Gameplay Data Analysis

Asking the Right Questions

Ian Thomas

- Database/ Web Development
  - Epic Games, Inc

Intended Audience

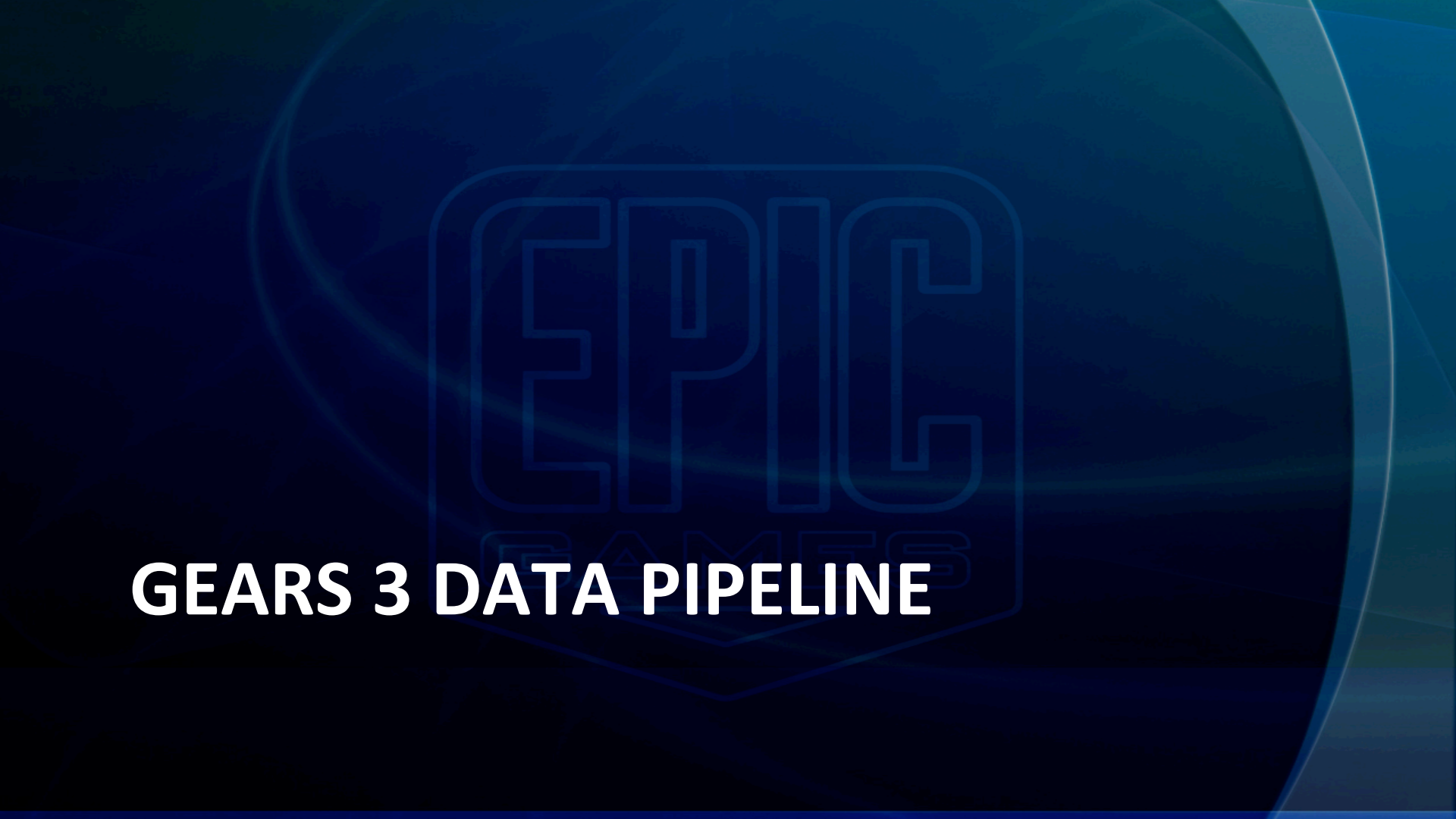
- Server and Database Programmers
- Analysts
- Gameplay Programmers
- Producers
- Designers

Too Much or Too Little?

- Collect Too Much Data
  - Expensive
  - Can't Analyze
- Collect Too Little Data
  - Cheap
  - Can't Analyze

Collecting the Right Data

- Gears 3 Data Pipeline
  - Flexible
- (Gears of) War Story
- How to Determine Which Data to Collect
  - And How To Store It



GEARS 3 DATA PIPELINE

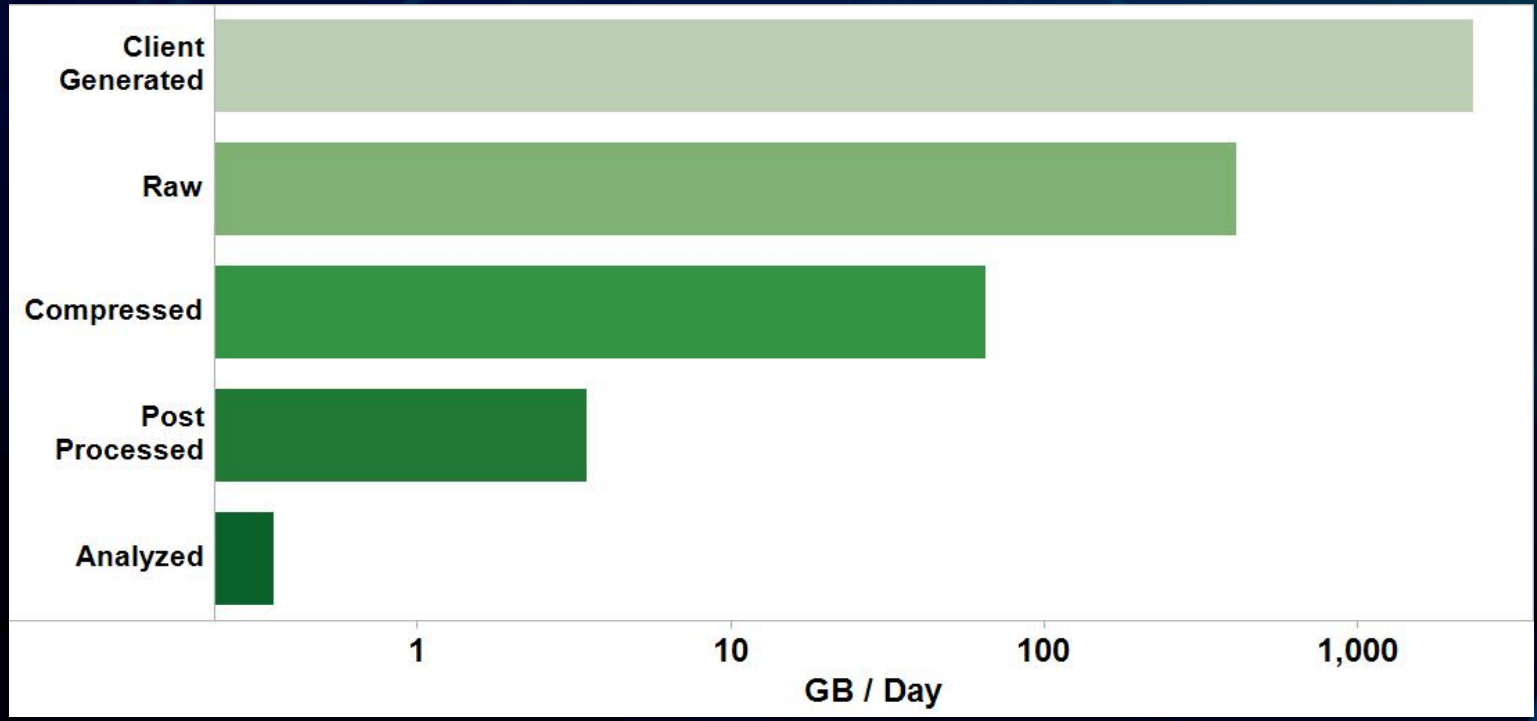
Gears of War 3

- 18 M. Franchise
- 5.5 M. Gears of War 3

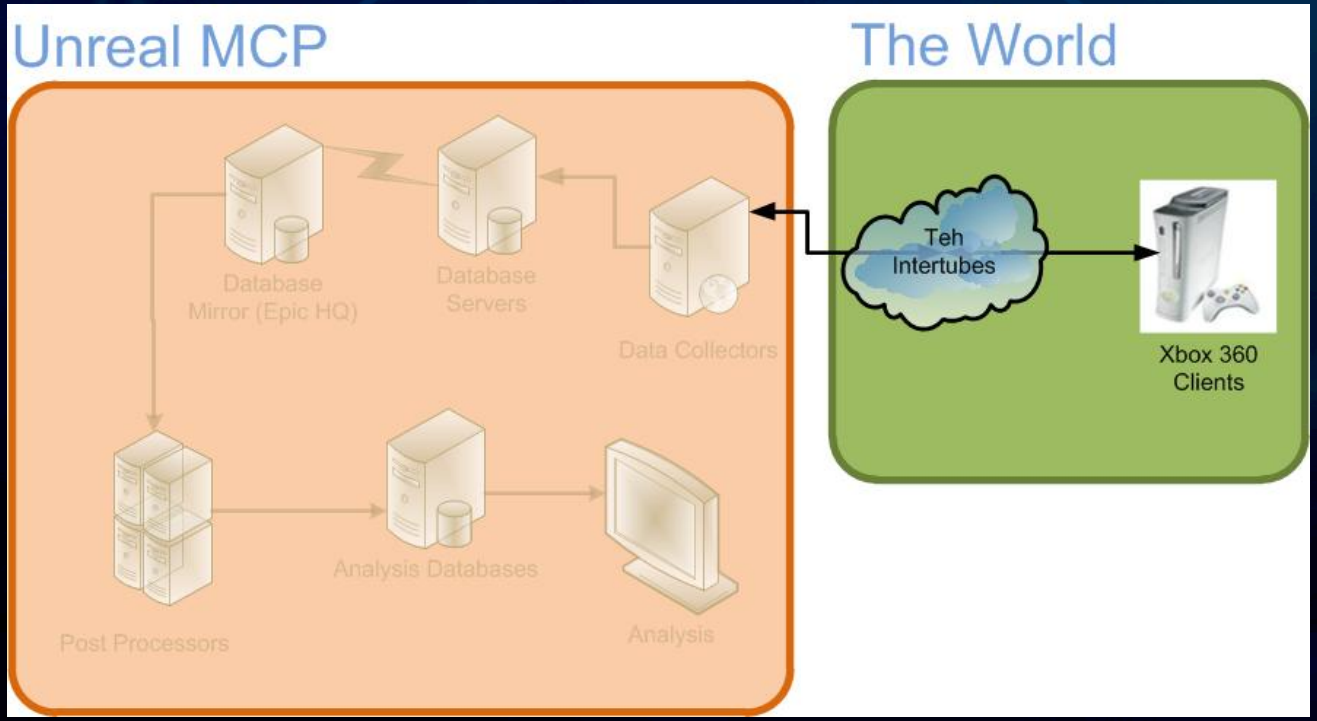
Peak Data Sizes

- Storage
  - 65 GB / Day
  - 21 Million Rows / Day
- Traffic
  - 180 GB / Day
  - 25 Mbps

