Migrating a PC-Based legacy financial system to a modern, standards-based, web and mobile solution

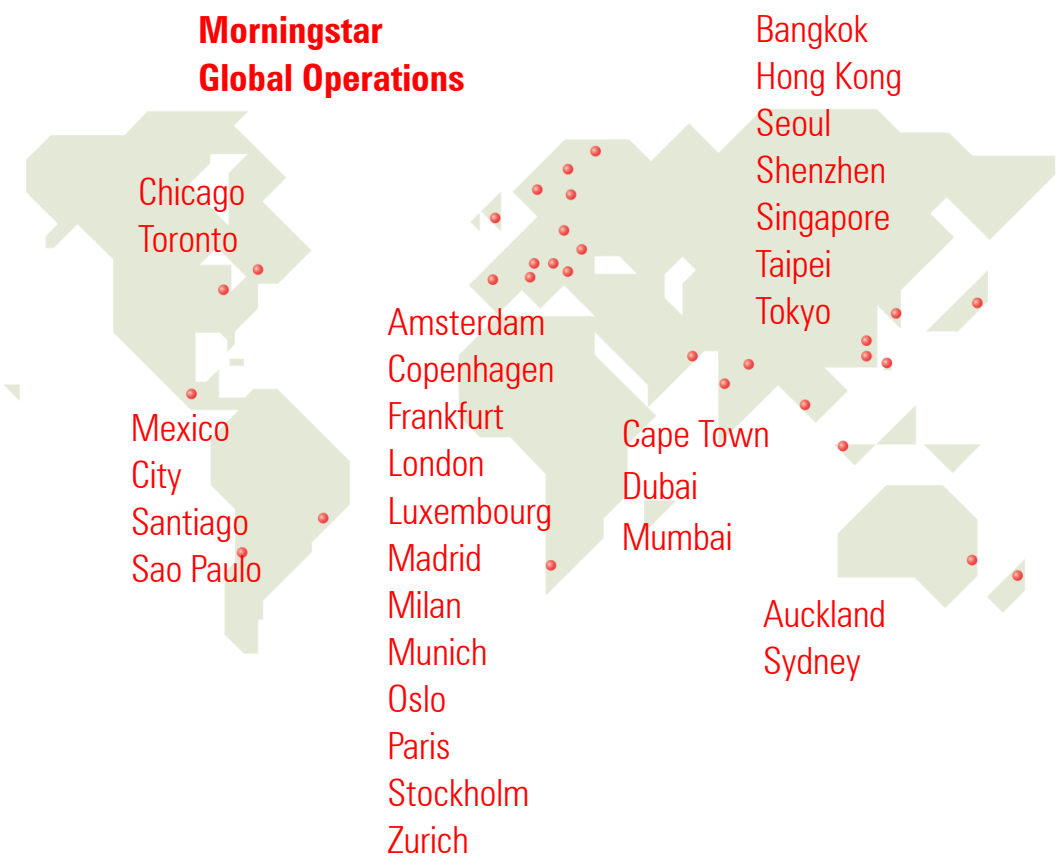
下一代金融投资研究平台：传统架构向标准化，Web及移动解决方案的演进

Sean O'Connor, Senior Director of Technology, Morningstar Inc.,
Chicago, Illinois, USA 晨星高级技术总监

Agenda 议程

- Company and product overview
- Current product state
- Future product state
- Roadmap
- Data technology
- Case studies
  - Re-architected reporting sub-system
  - Replace long-term storage solution

Who We Are 关于我们



- We're a leading provider of independent investment research.
- We serve clients globally through our presence in North America, South America, Europe, Asia, Australia, and the Middle East.
- Our 3,500 employees work in offices worldwide, offering local market expertise.
- Since 1984, we've been recognized for pioneering contributions to the investment industry.
- Our global database includes approximately 446,000 investments.

Morningstar

Who We Serve Worldwide 我们的全球客户

Our mission is to create great products that help investors reach their financial goals. We help individual investors, and the institutions and advisors that serve them.

Institutions

5,100 institutional clients

8,500+ Morningstar Direct℠ licenses

$152.1 billion in assets under advisement and management

24 million retirement plan participants with access to our retirement advice services through 237,000 plan sponsors and 26 plan providers

Individuals

9.3 million individual investors

124,000 paid Premium Members of Morningstar.com®

One of the largest independent sources for equity and credit research

Advisors

260,000 financial advisors

About 25% of financial advisors worldwide have access to Morningstar's solutions

$7.3 billion in assets under management in Morningstar® Managed Portfolios℠

169,000+ U.S. Morningstar® Advisor Workstation℠ and Morningstar Office℠ licenses

Assets under management and advisement as of Dec. 31, 2013.

