2018 Annual Risk Management Review

The Risk Management Function

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TMRS
Texas Municipal Retirement System

Agenda

I. Governance & Resources: Overview

II. Delivery & Operation: What do we deliver and how do we do it?

   A. Risk Analysis, Monitoring and Reporting

   B. Data Management

   C. Research

III. Conclusion

IV. Appendices

Section I

GOVERNANCE & RESOURCES: OVERVIEW

TMRS IPS Language Regarding the Risk Management Function

- VII. ROLES AND RESPONSIBILITIES

  E. The non-CIO Investment Staff report to the CIO . . .

  Investment staff responsible for risk management supports the investment program at the strategic and operational levels through the establishment of appropriate policies and procedures as well as implementation and maintenance of analytical tools to measure and monitor risk as further described in the IPS and procedures documents.

- XIII. INVESTMENT RISK MANAGEMENT

  A. Risk Management

  . . .

  2. 2nd Line of Defense: The CIO establishes and oversees risk management and compliance functions to ensure the first line of defense is properly designed, in place, and operating as intended, including by ensuring that policies and procedures are documented and followed regarding risk identification, evaluation and management within the investment department.

  . . .

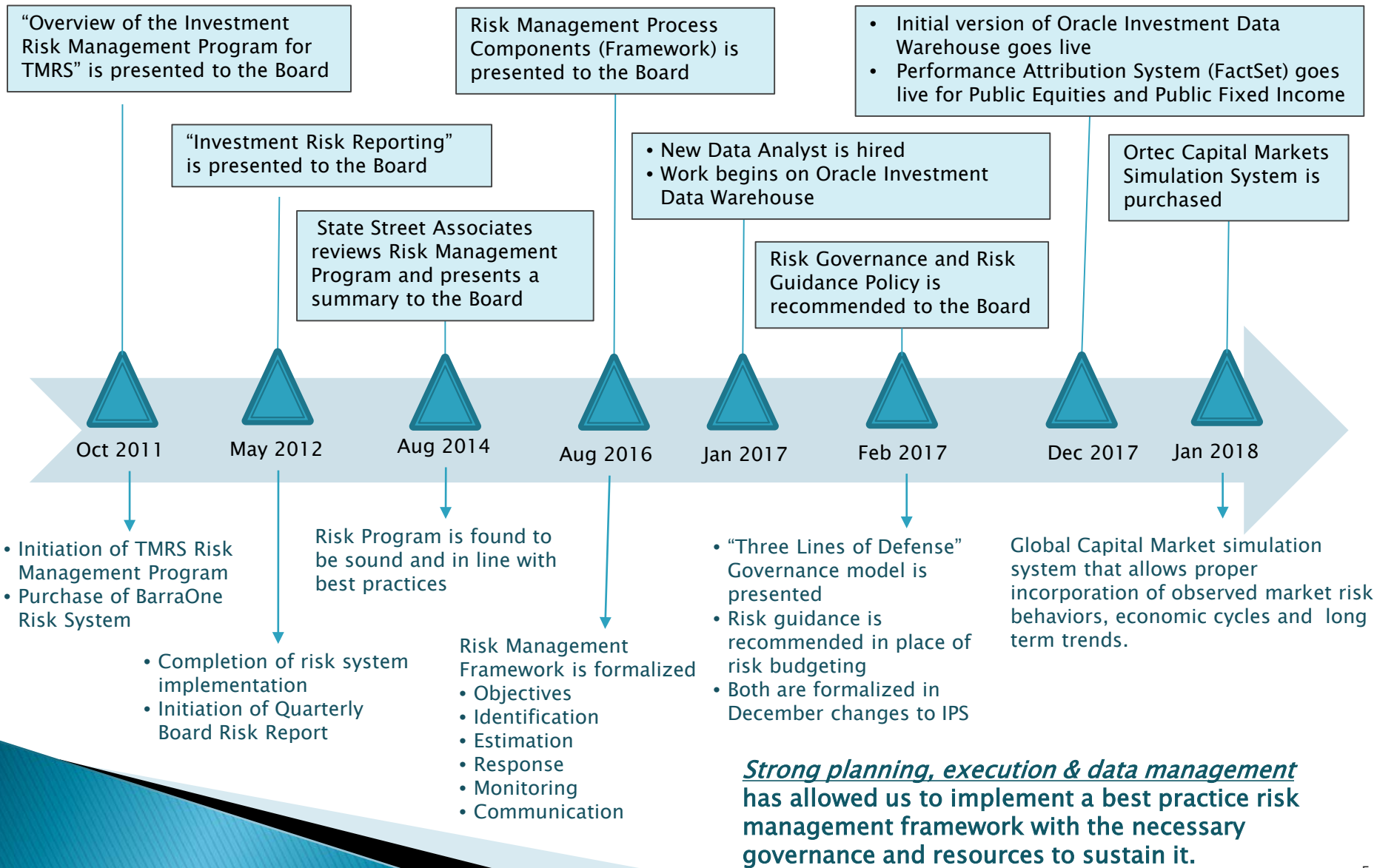
  D. Investment Risk Reporting

  Investment risk reporting is the responsibility of the risk management function. The reporting will be done at least quarterly to senior management and the Board through implementation of internal analytical resources and are expected to address the following areas at a minimum:

  Range of risk implied by IPS Asset Class Guidelines and the risk in the current Asset Class implementations. Holdings based estimate of asset class total market risk and relative to risk expectations used in Asset Allocation studies.

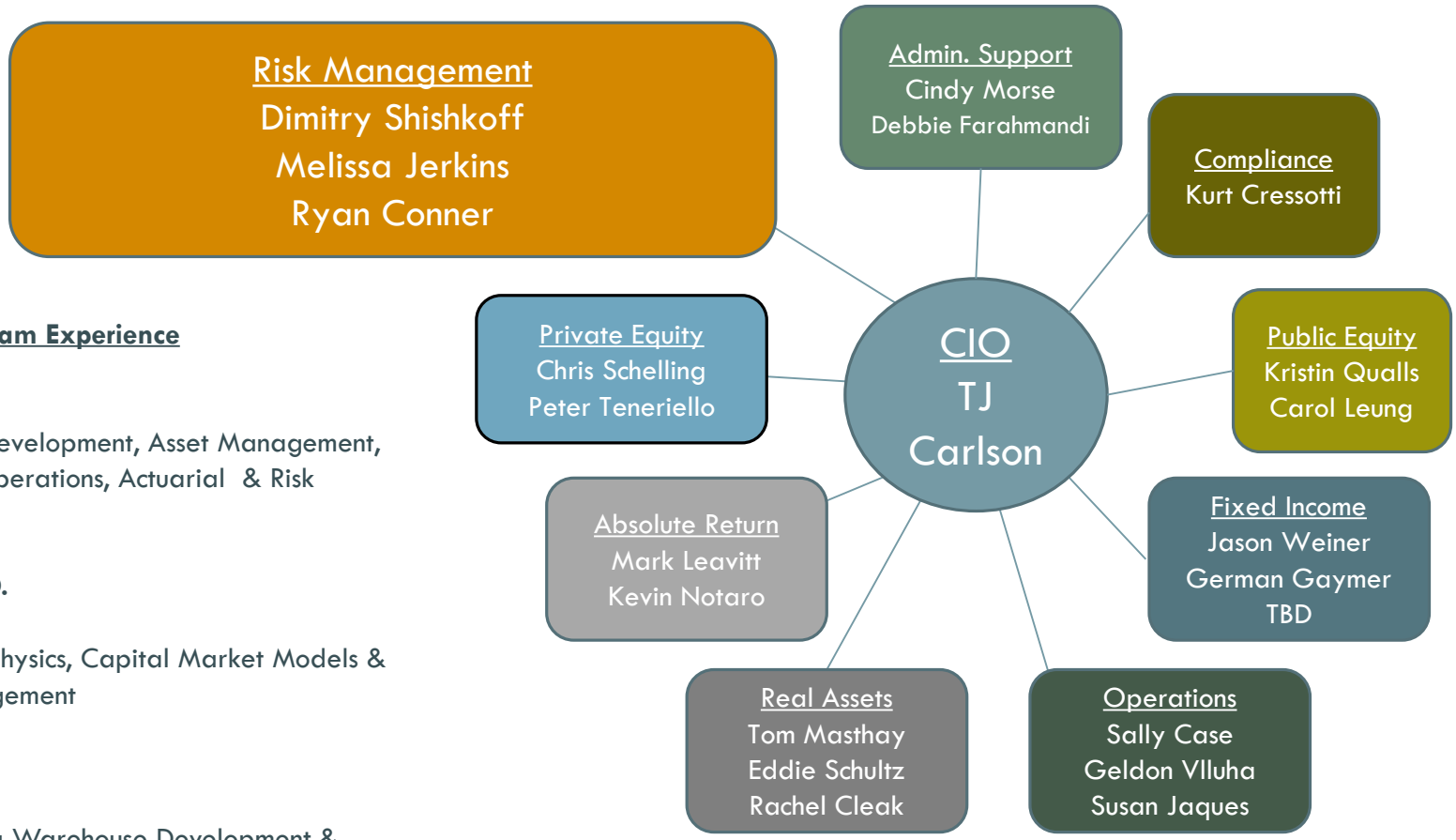
Development of the Risk Management Function