Flexible Storage Pipeline



Network Infrastructure



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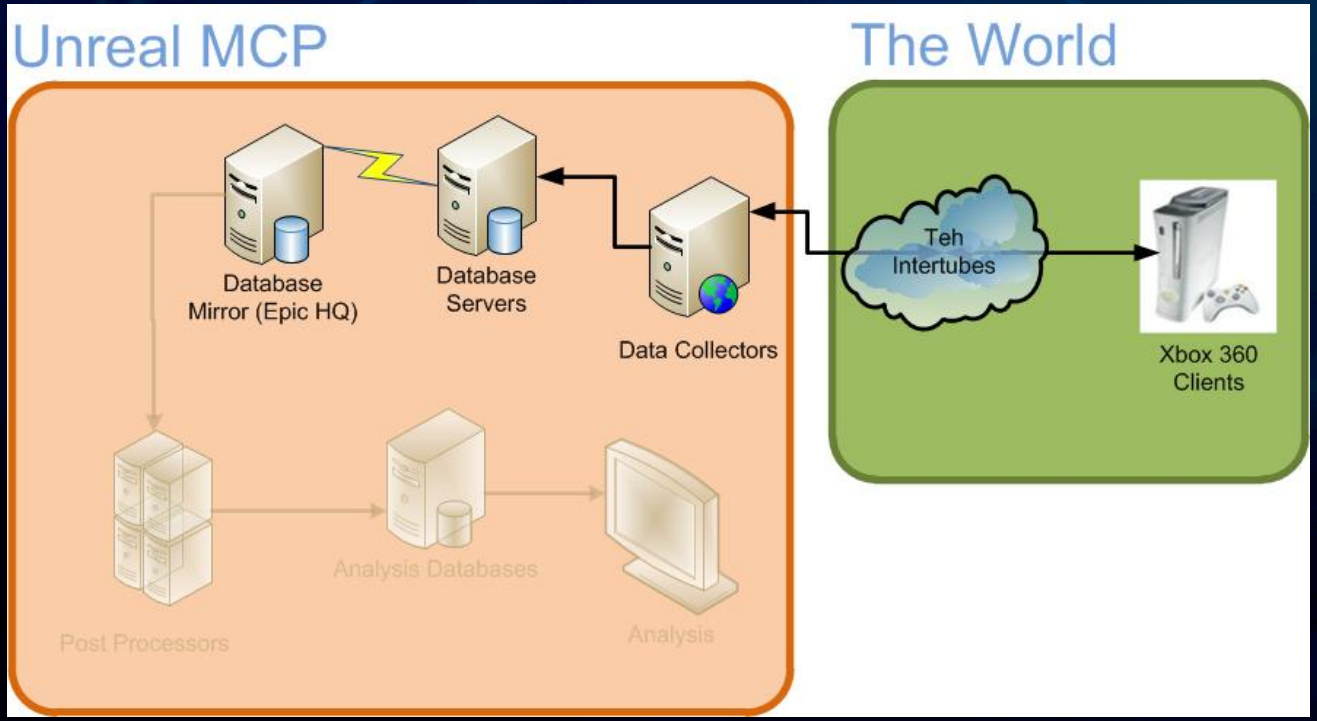

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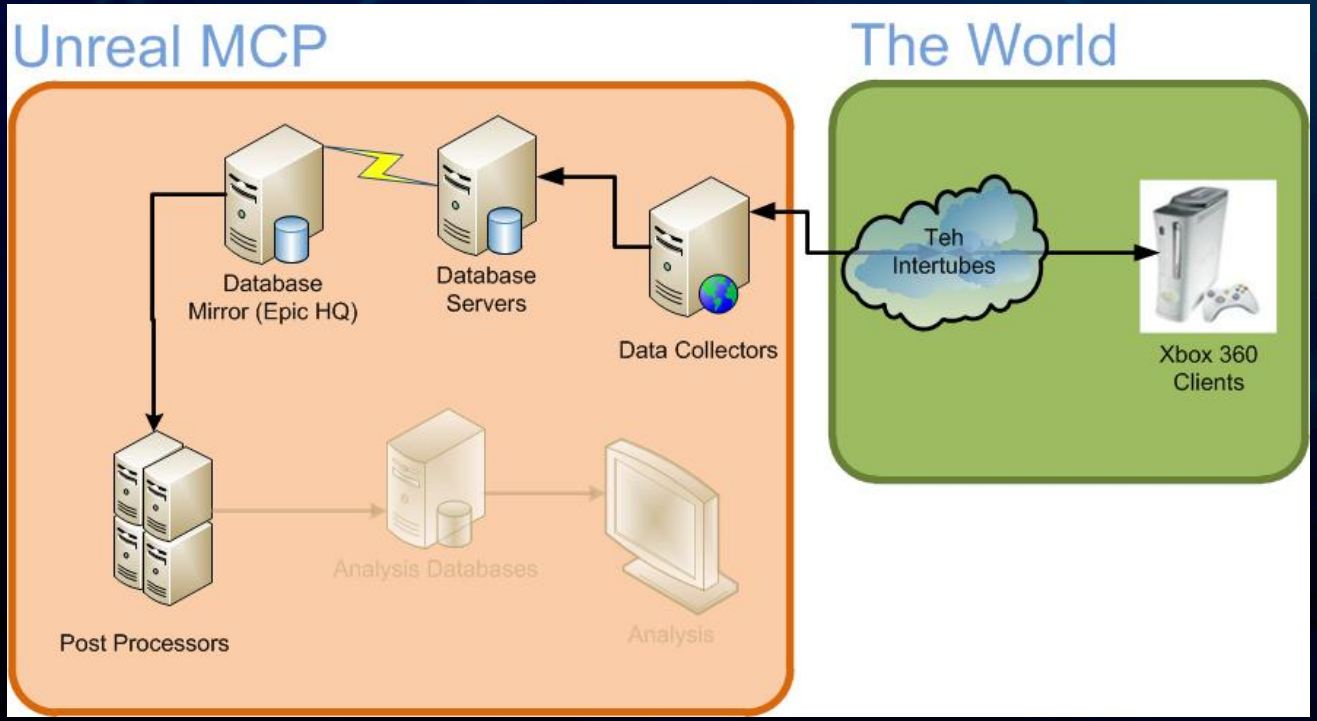
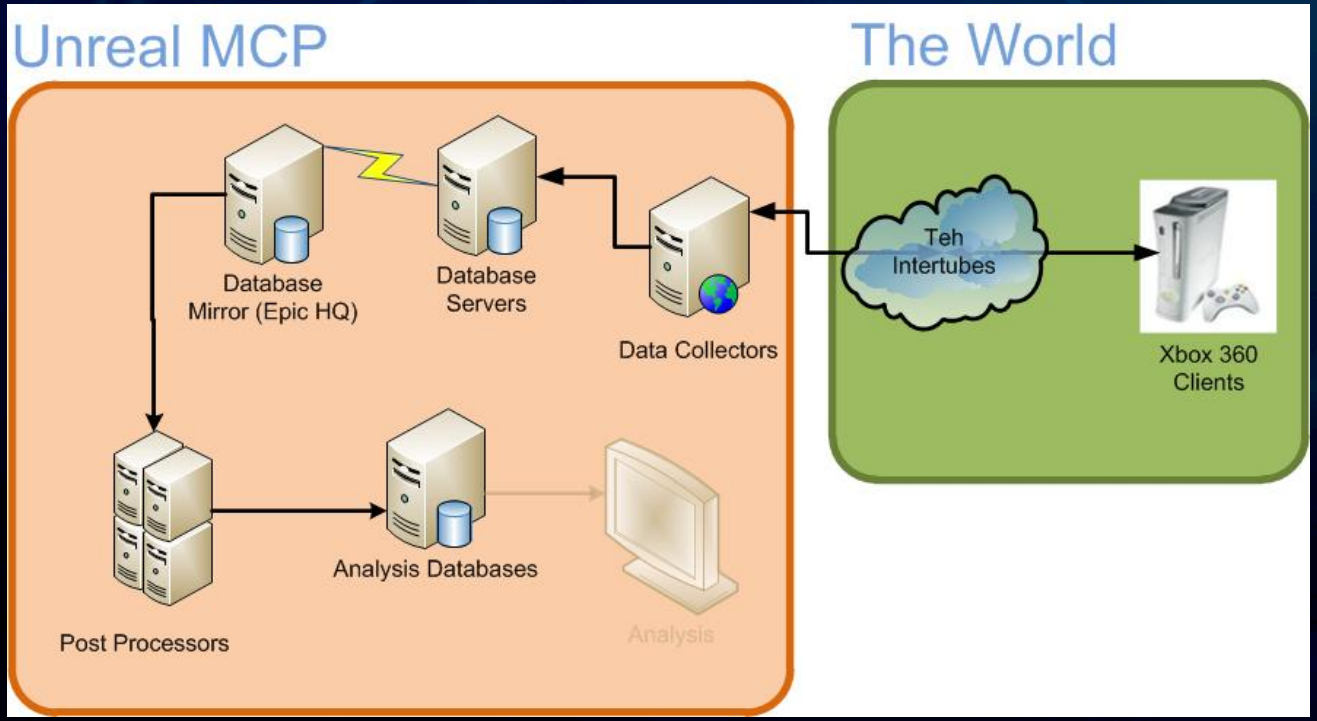
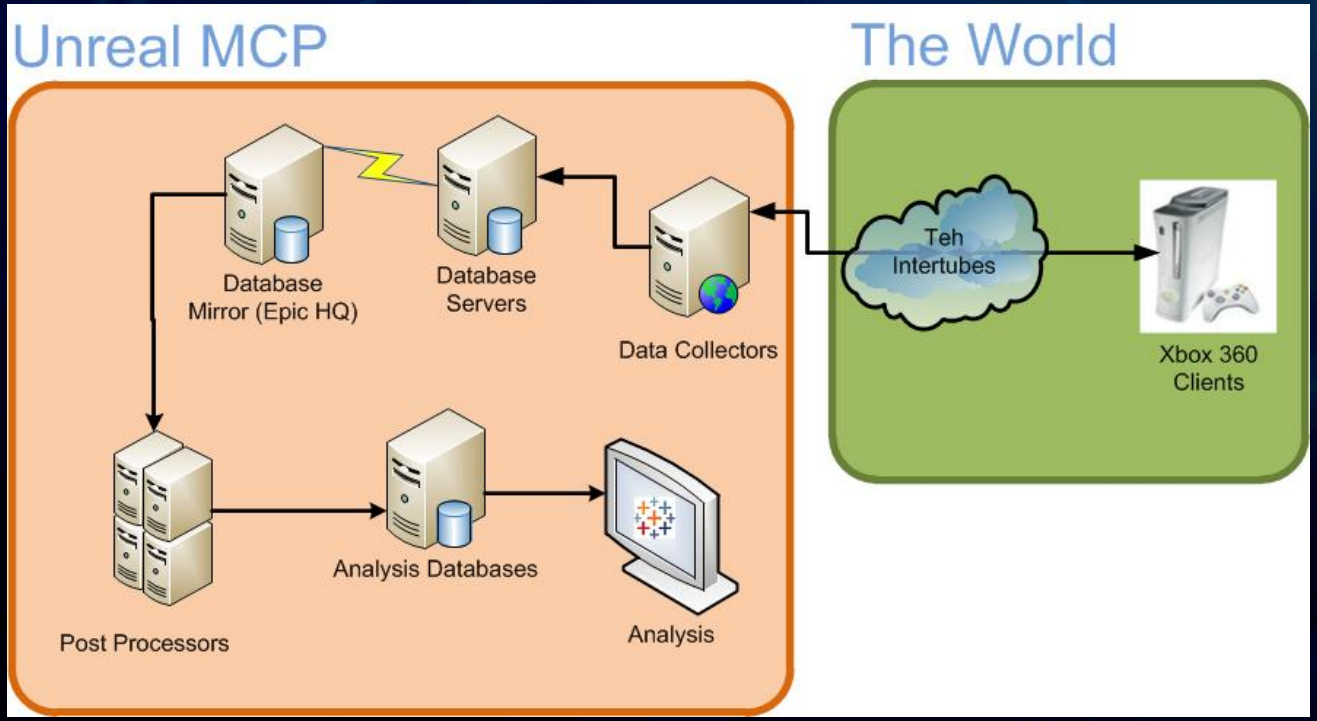


Network Infrastructure



Network Infrastructure



Flexible

- Mitigate Costs
- Able to Send Anything
- Can Add or Remove Data Points

(GEARS OF) WAR STORY

Priorities for Beta

1. Matchmaking
2. Weapon Balance
3. Achievement Progression
4. Anything that might come up

The One Thing we Weren’t Concerned with Was …

DEDICATED SERVER MONITORING

Are the Dedicated Servers Up?

- Forums Say They're Down
- IT Says They're Up
- We Play Some Games
- … And They're Down
- WTF !?!