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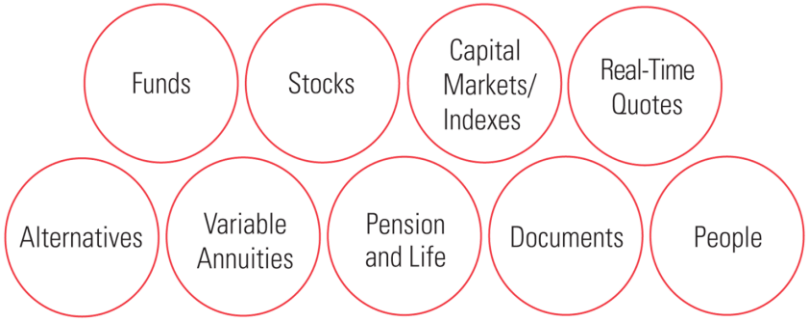
Accurate, Timely, Complete Data 准确，及时，完整的数据

446,000 investments



- Database highlights:
  - ETP data points such as Tracking Volatility and Market Impact Cost
  - Earnings conference call transcripts and company events
  - Stock and fund ownership data
  - Identifier data for 9.6 million securities
- Additional coverage:
  - 650 types of company and fund documents
  - 10,000,000+ real-time market data instruments
  - 200+ sources of energy and commodity data

Morningstar Shenzhen – A core team for Morningstar global product development

晨星深圳 – 核心产品研发团队

Technology is a core competency of Morningstar 技术是晨星的核心竞争力

Great people, great team 卓越人才，卓越团队

- Morningstar(Shenzhen) Ltd. is a wholly owned subsidiary of Morningstar, was established in 2003. Mainly engaged in software development, data analysis, and investment research.
- 900 employees, of whom nearly 500 are technologists.
- Morningstar Shenzhen teams is a core part of global teams to deliver leading investment research software for global markets
- Morningstar Shenzhen is one of ten companies that are licensed by China Securities Regulatory Commission to publish fund rating, the only foreign entity.

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Overview of Morningstar Direct
晨星投资研究平台的概要介绍

- Institutional research investment platform with advanced analytical tools
- Used by portfolio managers, investment consultants, financial product managers, wealth managers
- Data on current and historical performance, operations, portfolio holdings, and asset flows
- Present data in custom-branded reports for internal audiences and marketing and sales groups
- Nearly 9000 users and more than $80M (USD) in annual revenue, 11.4% of total Morningstar revenue

Current Application State 产品现状

- Development began 9-10 years ago, when web browsers were much less powerful than today's browsers
- C++ based native Windows client/HTML hybrid
- Inconsistent user interface that has evolved over time
- Expensive to support, have to solve user's PC problems
- Expensive to update, users find it inconvenient to update or may not have admin privileges to run updates, need to support old versions
- Data from many sources, several large client-side calculations
- Products are isolated from other Morningstar products
- Many external dependencies for data that have grown over years
- Long release cycle

