Mists of Pandaria
- Specializes in simulation, back end, and live operations
- Started Horde, moved to Alliance

Themes

- We’ve come a long way in over 20 years of active development, and the way we make and support the game have evolved over that time.
- Far from being in “maintenance mode”, we are always upgrading the experience and creating the systems to support new ideas and content.
- The issues we’ve encountered over the years taught us the value of tooling and support both before and after launches.
- Every expansion is a new game.

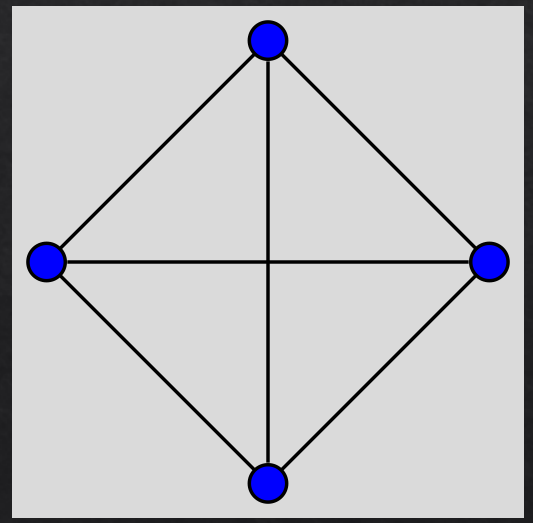
War Stories from Azeroth

- The Opening of the Gates of Ahn'Qiraj
- The Population Problems of Warlords of Draenor
- The Launch of Achievements in Wrath of the Lich King
- Updating Guilds in Battle for Azeroth
- Mini-Story: Adapting to COVID

Gates of Ahn'Qiraj

Gates of Ahn'Qiraj – Update Problem

"How many messages do I need to send to update connected clients about changes to unit state?"

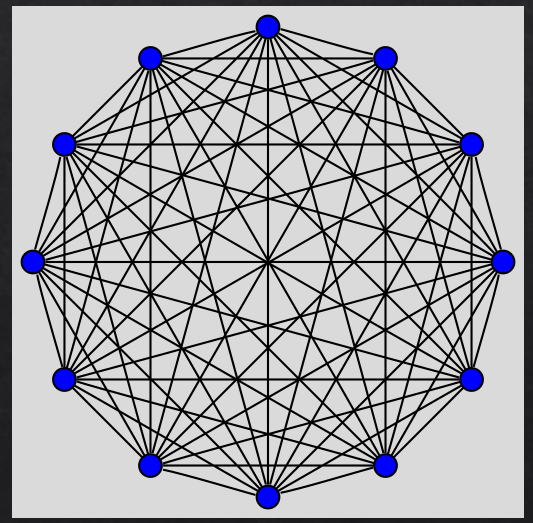


n = number of clients
n^2 = number of update messages

$n = 4$
$n^2 = 16$

Gates of Ahn'Qiraj – Update Problem

"How many messages do I need to send to update connected clients about changes to unit state?"

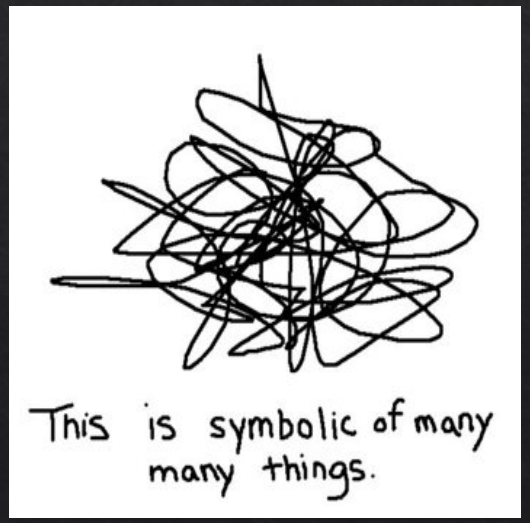


n = number of clients
n^2 = number of update messages

$n = 12$
$n^2 = 144$

Gates of Ahn'Qiraj – Update Problem

"How many messages do I need to send to update connected clients about changes to unit state?"