Key Milestones



Strong planning, execution & data management **has allowed us to implement a best practice risk management framework with the necessary governance and resources to sustain it.**

Risk Management Staff Resources



Risk Management Team Experience

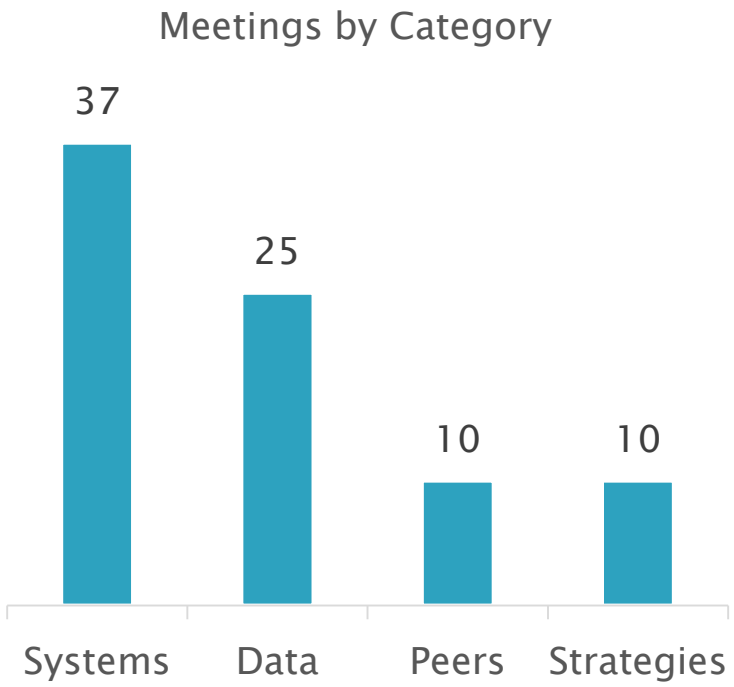
Dimitry Shishkoff
30 years experience
Investment Strategy Development, Asset Management, Financial Company Operations, Actuarial & Risk Management

Melissa Jerkins, Ph.D.
7 years experience
High Energy Particle Physics, Capital Market Models & Investment Risk Management

Ryan Conner
1 Year Experience
Oracle software, Data Warehouse Development & Portfolio Data Management