Future Application State 产品的未来

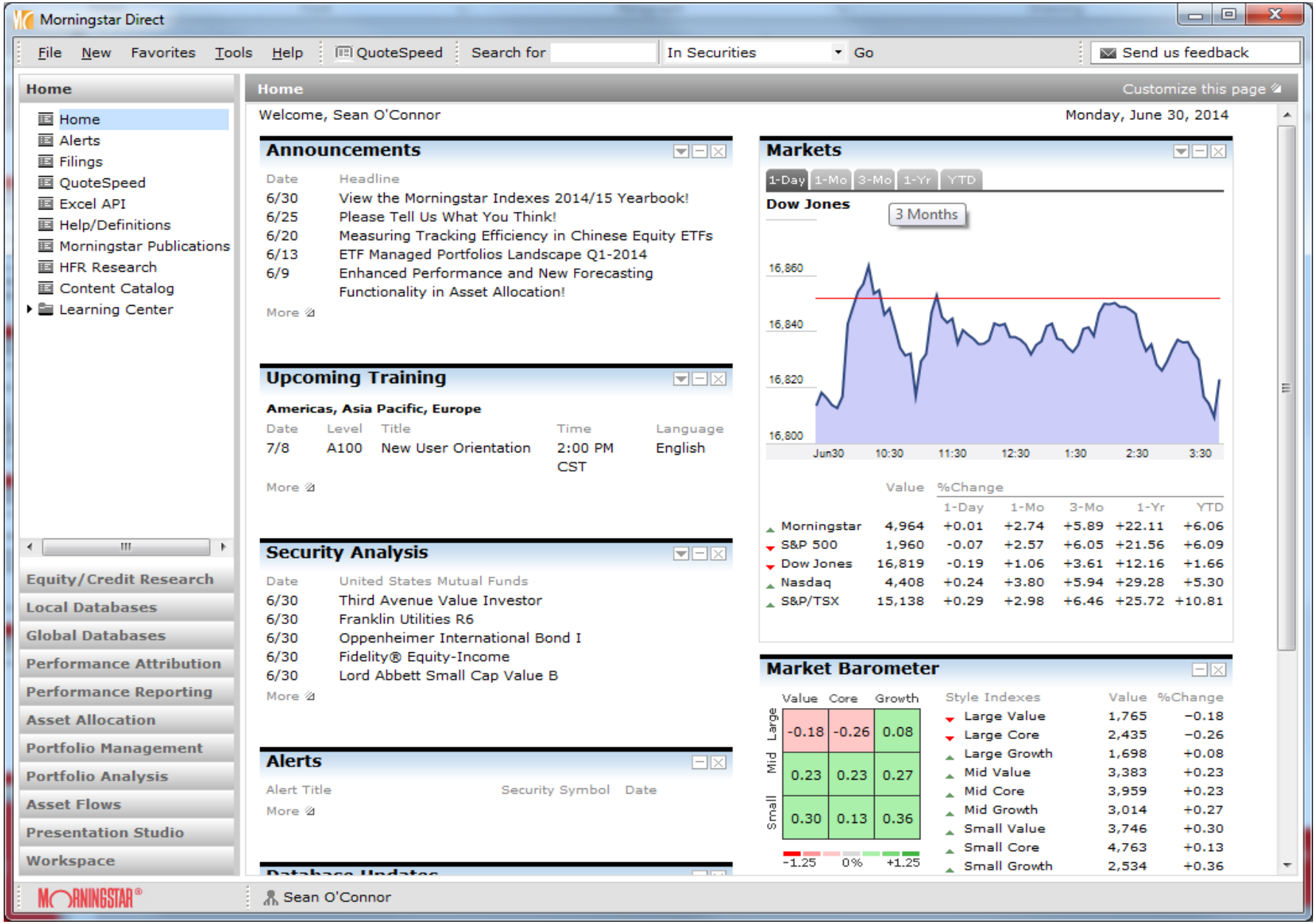
- Pure web-based HTML5 interface, multiple browser, tablet support (HTML, not a native app)
- Consistent, modern user interface across modules
- Reduced support costs, no need to support older versions
- Calculations moved to the server, physically closer to the data
- User interface is just presentation and interaction, while business logic moved to the server
- Data from a single high-performance source
- One to two month release cycles
- Easier integration with other Morningstar products
- Cloud-based deployment, high-availability, redundant, scalable

Standards-based 未来产品所基于的标准

- Web client using common JavaScript libraries such as jQuery, d3 (charts), Backbone, require, Handlebars, and a commercial high-performance grid control suite
- Web client based on HTML5 (IE10+, Firefox, Chrome, iPad) and CSS3
- RESTful web services offering XML and JSON data, implemented using both .NET WebAPI 2.x and Java Spring

Application Screenshots
应用程序展示

Current User Interface 目前的用户界面



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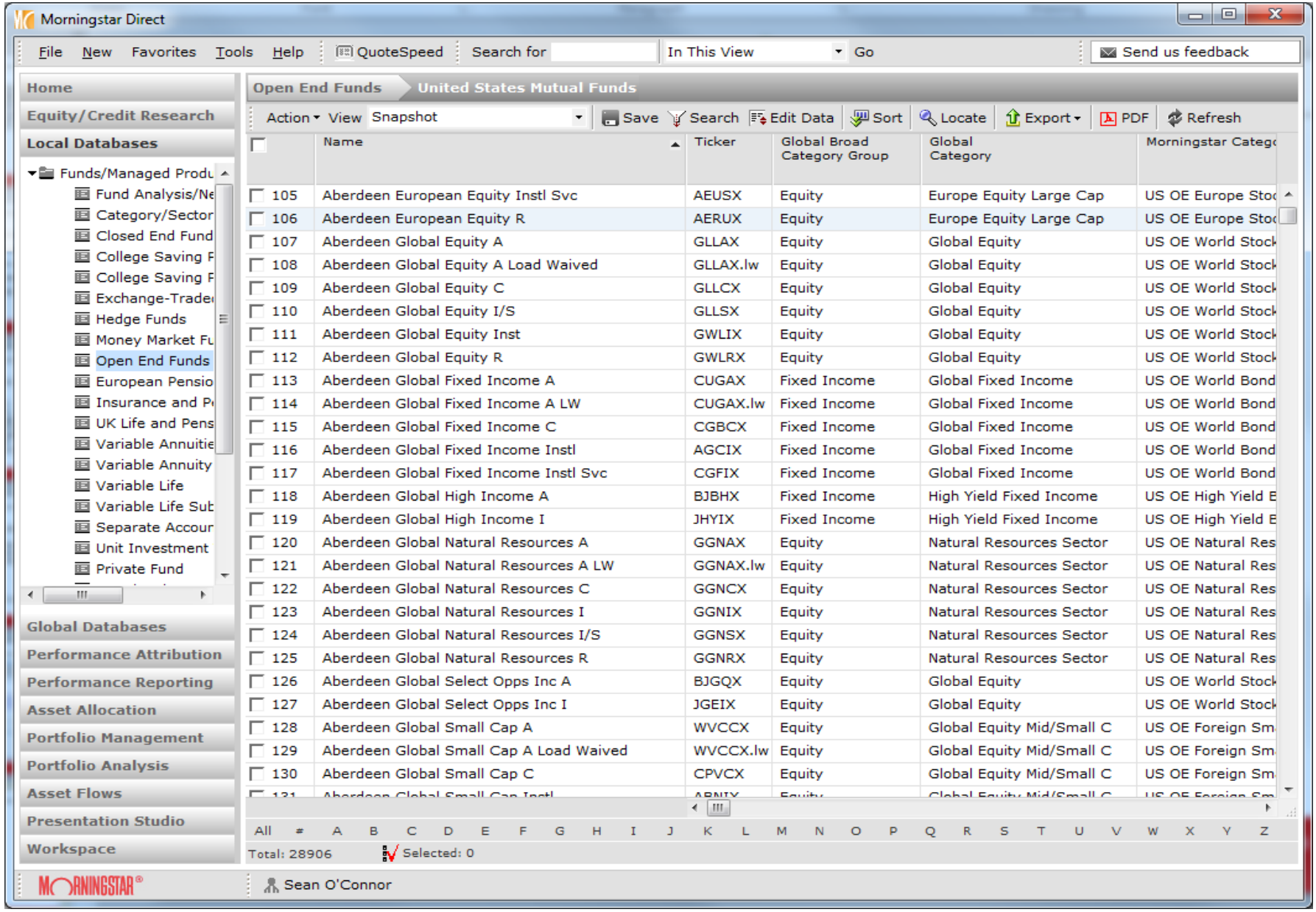