n = number of clients
n^2 = number of update messages

n = 1,000
n^2 = 1,000,000

Gates of Ahn'Qiraj – Confounding Factors

- Everybody on the server wanted to see the event for themselves.
  - Every viewer was considered an active participant.
  - There was no Twitch.
- The delay between the completion of the stockpiling and the actual opening encouraged tourists.

Gates of Ahn'Qiraj – Mitigation

- Update throttling/coalescing.

Gates of Ahn'Qiraj – Mitigation

- ~~Update throttling/coalescing.~~
- Multiple copies of world?

Gates of Ahn'Qiraj – Mitigation

- ~~Update throttling/coalescing.~~
- ~~Multiple copies of world?~~
- Limit AOI distance?

Gates of Ahn'Qiraj – Mitigation

- ~~Update throttling/coalescing.~~
- ~~Multiple copies of world?~~
- ~~Limit AOI distance?~~
- Log in GameMaster clients and teleport players away?

Gates of Ahn'Qiraj – Mitigation

- ~~Update throttling/coalescing.~~
- ~~Multiple copies of world?~~
- ~~Limit AOI distance?~~
- Log in GameMaster clients and teleport players away!

Eventually players even started doing their own mitigation.

Gates of Ahn'Qiraj – Lessons

- Design future content to use timed advances
  - Isle of Quel'Danas (patch 2.4)
  - Thunder Isle (patch 5.2)

- Design future content to be more diffuse

Gates of Ahn'Qiraj – Revisited

- 15 Years Later…
  - Automation tools allow us to pre-test with several thousand headless clients.
  - Modern profiler tools allow us to find hotspots.
  - Ignore simple facing updates and cull many movement updates.

Gates of Ahn'Qiraj – Success!

2006

Gates of Ahn'Qiraj – Success!

2020

Warlords of Draenor

Warlords of Draenor – History

- Multiple patch and expansion launches under our belts.
- Concentrated populations present at launch were treated as a design problem.
  - Wrath of the Lich King has two different continent start locations.
  - Cataclysm had two different initial zones.
  - Mists of Pandaria had the Horde start on one side of the continent, and the Alliance at the other.

Mists of Pandaria

Mists of Pandaria

Warlords of Draenor – Tanaan Jungle

- Content designed to flow players through, rather than loop back on old paths to reduce overlapping AOIs.
- Would allow players to spread out over the first few hours of gameplay before arriving at Draenor proper.
- Run multiple copies (shards) of the zone to handle player concurrency away from player expectation of realm coherency.

Warlords of Draenor – Reality

- Multiple quest progression bugs following Tanaan Jungle re-concentrated players.

Warlords of Draenor – On Fire

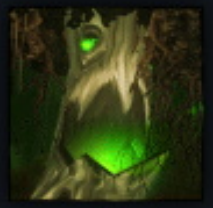
Warlords of Draenor – On Fire

Warlords of Draenor – Reality

- Multiple quest progression bugs following Tanaan Jungle re-concentrated players.
- Higher than expected first session play time led to higher concurrency.
- Our design solution was limited to one area, when the issue was game wide, and needed an engineering solution.

Warlords of Draenor – On Fire

Warlords of Draenor – On Fire



Bashiok
Community
Manager

#1 - 2014/11/13 08:59:00 PM

In attempts to pinpoint latency related issues we've temporarily lowered the maximum number of people allowed in each realm. This will result in higher queue times as realms who have populations above the cap will not allow any new players in until it decreases back down below the new player cap. We're continuing work on this and other issues impacting game latency.

Warlords of Draenor – On Fire

Warlords of Draenor – Sharding?