Additional Information

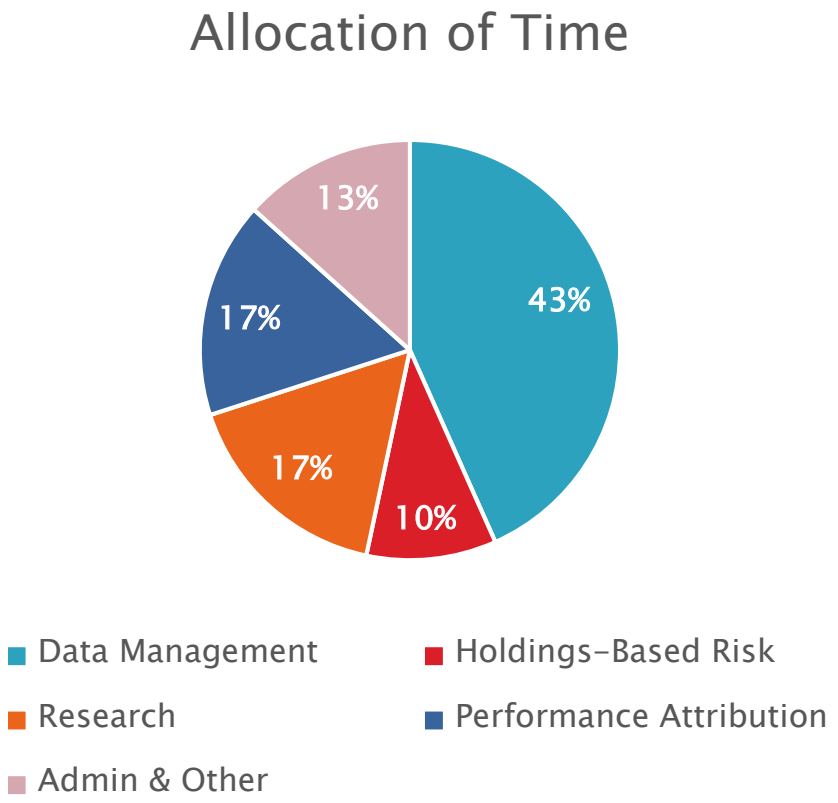
- 82 meetings held in 2017



- Service provider relationships managed
  - **Analytics Systems**
    - MSCI BarraOne (Risk System)
    - FactSet (Performance Attribution System)
    - ORTEC (Capital Market Simulation System)
  - **Index constituent data**
    - MSCI Global Equity
    - JP Morgan Emerging Market Debt
    - Russell Equity
    - Bloomberg (formerly Barclays) Fixed Income
    - BAML US High Yield
    - S&P Equity and Leveraged Loan
    - Burgiss Private Equity Funds data and index
  - **Other information sources/systems used**
    - Albourne Castle
    - Blackstone Hedgehog
    - Bloomberg
    - eVestment

Allocation of the Risk Management Function's Time Over the Past Year

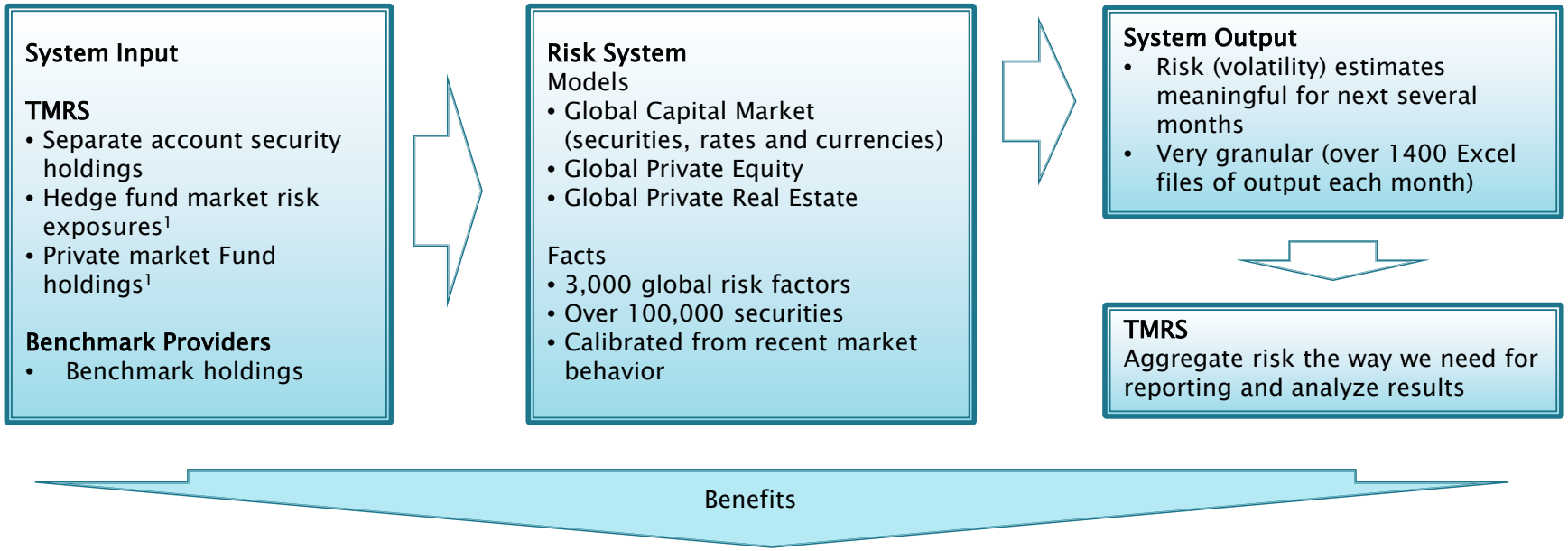
- Data Management is by far the largest allocation
- In the coming year we expect implementation of the public market Performance Attribution system to be complete and related time demands to decline
- Increases in available time will be allocated to research