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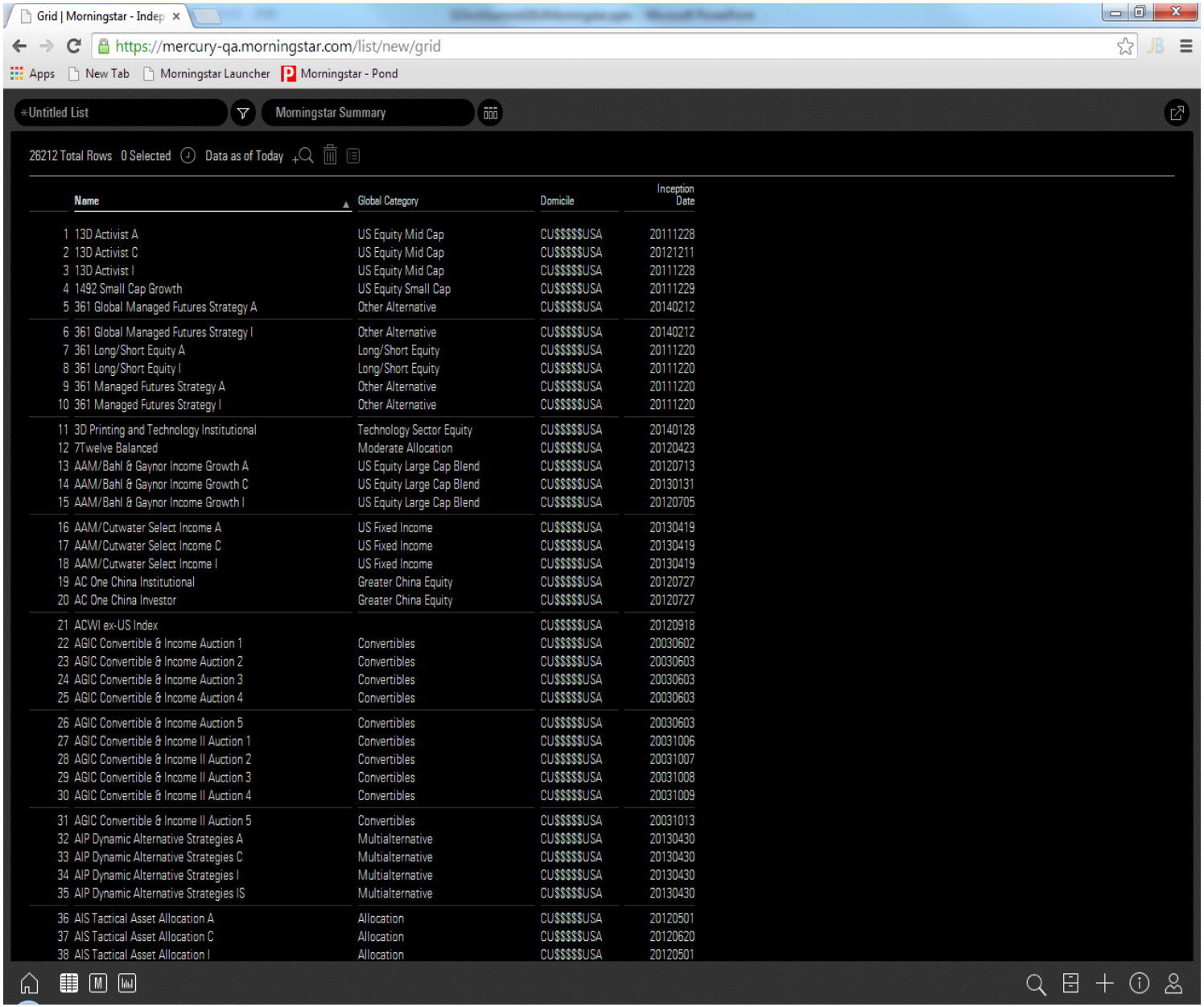
Future User Interface (Prototype) 将来的用户界面（原型）