Healthy Servers; Unhealthy Game

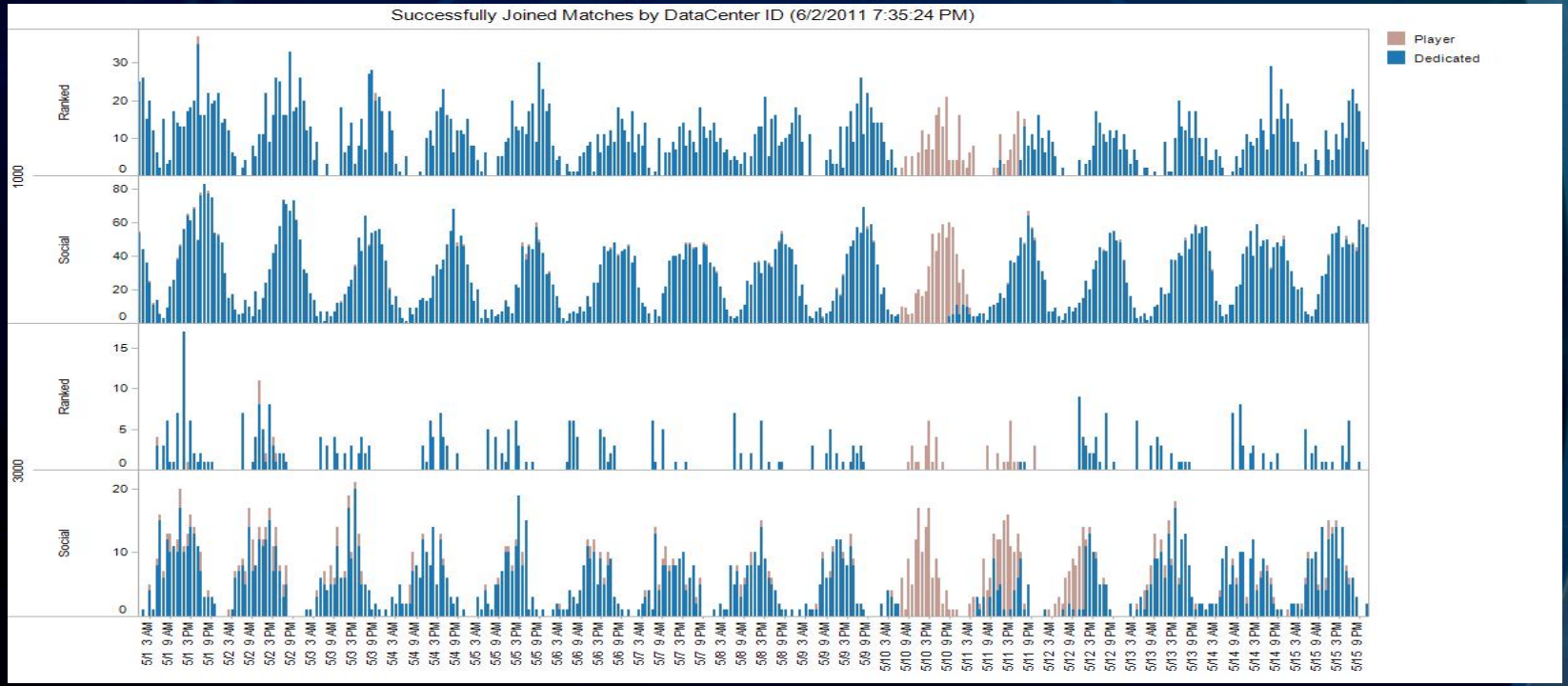
- Dedicated Servers ARE Up
- Logs Look Healthy
- Users are Playing
  - On Listen Servers

Are the Dedicated Servers Up?

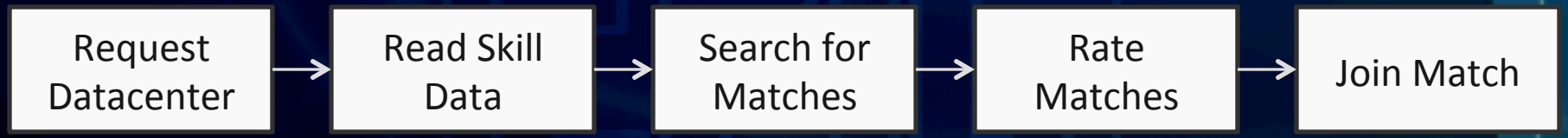
AHA!