- Conceptually possible – Tanaan Jungle worked
- Tanaan Jungle was one-shot, linear content, built to be shared.
- Using the tech on Draenor proper would definitely introduce paradoxes and bugs.

Warlords of Draenor – Sharding!

- Ran multiple Draenors per realm
- Before cloud infrastructures – needed IT heroics
- Some quest lines completely broken
- Enabled players to spread back out with higher concurrency caps

Warlords of Draenor – Lessons

- Don’t use design to solve engineering problems, and don’t use engineering to solve design problems.
- Communicate with players to make them allies.
- Time spent tooling is higher yield than time spent debugging.

New issues

- Familiar population issues are always a concern.
- However, expansions are never just “more of the same.”
  - New content from design drives new systems.
  - Technology improvements drive new and updated systems.
- Our next War Story is about one of those new systems that has since become a foundational part of the game.

WORLD OF WARCRAFT
WRATH of the LICH KING

WORLD OF WARCRAFT
WRATH of the
Achievements

The Achievement System

- Now common in gaming, milestones that mark progress with visual rewards.
- Provides a “scoreboard” that allows players to focus on areas of interest.
- Gives us more data on player behavior and intent.

Wrath of the Lich King Launch

- Pre-patch 6 weeks before retail date
  - Separates technical issues from content issues
  - Helps us address bugs before players experience the new expansion

- Immediately, the game was almost unplayable

CPU Usage
Time

CPU Usage
Time

Technical Issues

- Gameplay was affected by extremely heavy DB load
  - DB queries were being issued faster than they could be serviced resulting in slow login, and lag in game.
- Limitations
  - Our databases were underprovisioned
  - Not something we could address between systems and content launch
- An ambitious new system led to inefficiencies
  - There was no one “silver bullet” issue to improve performance
  - Small problems added up
  - We needed to solve them one by one until performance improved