	Name	Global Category	Domicile	Inception Date
1	13D Activist A	US Equity Mid Cap	CU$$$$$USA	20111228
2	13D Activist C	US Equity Mid Cap	CU$$$$$USA	20121211
3	13D Activist I	US Equity Mid Cap	CU$$$$$USA	20111228
4	1492 Small Cap Growth	US Equity Small Cap	CU$$$$$USA	20111229
5	361 Global Managed Futures Strategy A	Other Alternative	CU$$$$$USA	20140212
6	361 Global Managed Futures Strategy I	Other Alternative	CU$$$$$USA	20140212
7	361 Long/Short Equity A	Long/Short Equity	CU$$$$$USA	20111220
8	361 Long/Short Equity I	Long/Short Equity	CU$$$$$USA	20111220
9	361 Managed Futures Strategy A	Other Alternative	CU$$$$$USA	20111220
10	361 Managed Futures Strategy I	Other Alternative	CU$$$$$USA	20111220
11	3D Printing and Technology Institutional	Technology Sector Equity	CU$$$$$USA	20140128
12	7Twelve Balanced	Moderate Allocation	CU$$$$$USA	20120423
13	AAM/Bahl & Gaynor Income Growth A	US Equity Large Cap Blend	CU$$$$$USA	20120713
14	AAM/Bahl & Gaynor Income Growth C	US Equity Large Cap Blend	CU$$$$$USA	20130131
15	AAM/Bahl & Gaynor Income Growth I	US Equity Large Cap Blend	CU$$$$$USA	20120705
16	AAM/Cutwater Select Income A	US Fixed Income	CU$$$$$USA	20130419
17	AAM/Cutwater Select Income C	US Fixed Income	CU$$$$$USA	20130419
18	AAM/Cutwater Select Income I	US Fixed Income	CU$$$$$USA	20130419
19	AC One China Institutional	Greater China Equity	CU$$$$$USA	20120727
20	AC One China Investor	Greater China Equity	CU$$$$$USA	20120727
21	ACWI ex-US Index		CU$$$$$USA	20120918
22	AGIC Convertible & Income Auction 1	Convertibles	CU$$$$$USA	20030602
23	AGIC Convertible & Income Auction 2	Convertibles	CU$$$$$USA	20030603
24	AGIC Convertible & Income Auction 3	Convertibles	CU$$$$$USA	20030603
25	AGIC Convertible & Income Auction 4	Convertibles	CU$$$$$USA	20030603
26	AGIC Convertible & Income Auction 5	Convertibles	CU$$$$$USA	20030603
27	AGIC Convertible & Income II Auction 1	Convertibles	CU$$$$$USA	20031006
28	AGIC Convertible & Income II Auction 2	Convertibles	CU$$$$$USA	20031007
29	AGIC Convertible & Income II Auction 3	Convertibles	CU$$$$$USA	20031008
30	AGIC Convertible & Income II Auction 4	Convertibles	CU$$$$$USA	20031009
31	AGIC Convertible & Income II Auction 5	Convertibles	CU$$$$$USA	20031013
32	AIP Dynamic Alternative Strategies A	Multialternative	CU$$$$$USA	20130430
33	AIP Dynamic Alternative Strategies C	Multialternative	CU$$$$$USA	20130430
34	AIP Dynamic Alternative Strategies I	Multialternative	CU$$$$$USA	20130430
35	AIP Dynamic Alternative Strategies IS	Multialternative	CU$$$$$USA	20130430
36	AIS Tactical Asset Allocation A	Allocation	CU$$$$$USA	20120501
37	AIS Tactical Asset Allocation C	Allocation	CU$$$$$USA	20120620
38	AIS Tactical Asset Allocation I	Allocation	CU$$$$$USA	20120501