Section II A.

DELIVERY & OPERATION: RISK ANALYSIS, MONITORING AND REPORTING

Holdings-Based Risk System: Independent and Objective Short Term Risk Monitoring



Objective and independent view of actual investments

Disciplined representation of global capital market risks and their interrelationships

<u>Independent monitoring of market exposure risk relative to objectives</u>:

- Policy Index (Total Fund Benchmark)
- Policy Benchmarks (Asset Classes)
- Manager Benchmarks or Expectations

1. We develop customized solutions for hedge funds and certain private funds where sufficient holdings information is unavailable

Holdings-Based Risk System: Attainable Precision of Short Term Risk Declines Together With Transparency and Liquidity

Characteristics of investments held in portfolios	Stock and/or Bond Portfolios	Alternative Strategy Portfolios		
		Transparent Funds	Limited Transparency Funds	Private Market Funds
Information	Abundant, publicly available and cheap	Expensive and/or highly complex	Only market segment exposures	Not publicly available and expensive
Liquidity	High liquidity (securities trade daily in large volume)	Medium to low liquidity (securities trade once in a few months or less)	Can vary from low to high liquidity	No liquidity (trade once in a few years or less)
Price Behavior Information	Large amount of meaningful data	Moderate to small amount of often not meaningful data	We only know the market segment allocation	Pricing more an art than a science
Volatility of Annual Return	Measurable	Somewhat measurable	Measurable for the market segments	Educated guess
Precision of Risk Measurement	High	Medium to low	Medium to low	Very low
Value of Holdings Based Analysis	Detailed active risk analysis → Market risk exposure			

Implementation Risk Implied by IPS Asset Class Guidelines: Board Communication Tool

IPS Asset Class Guidelines

Risk Management Solicits Asset Class Team Views on Asset Class Investment Opportunities and Related Risks