Code Inefficiencies

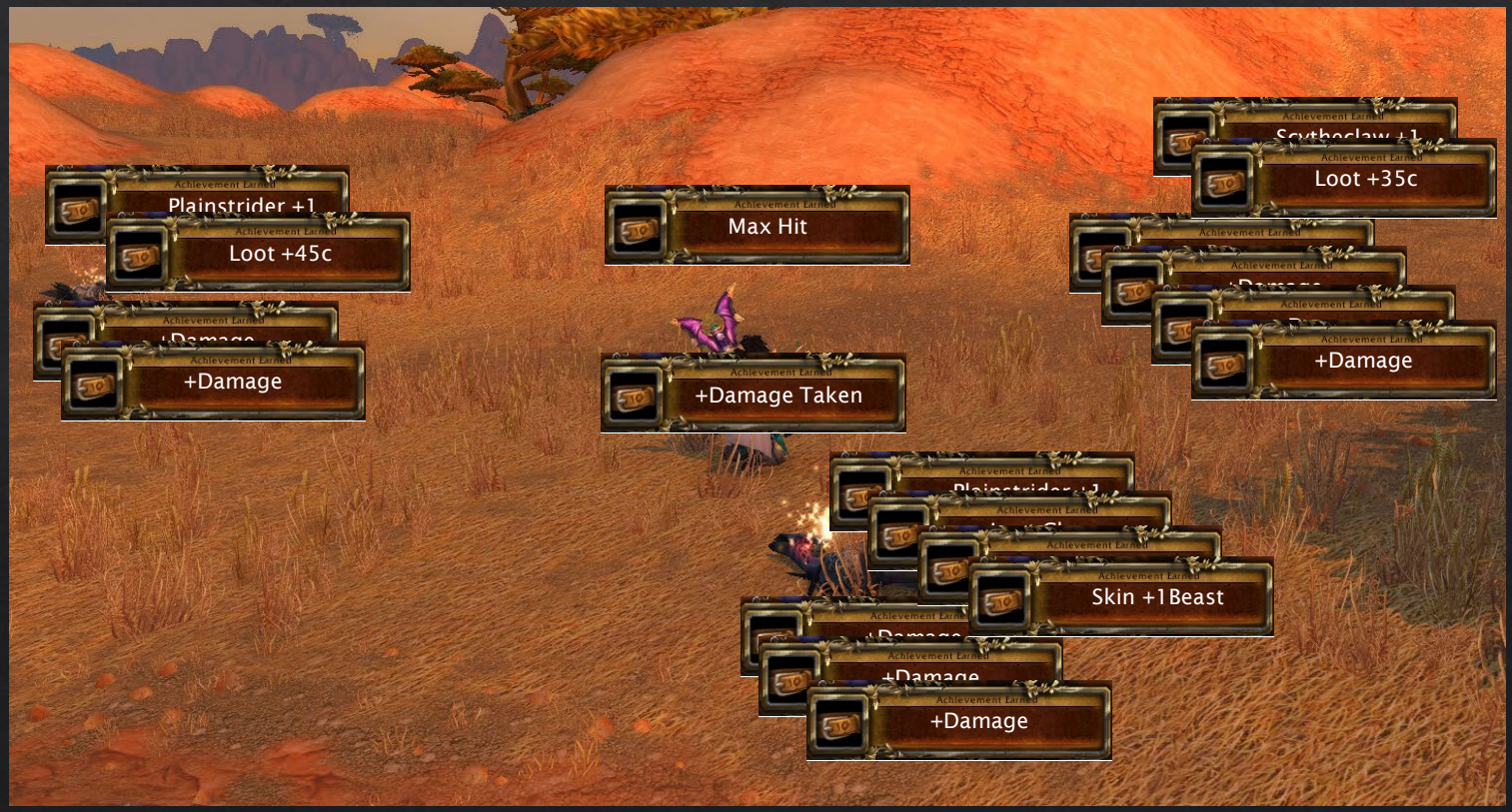
- Day One issues
- Saving too aggressively
- Code bugs with saving