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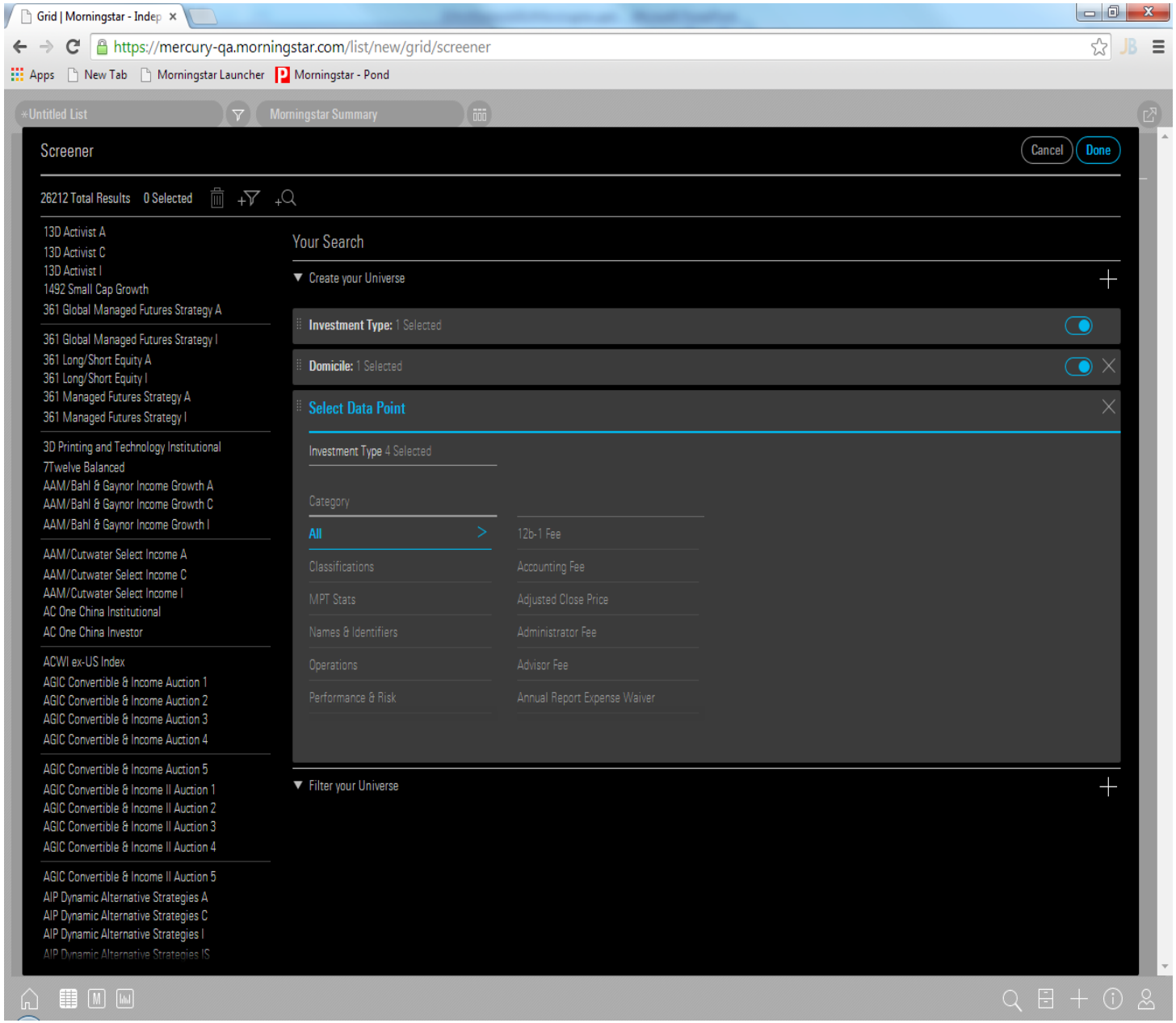
Future User Interface (Prototype) 将来的用户界面（原型）



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Roadmap 规划

- Identify key functionality areas with largest user base, get the most value by migrating this functionality first
- Designers create user interface wire frames for new and migrated functionality
- Developers implement the new user interface and supporting business services
- Release beta version with new user interface to collect user feedback
- Make adjustments based on feedback
- Release web-based version of migrated functionality
- Continue to iterate with more web-based functionality each release, multi-year process, too much to convert at once

Challenges and Potential Pitfalls 挑战和潜在困难

- Moving computing power of thousands of users' PC's to our data center
- Handle spikes in load processing quarterly and year-end financial data
- Many users on older operating systems (XP) and older browsers that don't support HTML5 (IE8 still heavily used), companies slow to upgrade
- Users may need training on a new UI

Performance Challenges and Solutions 性能方面的挑战和解决方案

- How to make the browser perform as well (or nearly) as native code?
- Process smaller data sets on the client
- Limit and possibly remove all business logic from the client
- Introduce features such as virtual scrolling for large grids, use server-side caching
- Client-side HTML rendering takes advantage of performance improvements in recent browser releases
- Implement facade design pattern on the server to combine data from several sources before sending to the client