- Matchmaking Results Can Be Used to Infer Game Health

Inferred Datacenter Health

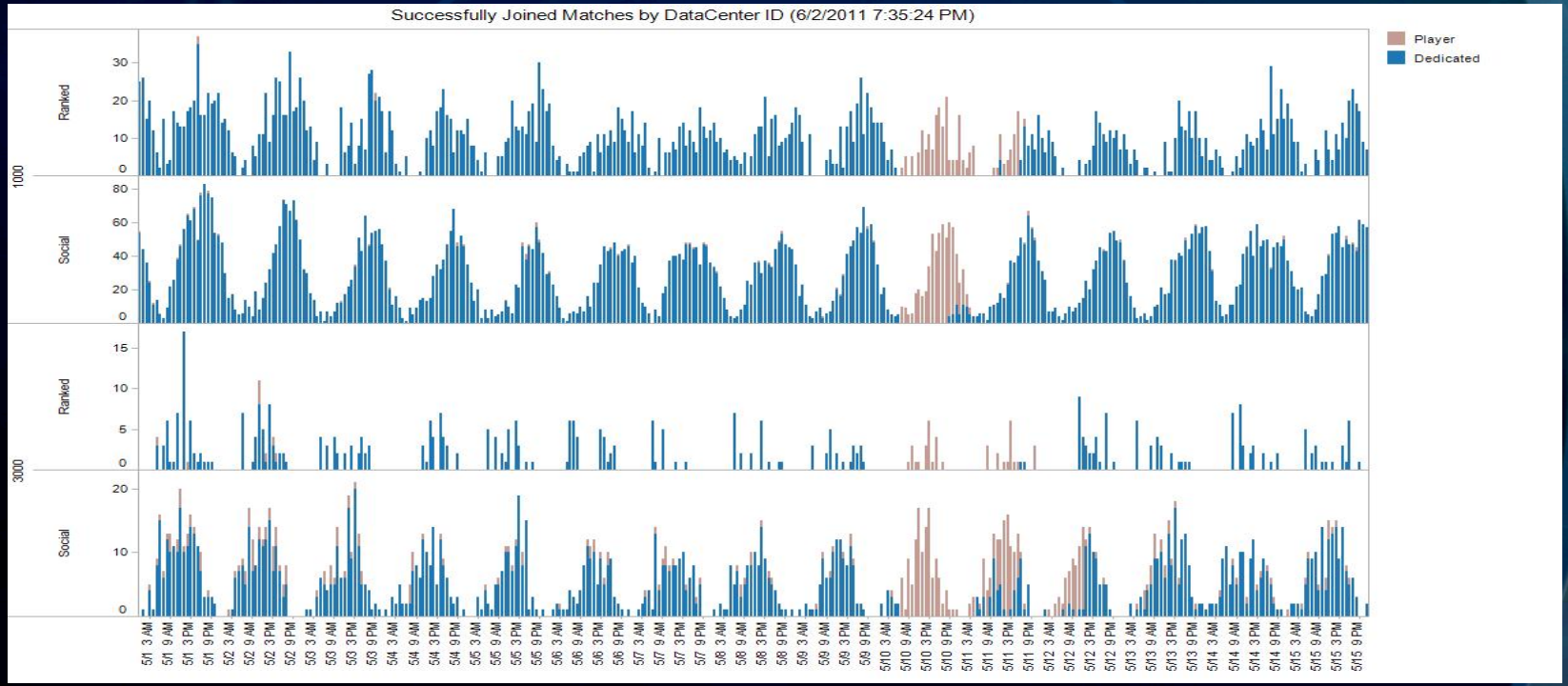


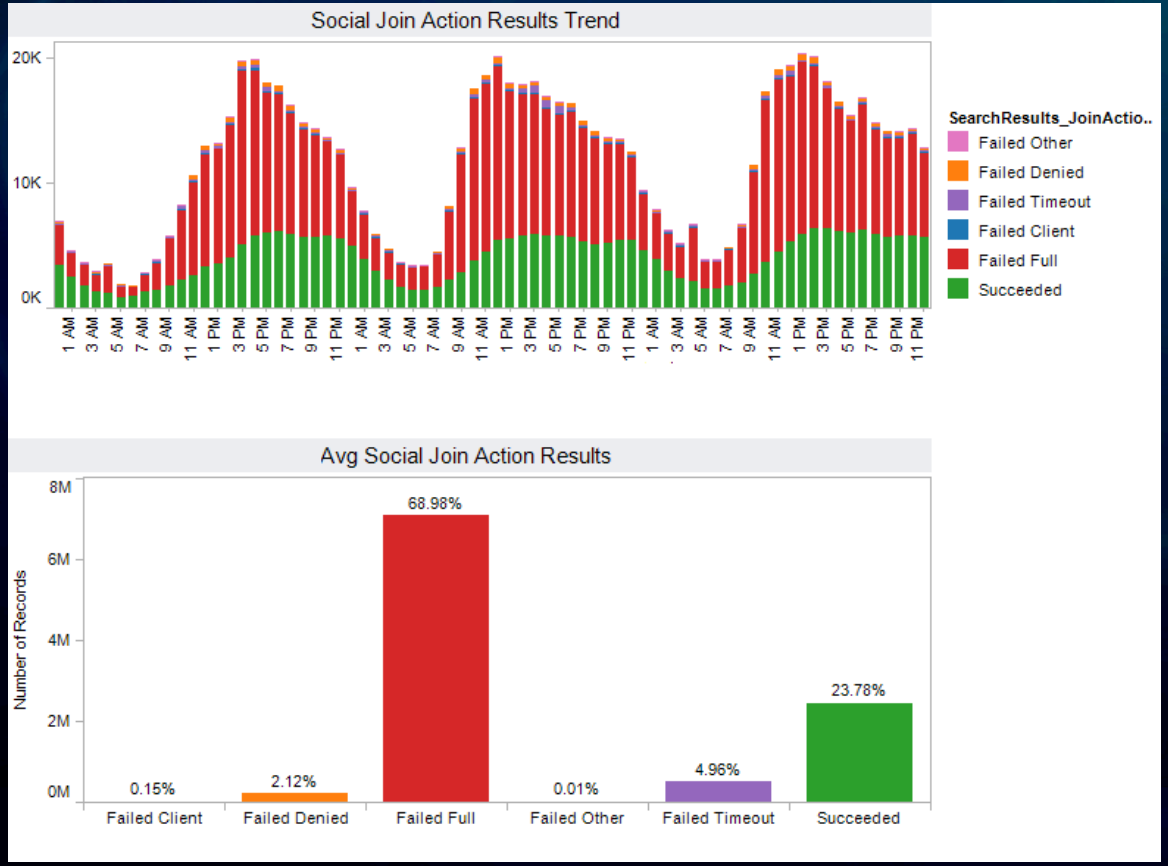
Matchmaking Process

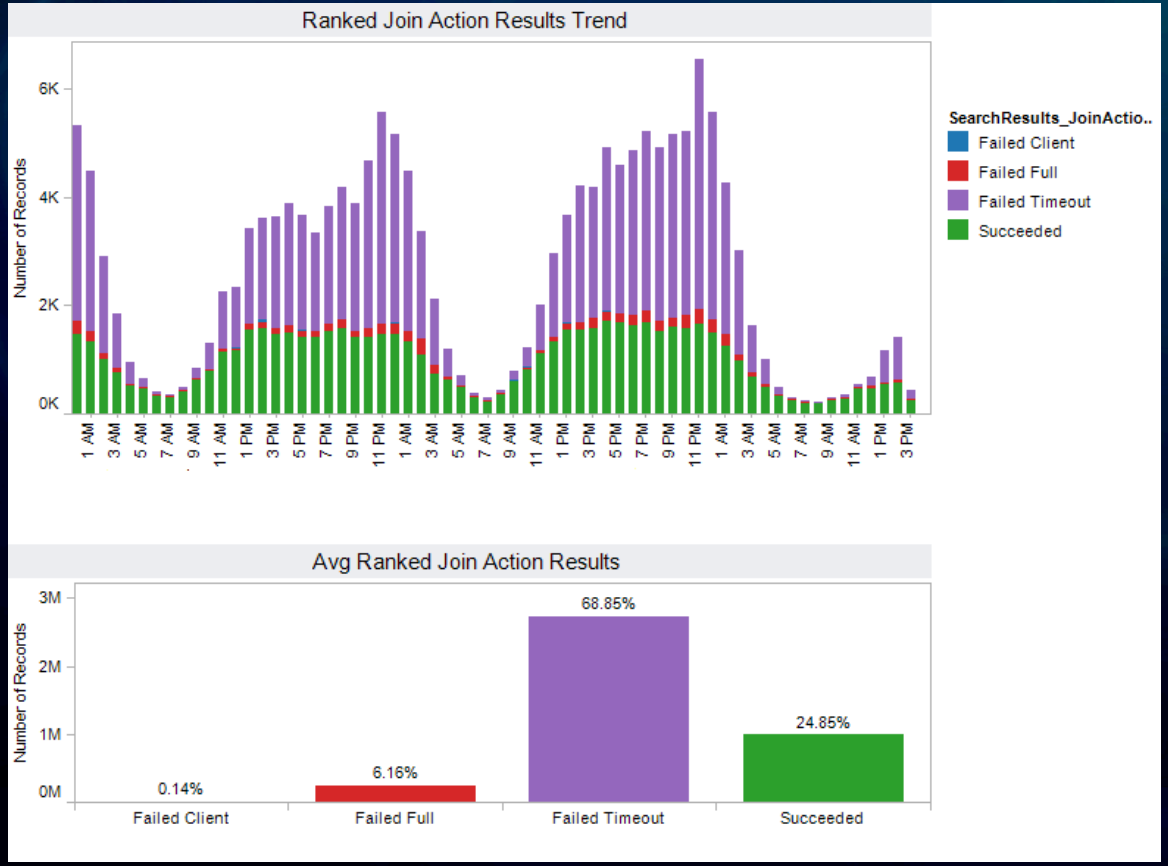


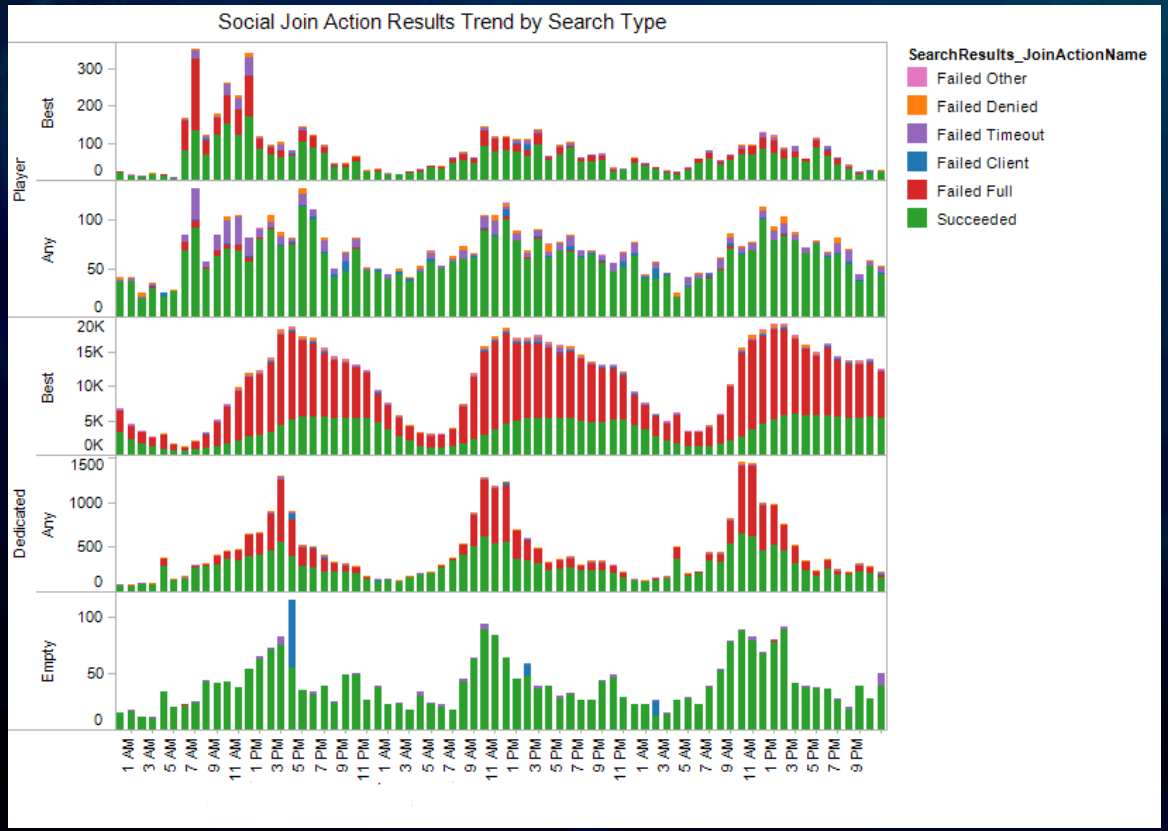
Analysis -> Monitoring

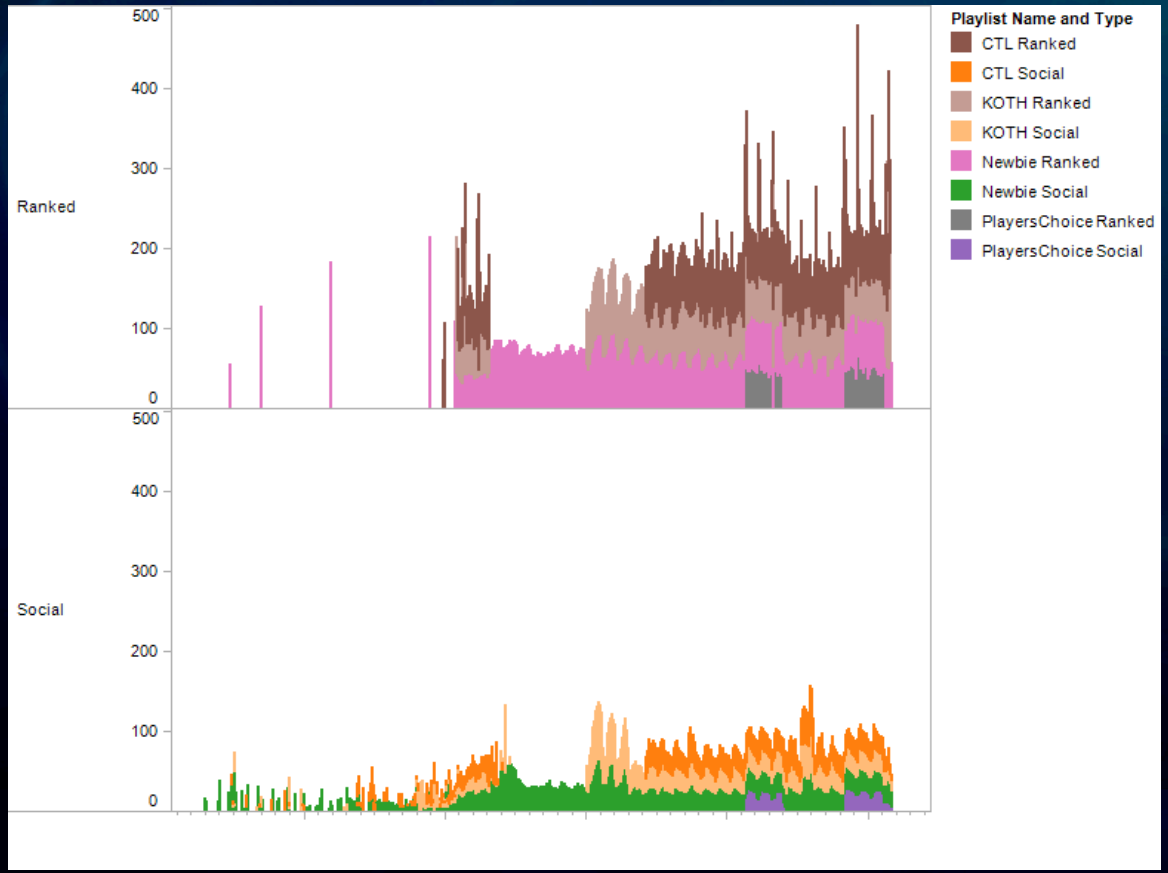
- 25 – 2,500 Results per Matchmaking Request
- Full Dataset: 1 Day Turnaround
- Small Sample: 15 Minutes

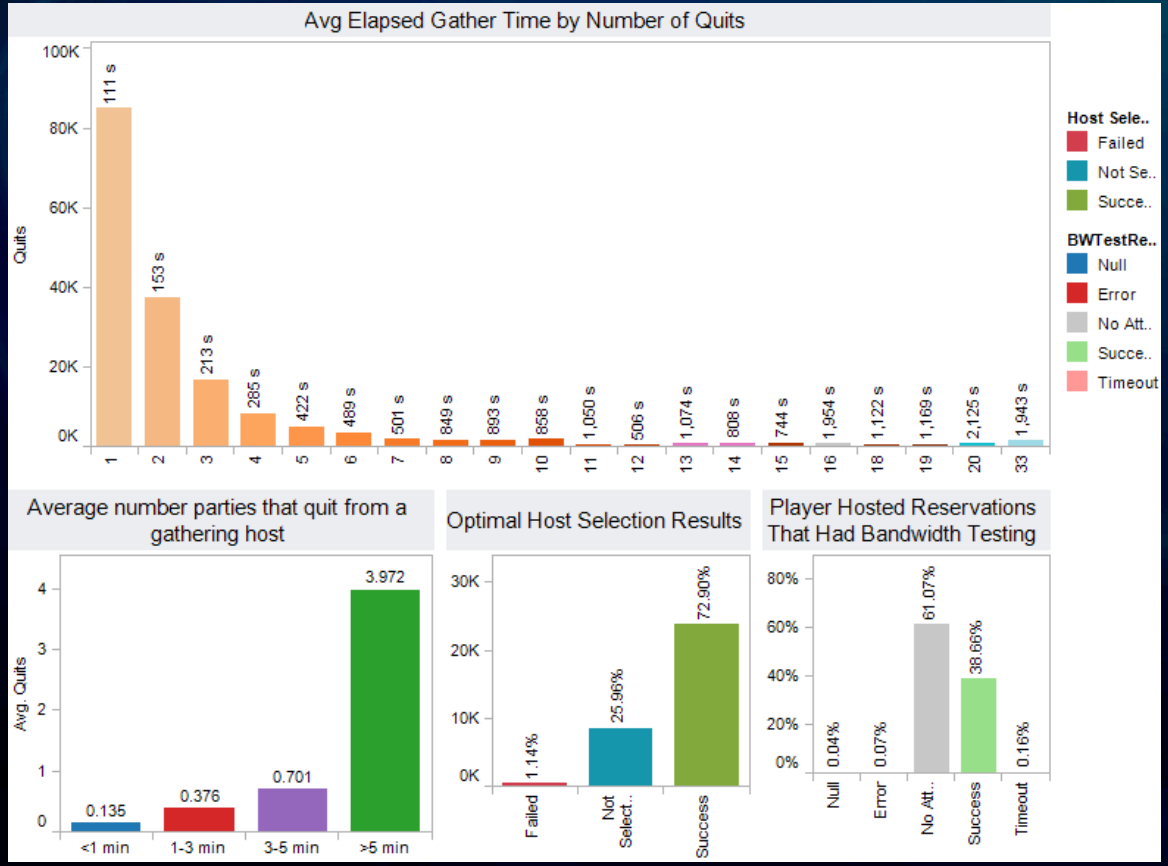

Successfully Joined Matches by DataCenter ID (6/2/2011 7:35:24 PM)
Player
Dedicated
1000
Ranked
Social
3000
Ranked
Social