Code Inefficiencies

- Day One issues

Code Inefficiencies

- Too-frequent saves



Code Inefficiencies

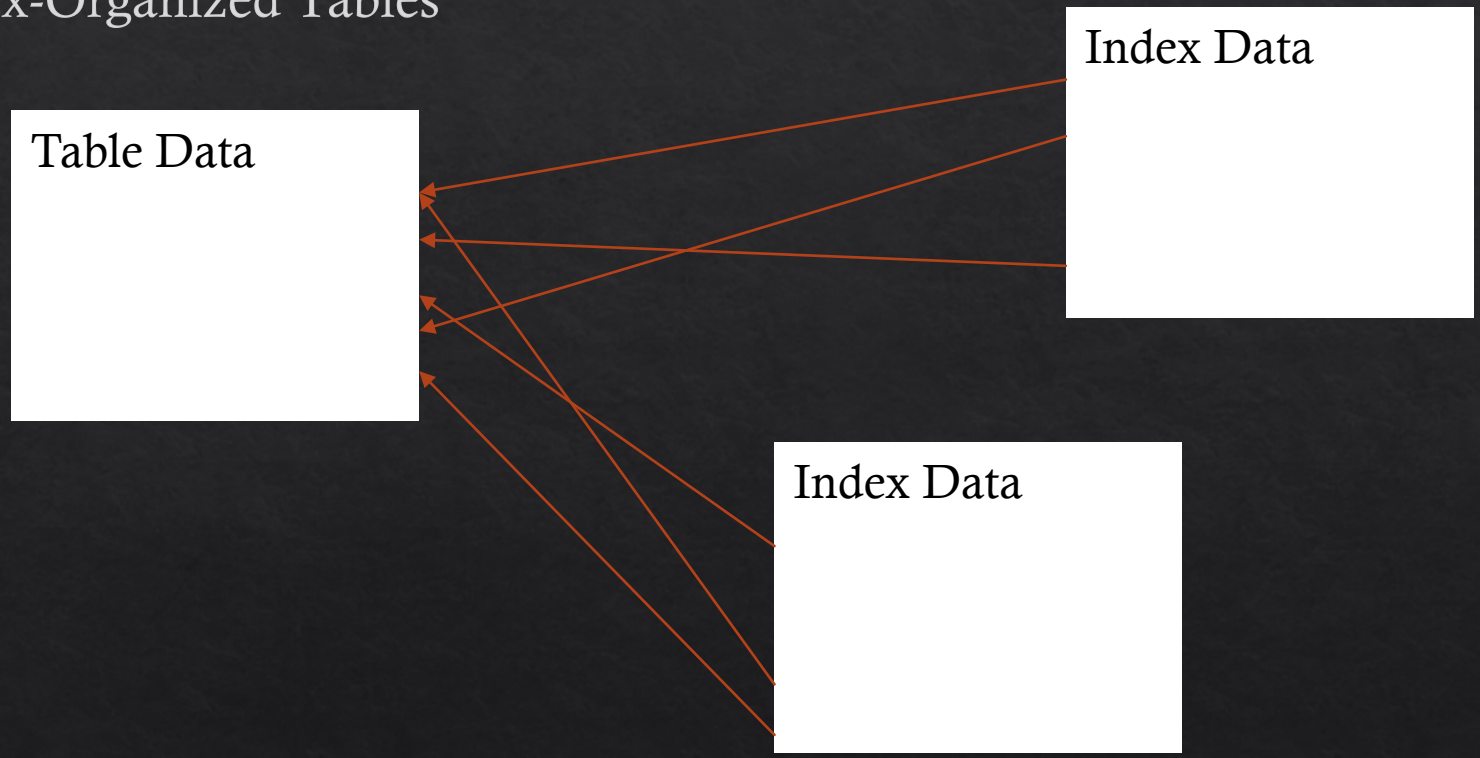
- Code bugs

Database Inefficiencies

- WoW uses Oracle database
  - The server talks through a DB Proxy (write-through cache) to Oracle
  - We explored options within Oracle to improve performance
- Commit settings

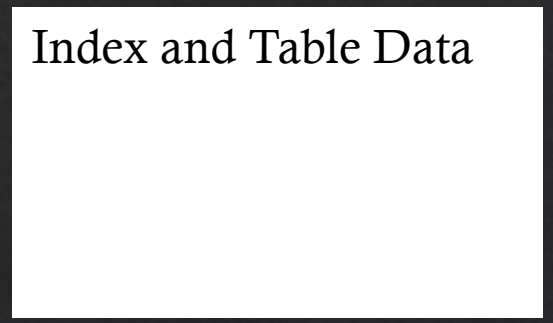
Database Inefficiencies

- Index-Organized Tables



Database Inefficiencies

- Index-Organized Tables



- If a table is narrow and there is only one primary index, IOT can improve performance. But other indexes perform worse and too many columns make the primary index inefficient.
- The achievement tables are narrow and use one index. Significant savings were created by converting them to IOT.

Recovery and Lessons

- Step by step, we were able to reduce load
  - A few percent here, a few percent there
  - Eventually performance recovered and players enjoyed Wrath of the Lich King
- This experience led to some long term process improvements
  - Stronger hardware requirements for future expansions
  - Rigorous monitoring of DB performance
  - More concentration from developers over integrating new features
- Process improvements paid off in future expansions

Improving Our Process

- From these stories you might think that every expansion is complete chaos.
  - Expansions introduce complex changes to the game
  - We don’t always know what we’re getting into.
- With each expansion though, we iterate over our development process.
  - Lessons from the performance of new and updated systems are applied to the next cycle.
  - This refinement leads to better processes, tools, monitoring, and team structure.
- Not every project gets as many expansions as we do, but hopefully these issues and lessons can inform your projects.