Asset Class Strategy Allocations

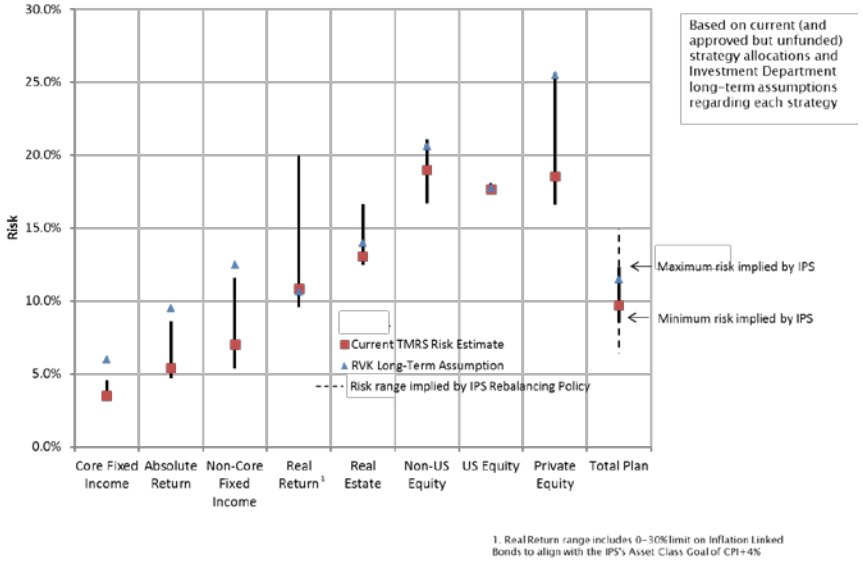
Based on Staff Risk Views Risk Management Calculates:

- Risk Ranges Implied by Guidelines
- Risk Estimate of Current Implementation

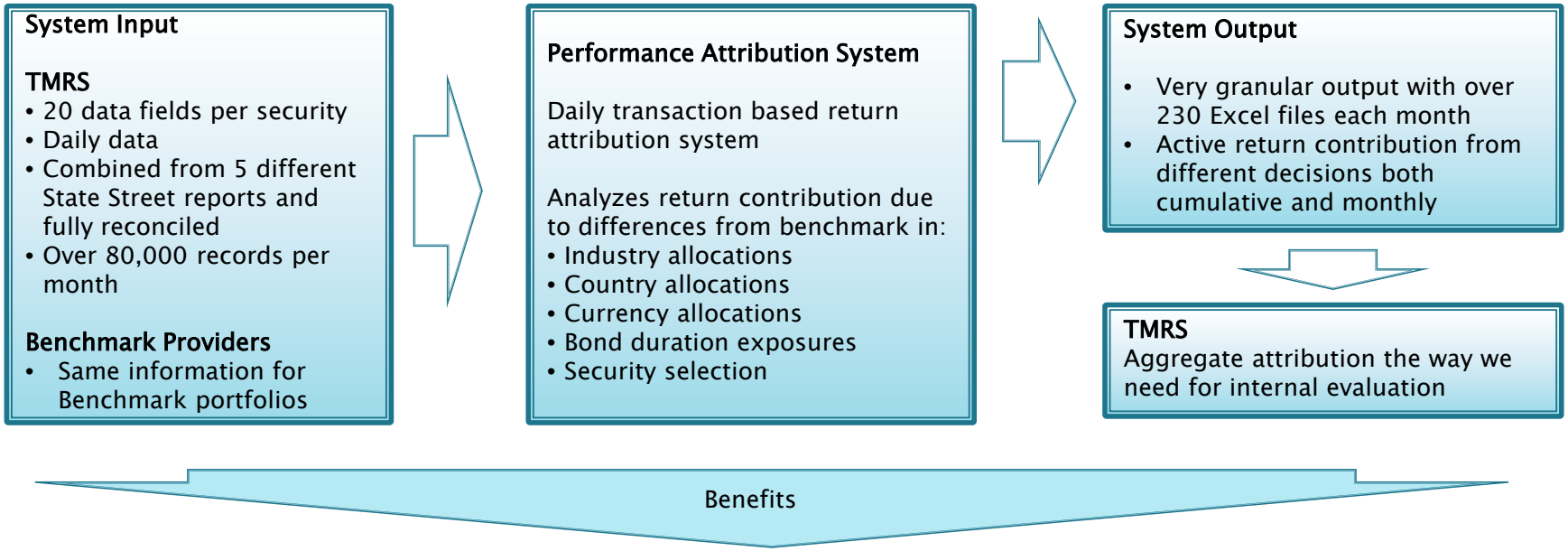
Resulting Chart is used to Communicate with the Board regarding Implementation Risk:

- Quarterly Risk Reporting
- Annual Asset Class Reviews

- Risk ranges implied by asset class guidelines (**black** bars)
- Risk of the current implementation (**red**)
- RVK risk assumptions used in asset allocation (blue)