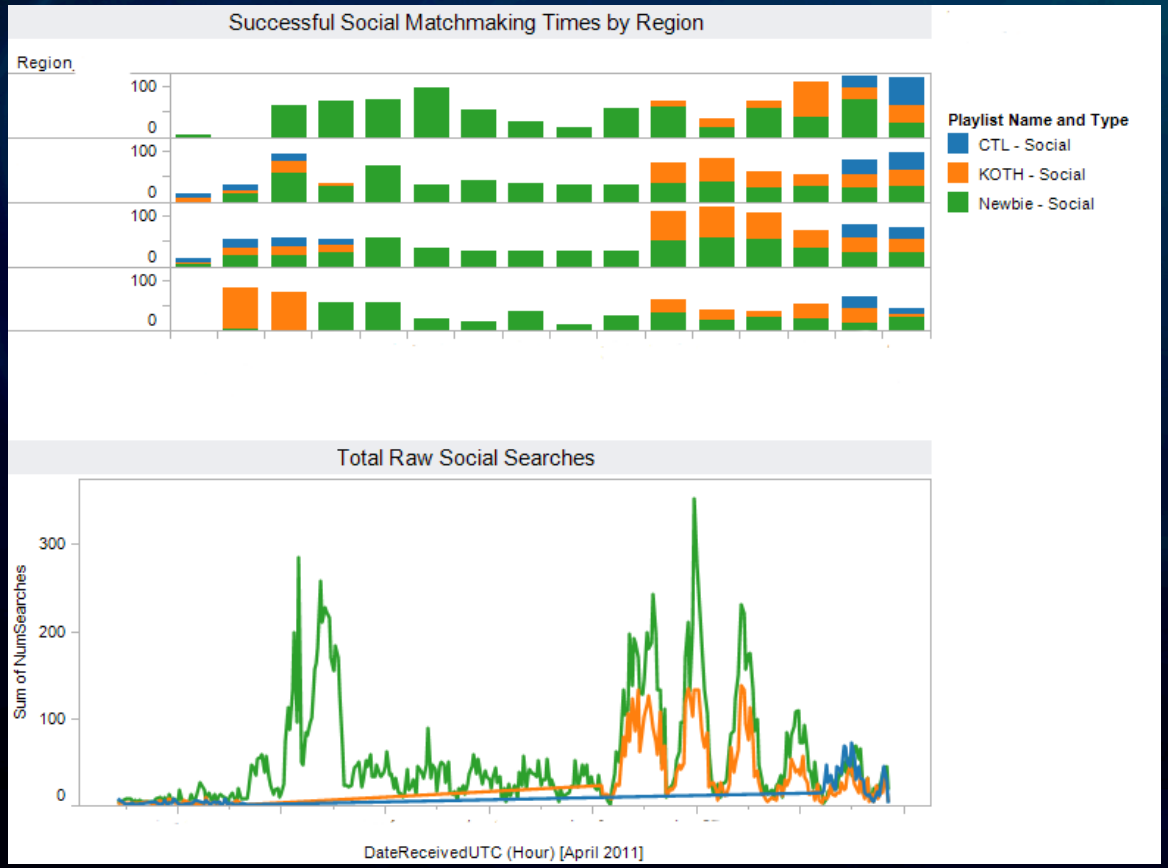

Social Join Action Results Trend
20K
10K
0K
1 AM
3 AM
5 AM
7 AM
9 AM
11 AM
1 PM
3 PM
5 PM
7 PM
9 PM
11 PM
SearchResults_JoinActio..
Failed Other
Failed Denied
Failed Timeout
Failed Client
Failed Full
Succeeded
Avg Social Join Action Results
Number of Records
8M
6M
4M
2M
0M
0.15%
2.12%
68.98%
0.01%
4.96%
23.78%
Failed Client
Failed Denied
Failed Full
Failed Other
Failed Timeout
Succeeded


Ranked Join Action Results Trend
Number of Records
6K
4K
2K
0K
1 AM
3 AM
5 AM
7 AM
9 AM
11 AM
1 PM
3 PM
5 PM
7 PM
9 PM
11 PM
1 AM
3 AM
5 AM
7 AM
9 AM
11 AM
1 PM
3 PM
5 PM
7 PM
9 PM
11 PM
1 AM
3 AM
5 AM
7 AM
9 AM
11 AM
1 PM
3 PM
SearchResults_JoinActio..
Failed Client
Failed Full
Failed Timeout
Succeeded
Avg Ranked Join Action Results
Number of Records
3M
2M
1M
0M
0.14%
6.16%
68.85%
24.85%
Failed Client
Failed Full
Failed Timeout
Succeeded

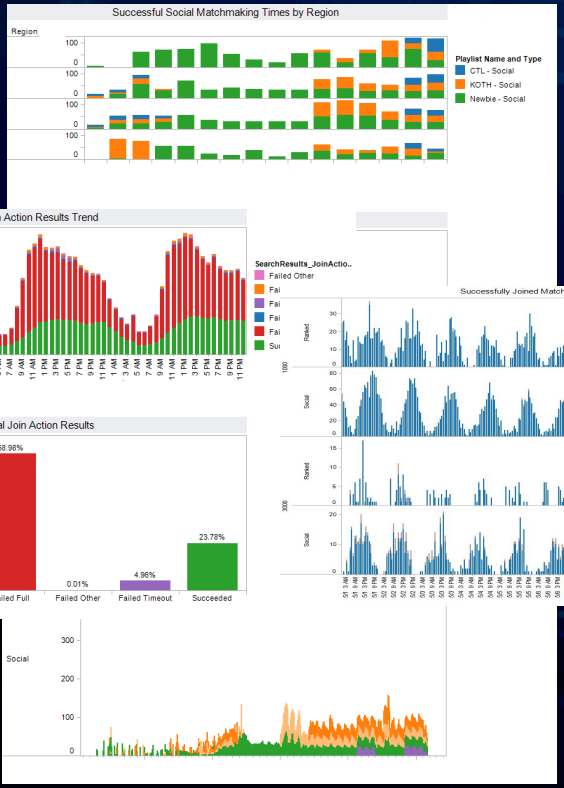

Social Join Action Results Trend by Search Type
SearchResults_JoinActionName
Failed Other
Failed Denied
Failed Timeout
Failed Client
Failed Full
Succeeded
Player
Best
Any
Dedicated
Best
Any
Empty
1 AM
3 AM
5 AM
7 AM
9 AM
11 AM
1 PM
3 PM
5 PM
7 PM
9 PM
11 PM

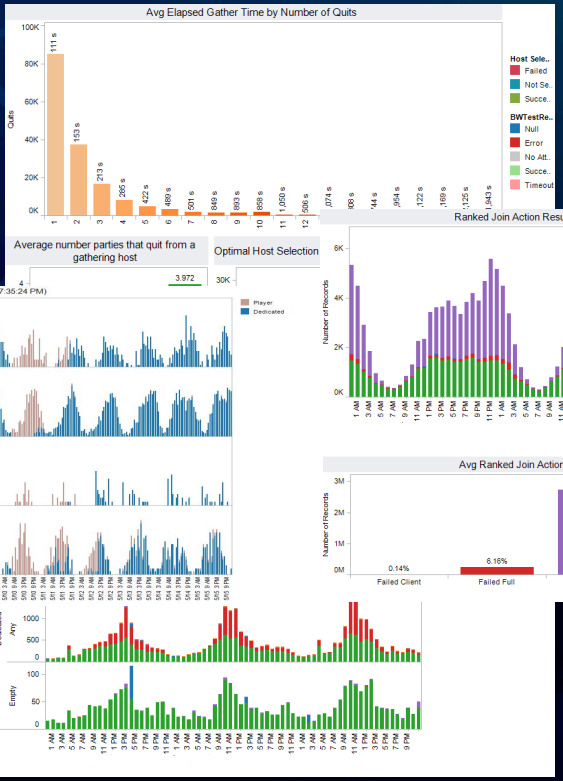

Ranked
Social
500
400
300
200
100
0
Playlist Name and Type
CTL Ranked
CTL Social
KOTH Ranked
KOTH Social
Newbie Ranked
Newbie Social
PlayersChoice Ranked
PlayersChoice Social

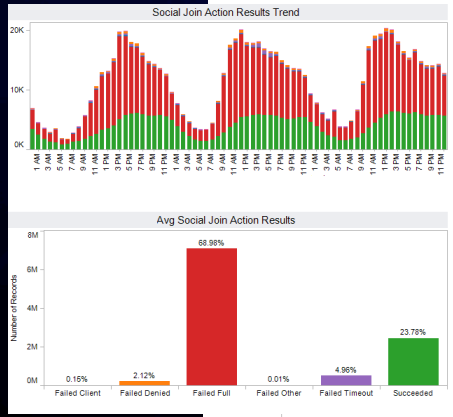

Avg Elapsed Gather Time by Number of Quits
Quits
100K
80K
60K
40K
20K
0K
111 s
153 s
213 s
285 s
422 s
489 s
501 s
849 s
893 s
858 s
1,050 s
506 s
1,074 s
808 s
744 s
1,954 s
1,122 s
1,169 s
2,125 s
1,943 s
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
18
19
20
33
Host Sele..
Failed
Not Se..
Succe..
BWTestRe..
Null
Error
No Att..
Succe..
Timeout
Average number parties that quit from a gathering host
Avg. Quits
4
3
2
1
0
0.135
0.376
0.701
3.972
<1 min
1-3 min
3-5 min
>5 min
Optimal Host Selection Results
30K
20K
10K
0K
1.14%
25.96%
72.90%
Failed
Not Select..
Success
Player Hosted Reservations That Had Bandwidth Testing
80%
60%
40%
20%
0%
0.04%
0.07%
61.07%
38.66%
0.16%
Null
Error
No Att..
Success
Timeout

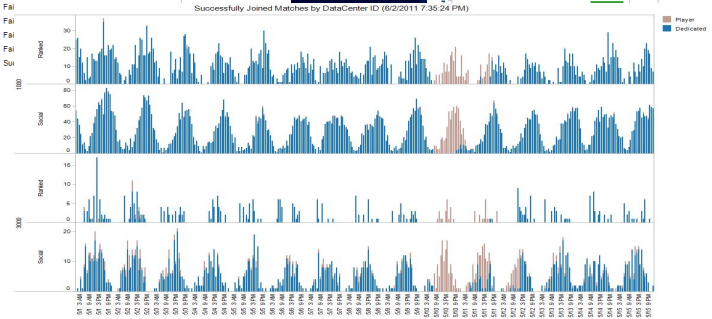

Successful Social Matchmaking Times by Region
Region
100
0
100
0
100
0
100
0
Playlist Name and Type
CTL - Social
KOTH - Social
Newbie - Social
Total Raw Social Searches
Sum of NumSearches
300
200
100
0
DateReceivedUTC (Hour) [April 2011]

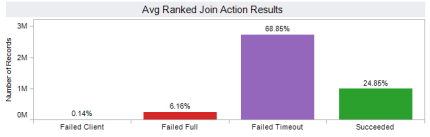
Ok, so what's wrong?