Battle for Azeroth

Battle for Azeroth

- Let’s look at our processes today with Battle for Azeroth.
- From the server perspective, we concentrate on:
  - Development
  - Testing
  - Launch

- Guild Update in Battle for Azeroth

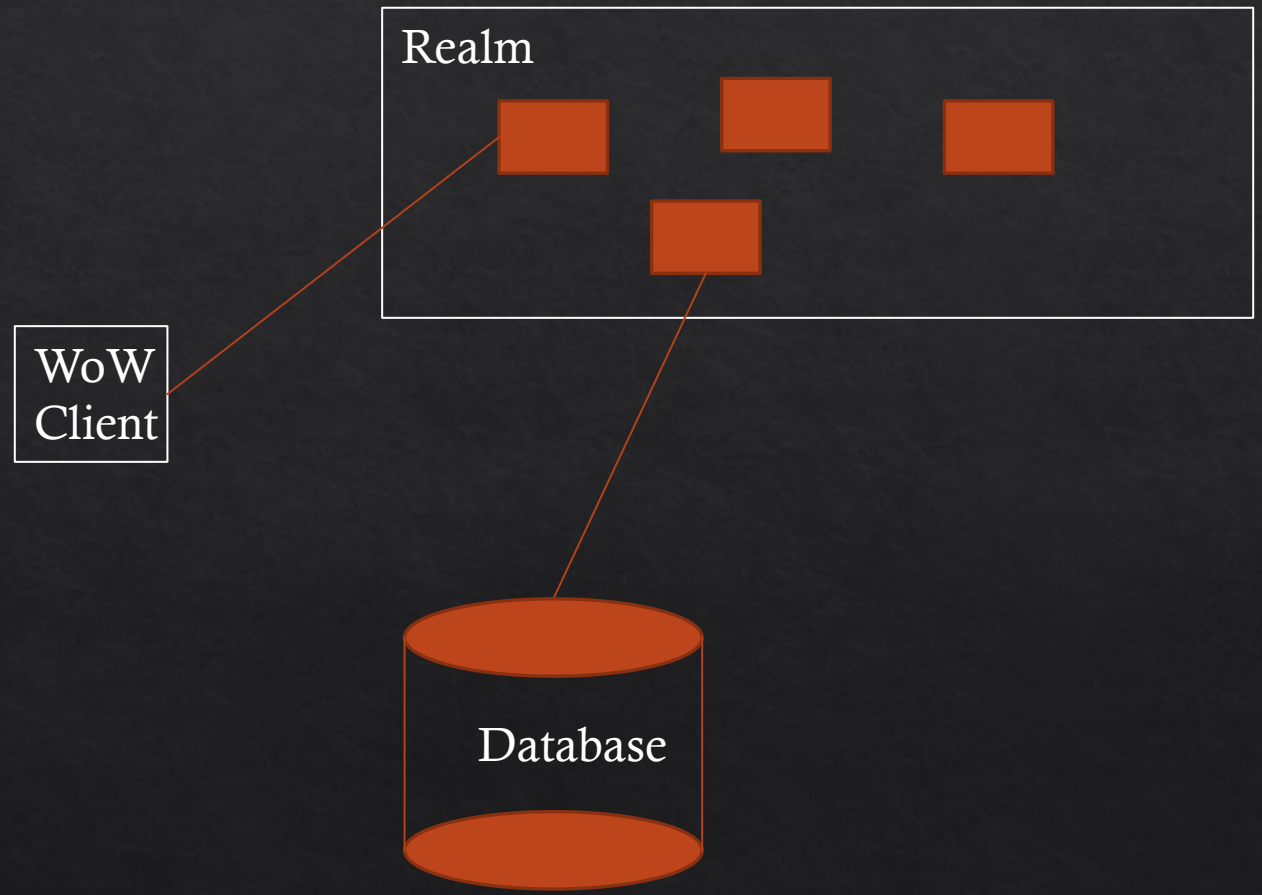
Guilds in WoW

- Guilds are a foundational social construct
  - They allow players to band together for many reasons
  - Guilds allow shared chat and provide an organizational structure
- Guilds have evolved over time, adding new features
  - Guild bank
  - Calendar
  - Reputation and perks
  - Guild finder tools for aiding recruitment