Distinguishing Luck From Skill By Attributing Performance to Public Market Manager Decisions



- Identifies a manager's patterns of good or bad decision making
  - Allows dialog in which managers must account for outcomes of their decisions
    - Provides independent and detailed monitoring of return from active risk

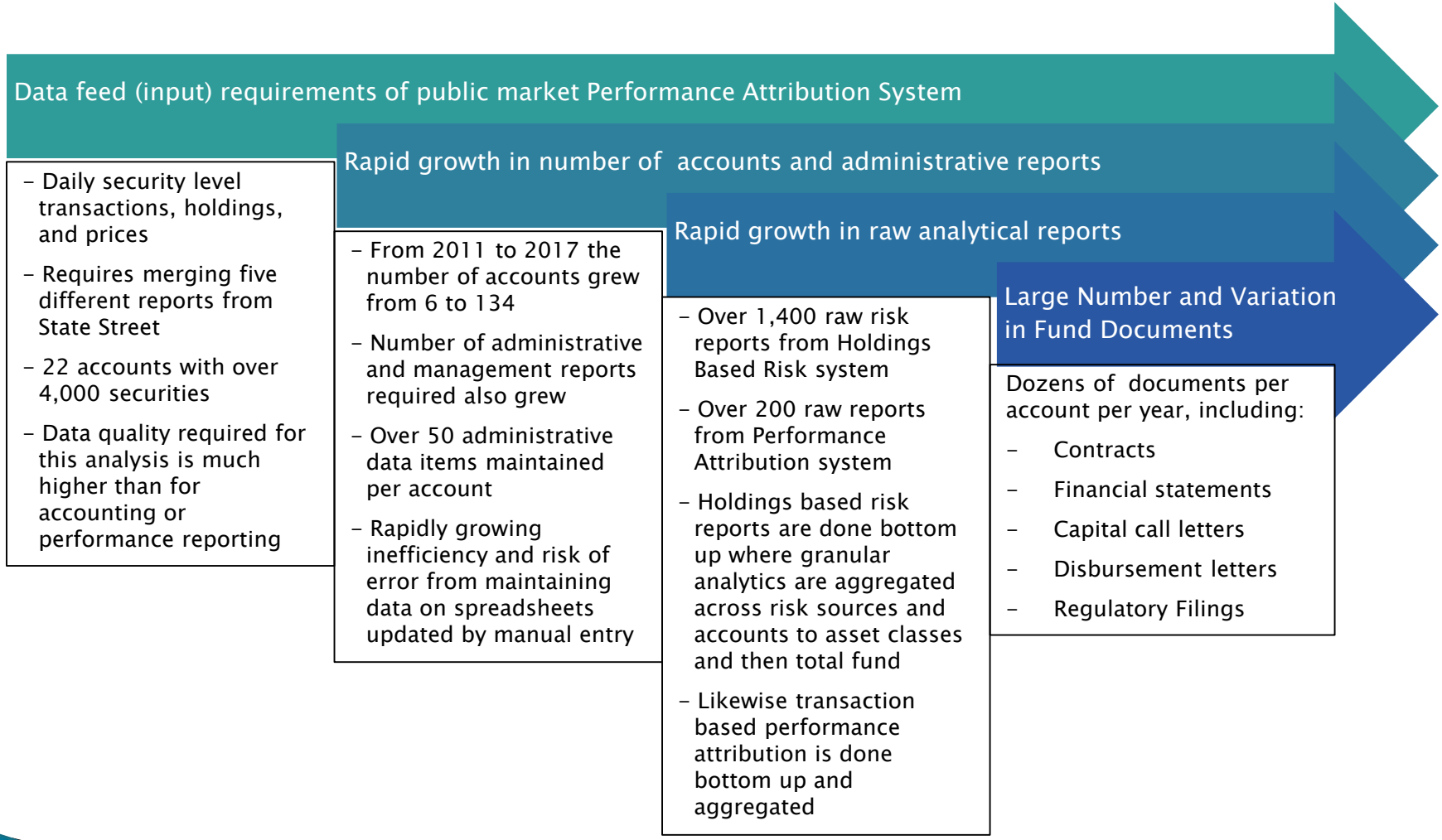
Currently Performance Attribution Can Be Done Only For Stock and Bond Portfolios