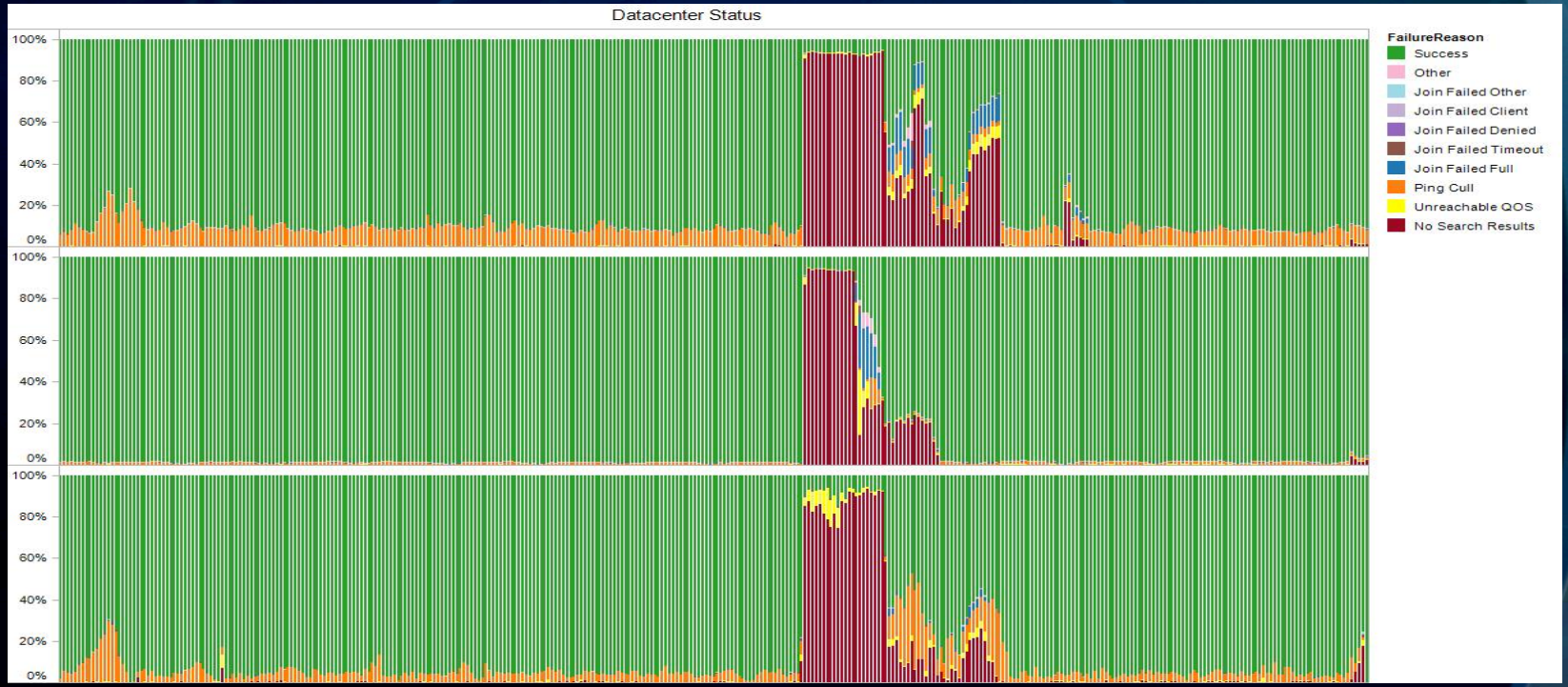
Comparing Apples to Oranges

- Different Granularities
- No Cohesive Picture
- Only Experts Could Divine Answers
- We Needed …

The One True Chart

- One View That Showed Everyone What Problems Servers Were Having

Datacenter Status



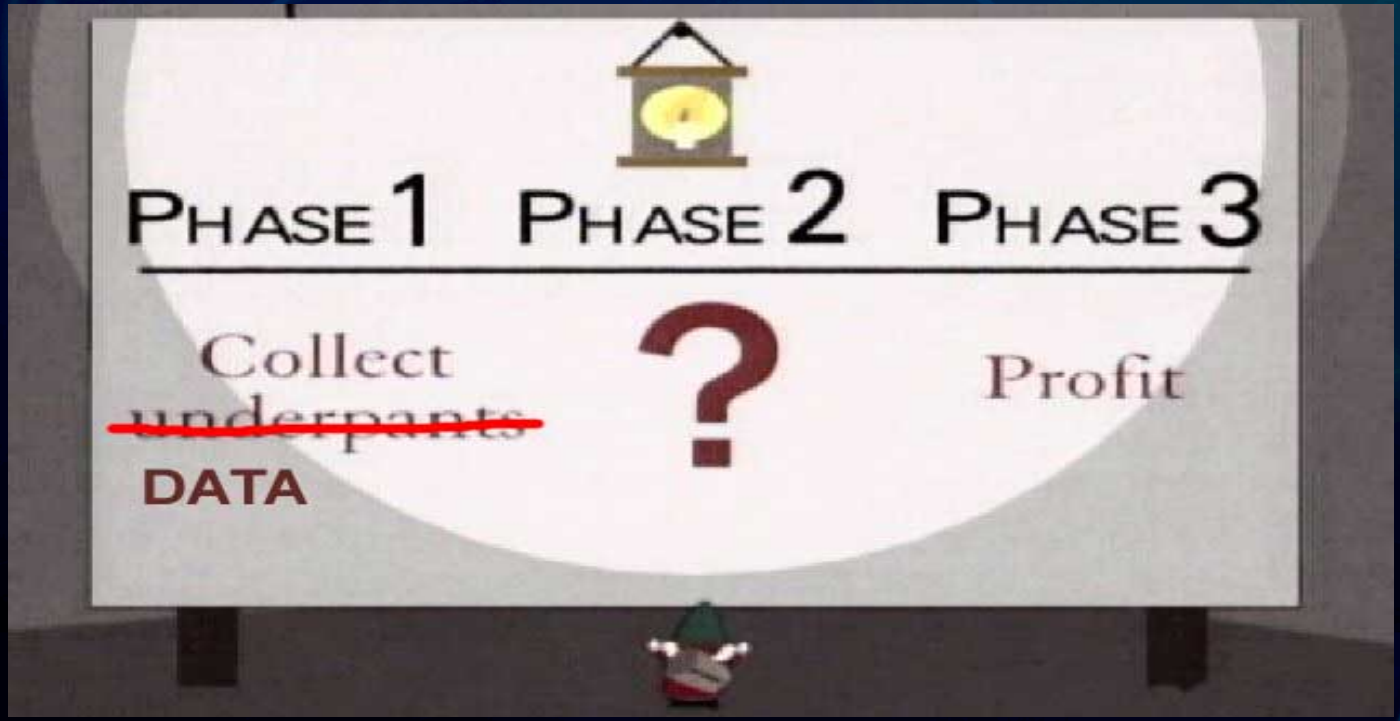
Lessons

- Priorities Change
- Schema Affects Analysis
- Iteration is Key
- Knowing What You Want Allows You to Optimize

How do you only collect the data
that you're going to use?

ASK THE RIGHT QUESTIONS

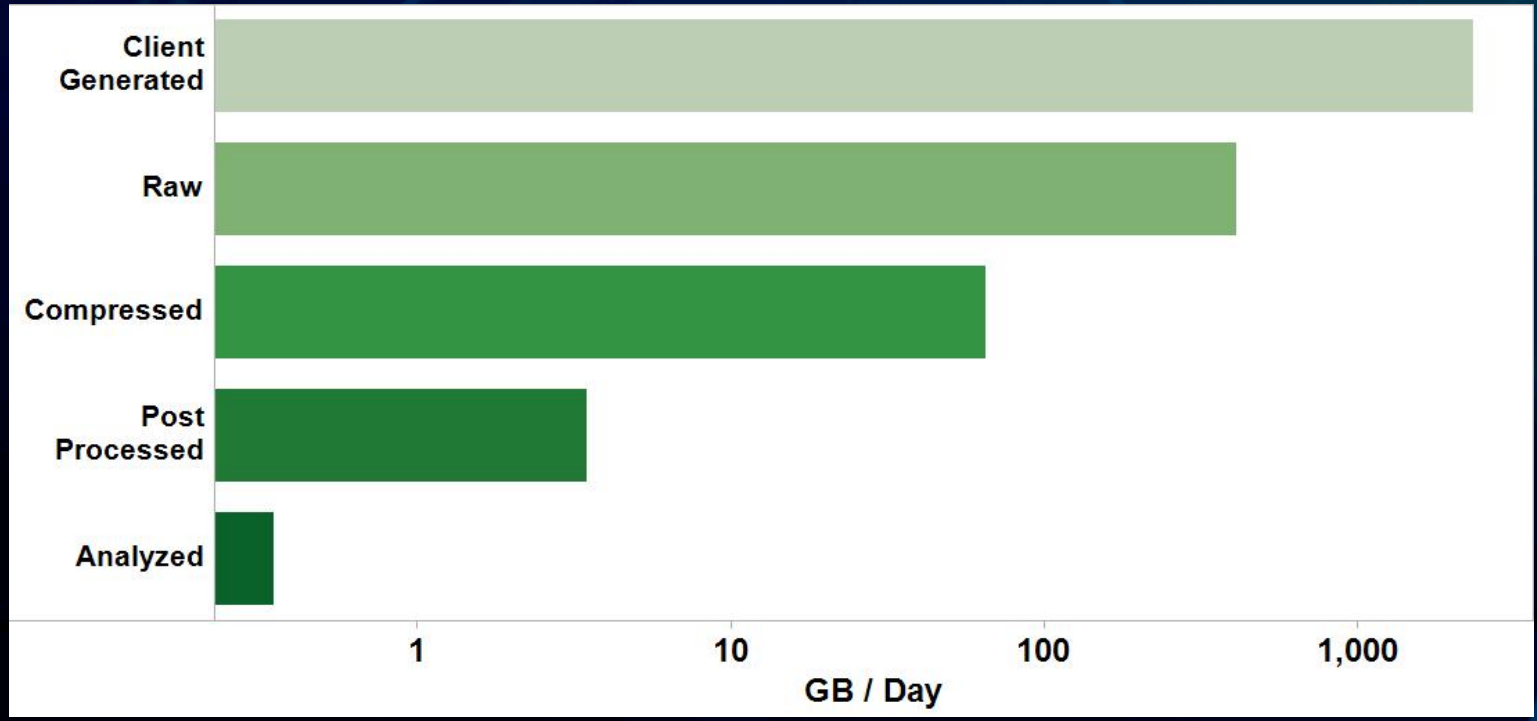
Everybody Wants Something


PHASE 1
PHASE 2
PHASE 3
Collect
underpants
DATA
?
Profit

Collect Everything; Answer Anything

- Holy Grail
  - Don’t Know What You Don’t Know
  - Can Only Ship Once
- Easier Than Trying to **Answer** Everything

Answer Anything You Want

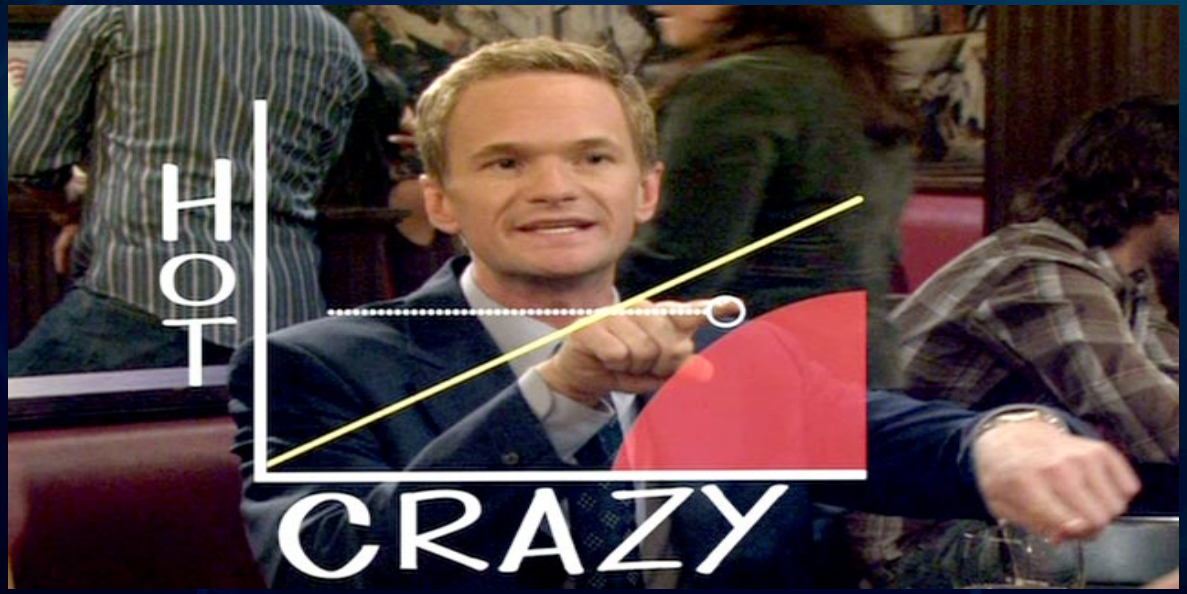


Selecting Questions to Answer

- Define Priorities
- Categorize
- Structure Data Accordingly
- Analyze
- Iterate

What are the most important things
you're expecting to get out of your data?