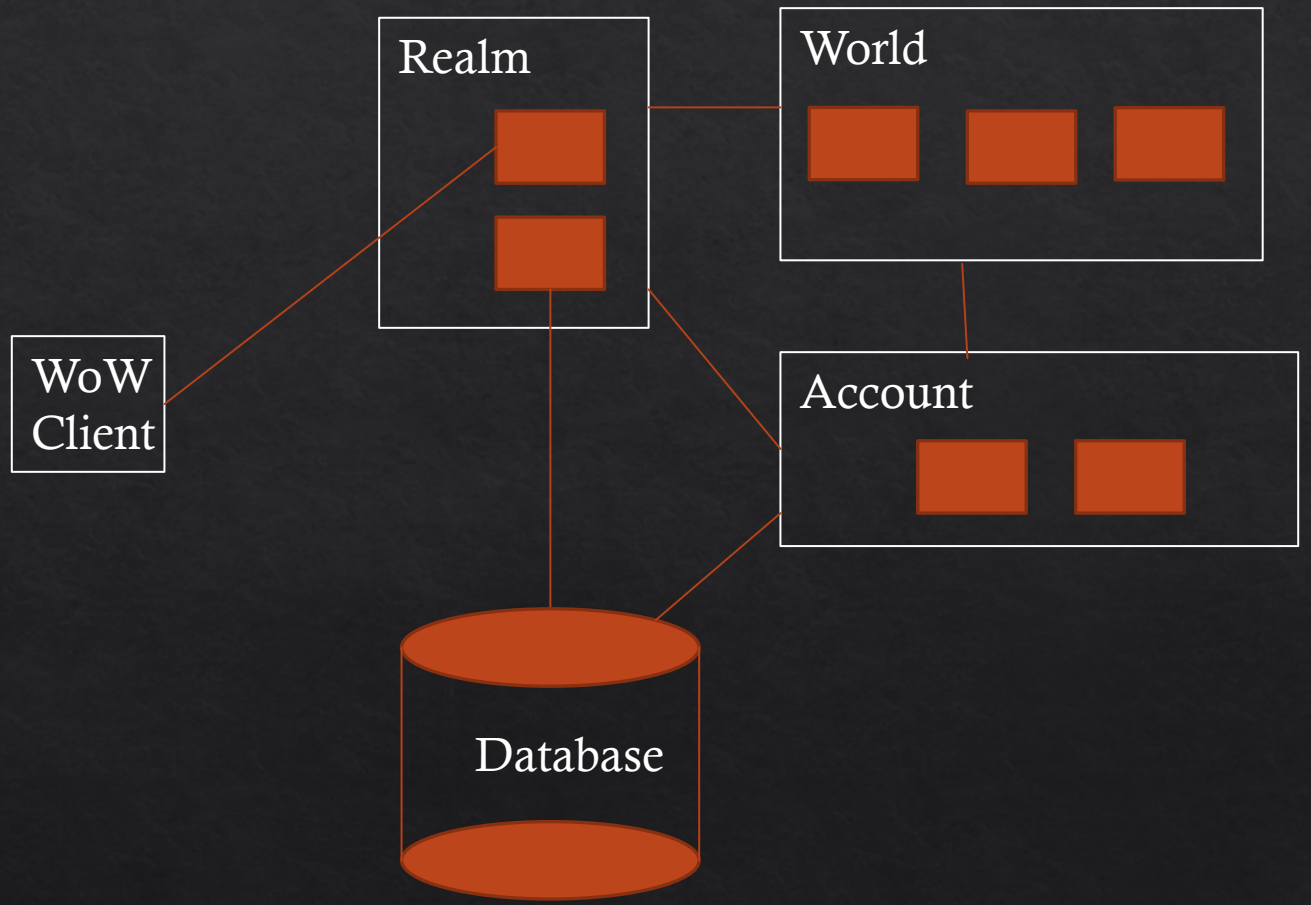
Guild update: Development

- Development goals for Battle for Azeroth
  - Open up social interaction and allow more flexibility for in-game chat
  - Standardize inter-game communication with other games
- UI and Gameplay changes as well as Server
- Server wanted to identify as many issues as possible
  - New dependencies with battle.net
  - More complex WoW server architecture

WoW Service, circa 2005



WoW Service, circa 2019



Guild update: Development

- Development challenges
  - Non-game data services
  - Guild information changed location
  - Legacy data
- Some challenges were anticipated, some found during development
  - Server worked with other teams to address issues as we discovered them
- As development continued, testing began

Guild update: Testing

- Developer iteration and testing
  - Create and play with local builds of guilds
- QA testing
  - Create and play with guilds and play with converted guilds
- Automation testing
  - Create and play and create and play with hundreds and thousands of characters

Guild update: Testing

Guild update: Testing

- “Soup Tasting”
  - Let the flavors develop as much as possible
- Public Test Realm
  - First chance for the public to play
  - More complete integration with live services
  - For guilds, bugs were found in data policies
- Dark Realm
  - Hidden realm on production hardware
  - Dev team gets to see everything with their live characters

Guild update: Launch

- Patch day preparation
  - Continuous shifts ready for 24 hour coverage
  - Other WoW team members in early, to test while realms are hidden
  - Production support: war room, moving meetings, coordinating with other teams, etc.
- Guild issues
  - Account load on conversion
  - Temporarily disabled feature to fix

Process Summary

- Process improvements lead to smoother releases.
- Attention is paid to all phases of Development, Testing, and Launch.
- We continue to revise, but that attention to all of these factors helps us ship better expansions.