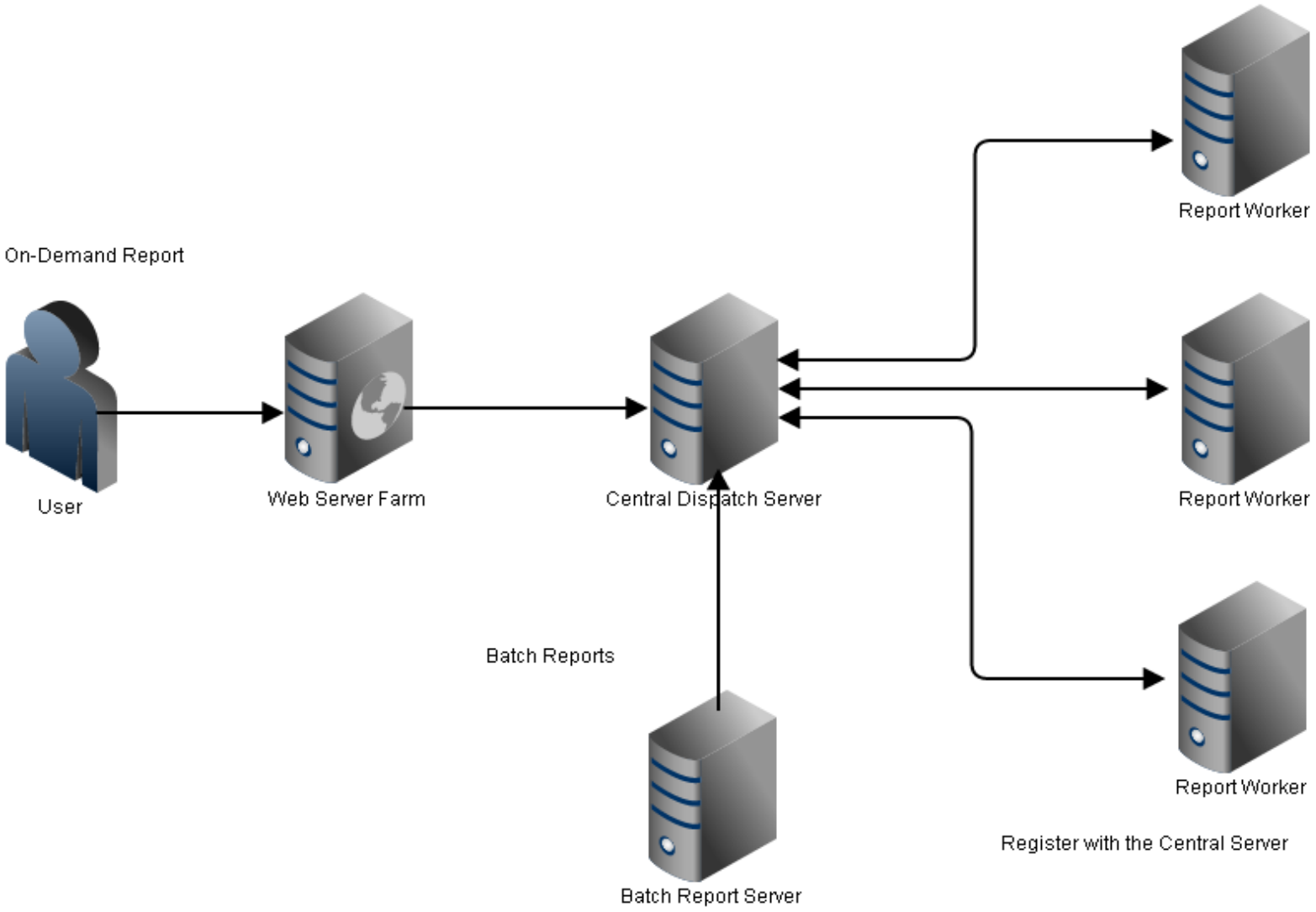
Data 数据

- Consolidate many data sources into one logical data source
- Ensure data and calculation consistency across products
- Queries and Calculations
  - Often implemented by product teams, may have inconsistent results across products
  - Can scale calculations in one place, rather than by product
  - Methodology changes immediately available across all products

- The IBM Netezza Performance Server (NPS) is an enterprise-class streaming analytic appliance, designed specifically for high-performance terascale analytics
- The NPS system architecturally integrates relational database, server, and storage in one compact power-efficient unit
- Enables Morningstar to perform complex screens on entire data sets, such as 10GB Price, 150GB Bond, 300GB Portfolio
- Enables Morningstar to support custom calculations with little or no operational overhead through on-the-fly calculations
- Reduces time to live by the operational time to prepare, correct, and restate data
- Provides a consistent answer by storing all data in one database

- Refactoring Batch Reporting Architecture
- Update and modernize long-term storage