DEFINE PRIORITIES



Cost / Benefit

You Want the **Hot** Information Without Spending **Crazy** Amounts of Effort to Get It.

Who Needs to Be Involved?

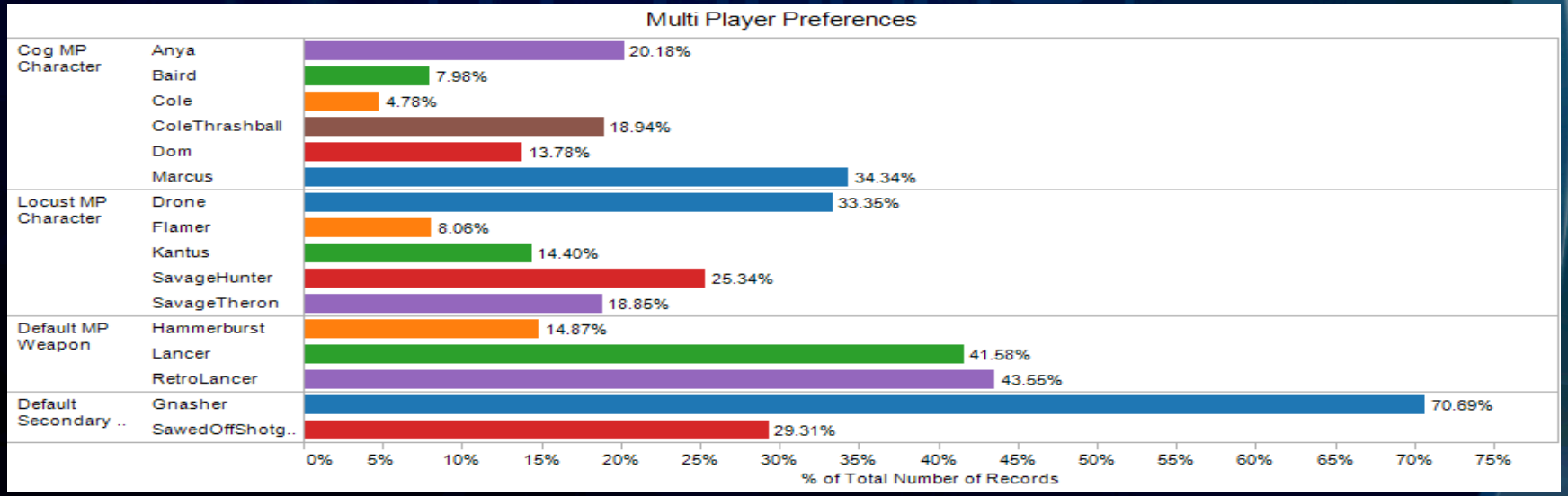
- Gameplay Programmers
- Designers
- Producers
- Operations
  - Dedicated servers
- External partners

Actionable Data

- What can you Change?
- When can you **Use** this Information?
  - Config files
  - Beta
  - Title Update
  - Next Game
  - Press Release
  - Forums

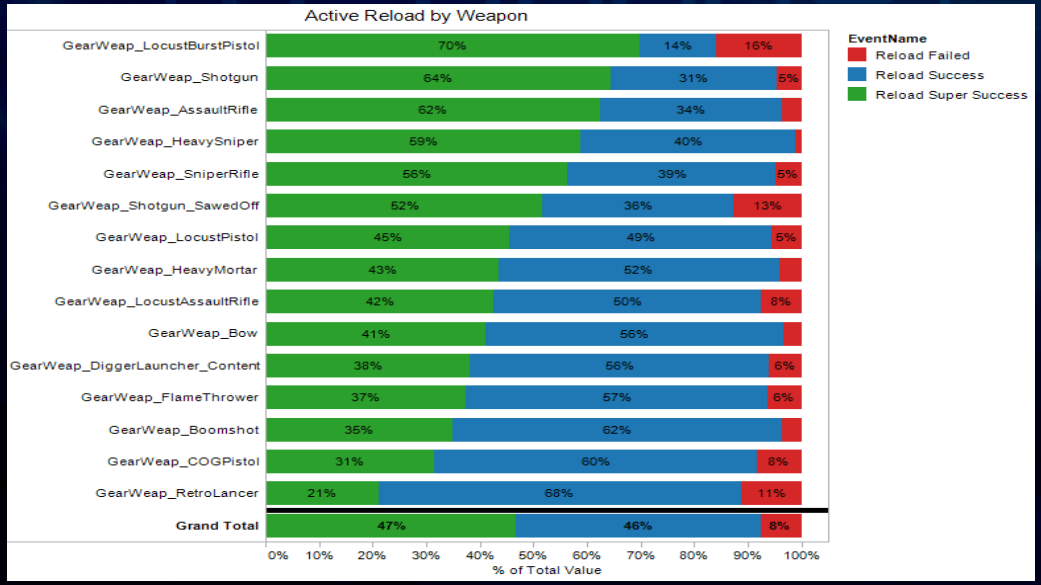
What Will Knowing Get You?

Multiplayer Character Preference:



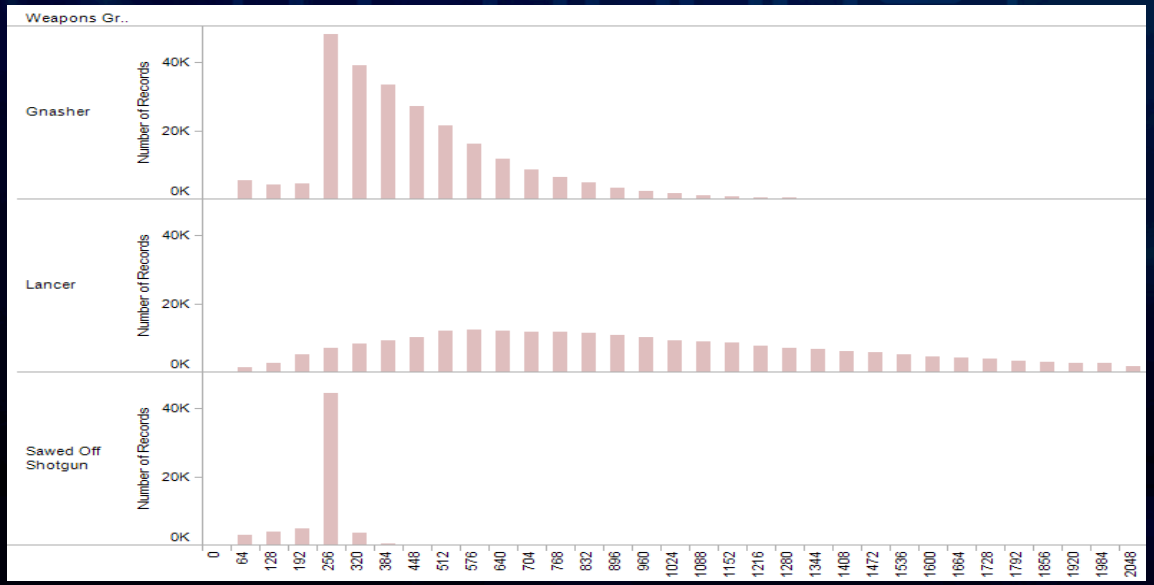
What Will Knowing Get You?

Active Reload Success Rates



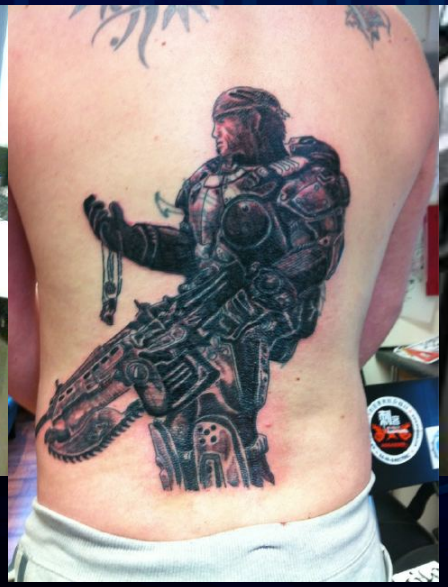
What Will Knowing Get You?

Downing Distances



What Will Knowing Get You?

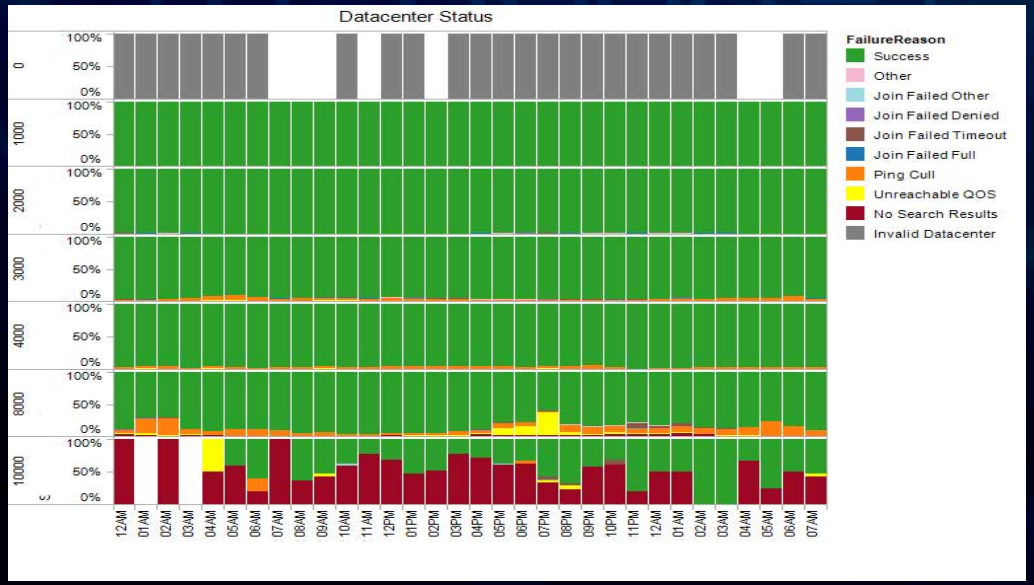
Avid Fans



What Will **NOT** Knowing **COST** You?

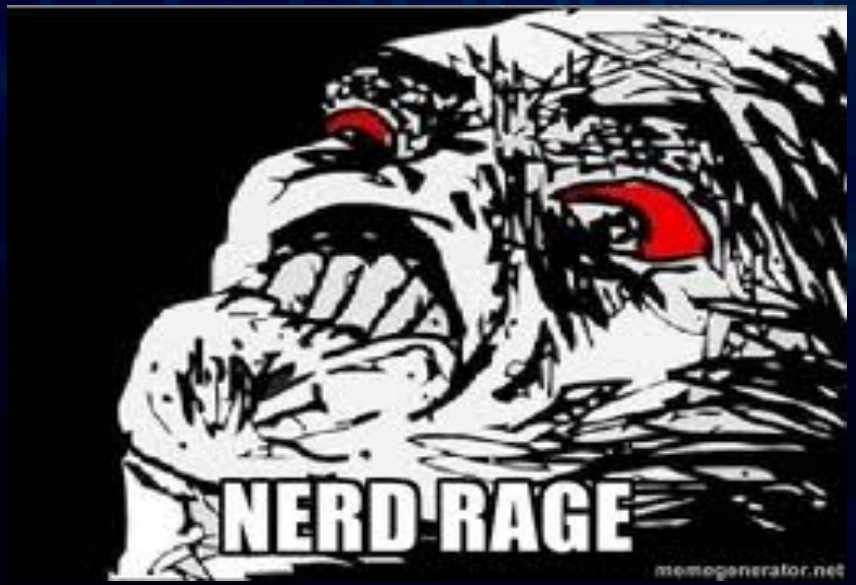
What Will **NOT** Knowing **COST** You?