- There will always be unexpected challenges and bugs.
- But Battle for Azeroth overall was a smoother launch because of these processes.

Unexpected Changes (a.k.a. welcome to 2020!)

- February and March 2020: global pandemic!
  - IT quickly pivoted from smaller Live Ops VPN solution to full corporate solution
- Existing processes meant the team knew what the schedule would be
- Leadership and production team kept everyone engaged.

- Pre-patch, October 13, 2020
- Release, November 23, 2020
- Completely WFH!

A Look Back

We hope you've found a few tips from these stories that can help your projects.

- The opening of the Gates of Anh'Qiraj taught us the dangers of too many players being encouraged to be in the same place at the same time.
- The Warlords of Draenor launch resulted in a much more effective way of sharing the population of players among world shards.
- Achievements reminded us of the value of developing with an eye to efficiency and revealed the danger of new features integrating with mature data.
- Our focus on improving our processes in all phases of development has helped our launches generally be smoother, and helped us adapt to one of the most drastic workforce changes ever.

Session Review/Summary

- The game has been in active development for over 20 years, with every expansion a new evolution of the game.
- The team has more stories than any one session could relate.
  - Server is only one part of engineering , and Engineering is only one part of the team.
  - Everyone has faced diverse and interesting challenges over the course of seven expansions (and counting)!
- The WoW team strives to take lessons from each launch and combine them with new ideas to make the game and service better each time we add a new chapter to the history of Azeroth.

Thank you!

Contact

- Kurtis McCathern
  - kmccathern@blizzard.com
  - @kurtismcc
- Joseph Cochran
  - jcochran@blizzard.com
  - @jsciv

- Enjoy your future adventures in Azeroth, whether for the Horde or the Alliance.