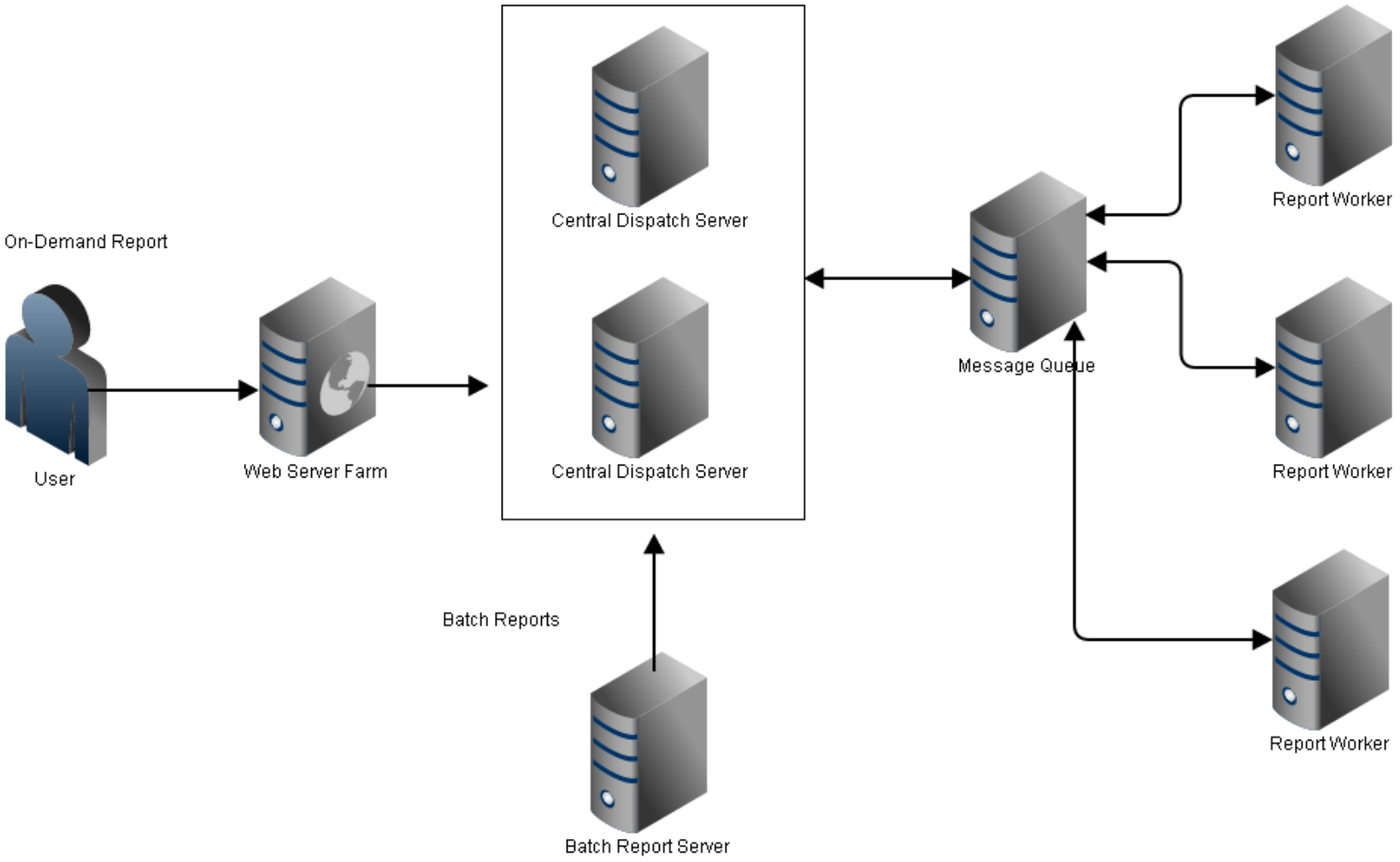
Legacy Batch Report Architecture 旧有批量报表的架构



Limitations

- Single point of failure
- Cannot scale out central dispatching server
- Push-based model requires central dispatching server to maintain state of workers
- High-priority reports can be blocked by long-running batch jobs

New Batch Report Architecture 新的批量报表架构



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Solution

- Introduce multiple message queues to distribute work load based on priority of report (low, medium, high)
- Pull-based approach, workers pull from the highest priority queue that has work waiting when they are ready to process a report
- Worker state no longer persisted in central dispatching server, can scale out central servers (introducing redundancy) or workers to add capacity
- Can have workers that only service high-priority queues for on-demand reports, large batches don't consume all resources

Storage Solution Evolution 存储方案的演进

- Large-scale, long-term storage requirement that does **not** require very fast access
- Used to store data blobs, such as PDF reports or user tasks and other types of data
- Limitations
  - Custom storage solution, multiple nodes with redundancy
  - Difficult to scale and add additional storage
  - Performance problems
  - Replication between data centers is limited and limits usefulness in Disaster Recovery

Solution

- Red Hat Storage Server
- Standards-based, built on GlusterFS
- Easy to scale, nodes can be added with disruption and storage is automatically rebalanced
- Replication between data centers is fully supported


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