Dedicated Server Outages



What Will **NOT** Knowing **COST** You?

Nerd Rage



Gears 3 Priorities

1. Matchmaking Analysis
   - Minimize User Wait Times
2. Actionable Gameplay Measurements
   - Weapon Balance
   - Achievement and Level Progress
   - Game Types

Gears 3 Priorities

1. Dedicated Server Health Monitoring
2. Matchmaking Analysis
   - Minimize User Wait Times
3. Actionable Gameplay Measurements
   - Weapon Balance
   - Achievement and Level Progress
   - Game Types

CATEGORIZE QUESTIONS

Brainstorm

- Work With Everyone
- Gather Large List of Potential Questions
- Filter These Through Priorities

Categories Will Emerge

- Game Info
  - Games by Hour of the day, Games by Game Type, Average Match Length
- Weapons
  - Kills by Weapon, DBNO by Weapon, Starting Weapon by Game Type
- User Settings
  - Resolutions, Control Scheme, Gore, Subtitles

Now is the Time to Think About How to

STRUCTURE DATA

Storage Basics

You Try Counting All Those Kills

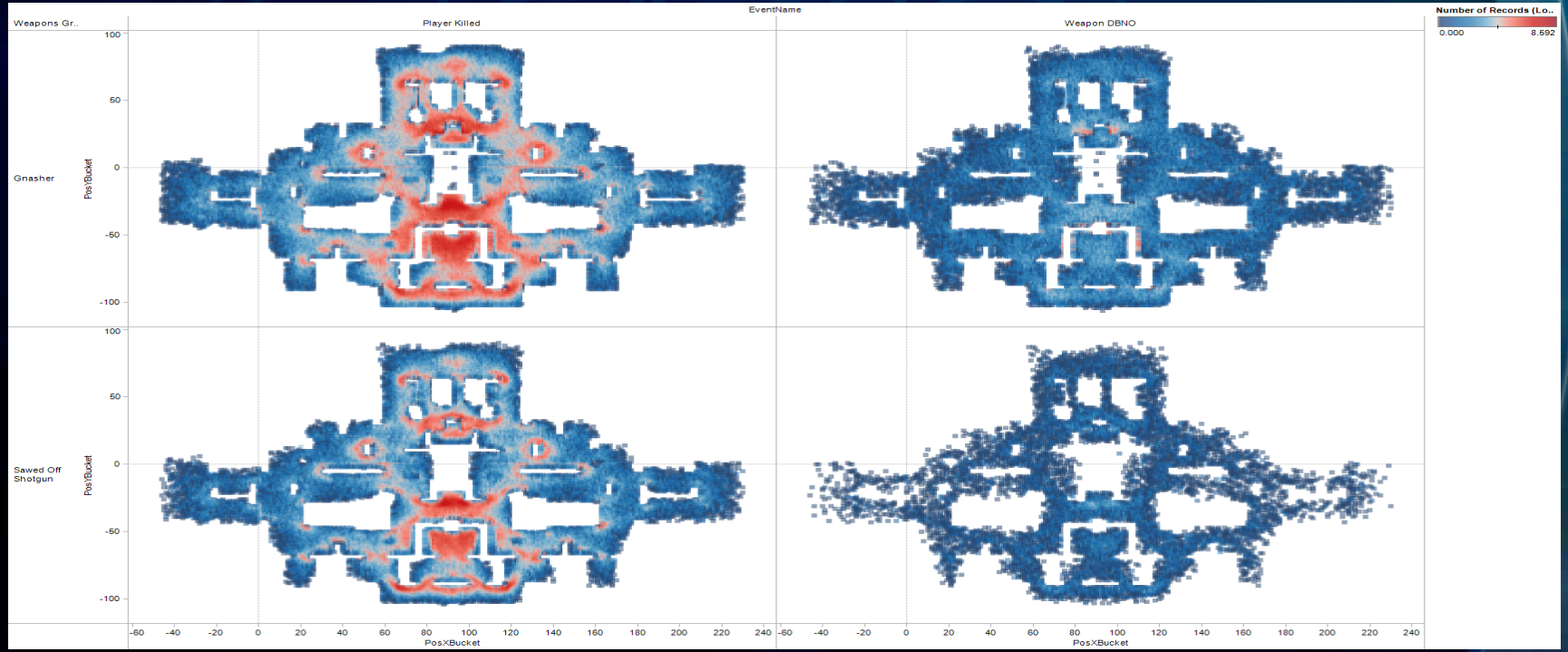
Events

Event	Damage Type	Source Player ID	Target Player	MapName
Kill	Lancer	P1	P2	MP_Hotel
Death	Lancer	P2	P1	MP_Hotel
Kill	Gnasher	P1	P2	MP_Hotel
Death	Gnasher	P2	P1	MP_Hotel
Kill	Sawed-Off	P1	P2	MP_Hotel
Death	Sawed-Off	P2	P1	MP_Hotel
...	...	...	...	...
Kill	Gnasher	P1	P2	MP_Hotel
Death	Gnasher	P2	P1	MP_Hotel
Kill	Gnasher	P1	P2	MP_Hotel
Death	Gnasher	P2	P1	MP_Hotel
Kill	Gnasher	P1	P2	MP_Hotel
Death	Gnasher	P2	P1	MP_Hotel

Counting Kills

Event	Damage Type	Source Player ID	Target Player	MapName
Kill	Lancer	P1	P2	MP_Hotel
Death	Lancer	P2	P1	MP_Hotel
Kill	Gnasher	P1	P2	MP_Hotel
Death	Gnasher	P2	P1	MP_Hotel
Kill	Sawed-Off	P1	P2	MP_Hotel
Death	Sawed-Off	P2	P1	MP_Hotel
…	…	…	…	…
Kill	Gnasher	P1	P2	MP_Hotel
Death	Gnasher	P2	P1	MP_Hotel
Kill	Gnasher	P1	P2	MP_Hotel
Death	Gnasher	P2	P1	MP_Hotel
Kill	Gnasher	P1	P2	MP_Hotel
Death	Gnasher	P2	P1	MP_Hotel

Event Driven Heat Maps



Events

- Granular
  - 1,000 rows/game
  - 7,500,000 sessions/ Day
  - 7,500,000,000 rows/Day!
    - If we were to all expand it all
- Expensive to Store and Analyze
  - 36 GB/Day Raw Compressed Data
    - Just for Game Events

Roll-ups

DateReceivedUT	MapName	WinningTeam	Kills	Deaths	DBNOs	ShotsFired
9/21/11 5:00 PM	MP_Sandbar	LOCUST	2988	1671	1402	83980
9/21/11 5:00 PM	MP_Hotel	COG	2864	1717	1477	83209
9/21/11 5:00 PM	MP_Hotel	LOCUST	3344	2046	1624	88872
9/21/11 5:00 PM	MP_Sandbar	COG	3872	2140	1950	108691

Counting Kills

DateReceivedUT	MapName	WinningTeam	Kills	Deaths	DBNOs	ShotsFired
9/21/11 5:00 PM	MP_Sandbar	LOCUST	2988	1671	1402	83980
9/21/11 5:00 PM	MP_Hotel	COG	2864	1717	1477	83209
9/21/11 5:00 PM	MP_Hotel	LOCUST	3344	2046	1624	88872
9/21/11 5:00 PM	MP_Sandbar	COG	3872	2140	1950	108691

Roll-ups

- Less granular
  - 1000 events -> 30 events
- Less Space
  - 7.5 Billion -> 480 rows/day
  - 2GB /Day Session + Rollup data
- Quick Reports

Things to Consider

- Timeliness
- Sample Size
- Outliers
- Discovery
- Dimensionality

ANALYZE

Decision Driven

- Your Job is to Help People Make Decisions
- Worry About Accuracy
  - So Decision Makers Don't Have To

Remember your Viewers

- People Tend to Confirm Beliefs
- Data Can be Difficult to Analyze
  - Nuanced Data Should be Simplified

Every Question Leads to Another

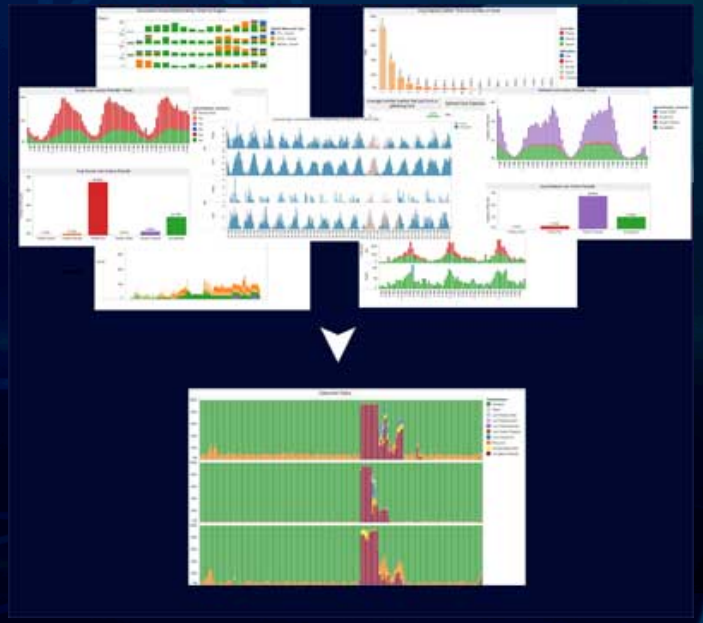
ITERATE

Iteration Data

- Generated
- Game QA
- Playtest
- Beta
- Live

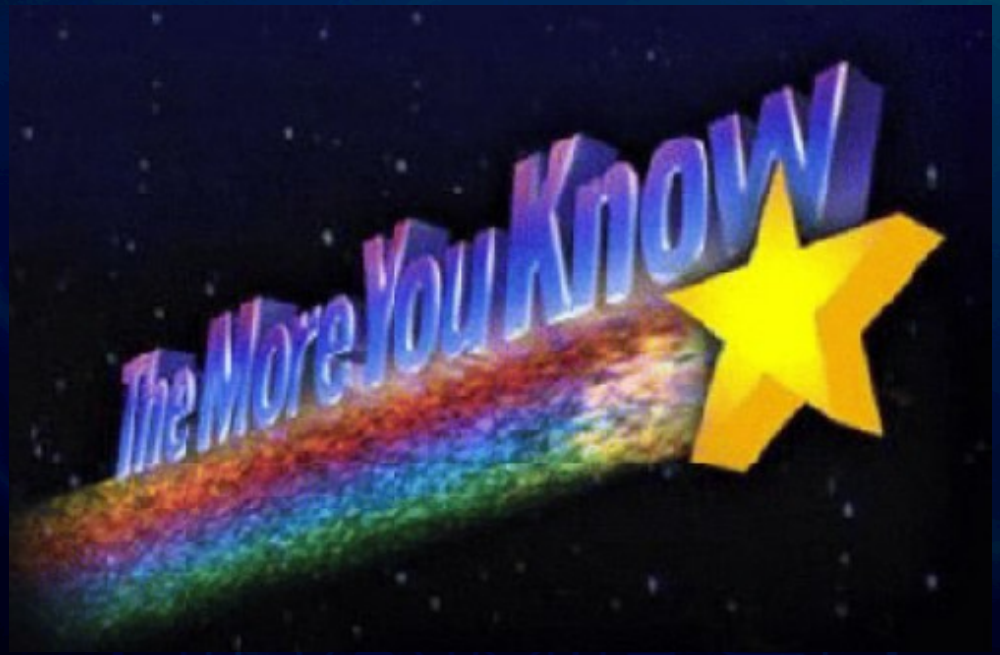
Constantly

- Evaluate Priorities
- Solidify Categories
- Tweak Storage Layout
- Improve Charts



Coming up with questions without real data is HARD

Answering unexpected questions on Launch day is HARDER



Conclusion

The More You Know About What Knowledge You Want From Your Data The More Efficient Your Collection and Analyses Will Be.

Gameplay Data Analysis

Collecting the Right Data

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