Characteristics of Portfolio Holdings	Stock and Bond Portfolios	Private Market portfolios
Information	Public and cheap	Not public and expensive
Liquidity	High	Virtually none
Pricing	Transaction based	More art than science
Benchmark	Cheap passive solutions	No passive solutions
Every Manager Decision	Can be identified and evaluated based on portfolio and market data	Cannot be identified or evaluated based on portfolio data; market data does not exist

Section II B.

DELIVERY & OPERATION: DATA MANAGEMENT

Evolution of Data Management Needs



Investment Department Data Management Needs

- **Investment Data Highlights** – There is a lot of very different data we need to keep track of
  - 134 investment accounts
    - Over 50 administrative data items per account
    - Full accounting and transaction history for each account
    - Over 4,000 securities in 22 Separately Managed Accounts
  - 63 countries, 33 currencies, 7 asset classes and more than 30 sub-asset classes
  - Dozens of market sector and industry classifications and multiple classification systems
  - Over 1,400 raw risk system reports used in production of Board and internal Risk Reports
  - Over 200 raw performance attribution system reports used in performance attribution analysis

- **Data Usage Needs** – Each function has its own specific set of data and reporting needs
  - Management and Administrative
  - Operational
  - Risk Management and Analytics
  - Investment Opportunity and Evaluation

- **Data Management Needs** – All the above translates into well-known data management requirements
  - Single (authoritative) version of every data item
  - Accurate
  - Searchable
  - Scalable

Volume and Types of Data We Need To Manage Will Continue to Grow Rapidly

- Growth in accounts (should reach stable level around 150)
- Growth in years (time span) of data history
- Potential growth in responsibilities like internal stock and bond portfolio management
- Increase in transparency and data availability of fund holdings
- Increase in market data available
  - Evaluating relative performance of our investments
  - Better understanding investment risks

Investment Department Data Management Program

- **Framework Components**
  - Data Governance (directs and controls the Investment Department regarding data policy and objectives)
  - Responsibilities and procedures
  - System
    - Internally developed Data Warehouse
    - Oracle Data Base and Business Intelligence (BI) platform

- **Conceptual Organization** (of Investment Data Warehouse)
  - Current
    - Account Related Data (administrative and performance data)
    - Portfolio transaction and holdings data (input to risk and performance analysis systems)
    - Analytics Output Data
  - Planned
    - Documents (aka Records) management
    - Fund holdings descriptive and analytical data
    - Other needs that may emerge

- **Resources**
  - Overall Program management – Director of Risk Management
  - Software Development and management of Data Warehouse – Data Analyst
  - Platform and technical support – IT Department, Data Base Administrator (DBA)

Section II C.

DELIVERY & OPERATION: RESEARCH

Research

Research is essential for achieving and maintaining best practice

- The one constant about Capital Markets is change
  - Change in market behavior and opportunities
  - Change in our understanding of the markets and analytical abilities
  - Growth in data availability and transparency

- Risk Management conducts research to:
  - Remain current
  - Address questions that arise in the department

Examples:

- Capital Market Behavior and Investment Strategies:
  - Factor Investing: white paper, monitoring for potential use
  - Volatility Capture Strategies: led discussion at two conferences, monitoring
  - Risk Parity Investing: presented at a conference, set aside
  - Tail Risk Strategies: presented at a conference, set aside
  - Order of Diversification & Reality of Non-US Equity: CIO presented at conference, monitoring
  - Implied path risk of private market investments: incorporated in assumption setting
  - Currency trade execution: summary Paper, internal procedures and manager guidelines
  - Return to rebalancing: internal presentation

- Research on Risk Measures & Analytical Methods:
  - VaR and Within Period VaR: write up and internal calculation resource
  - Expected Max Draw Down: internal presentation and calculation resource

Section III

CONCLUSION

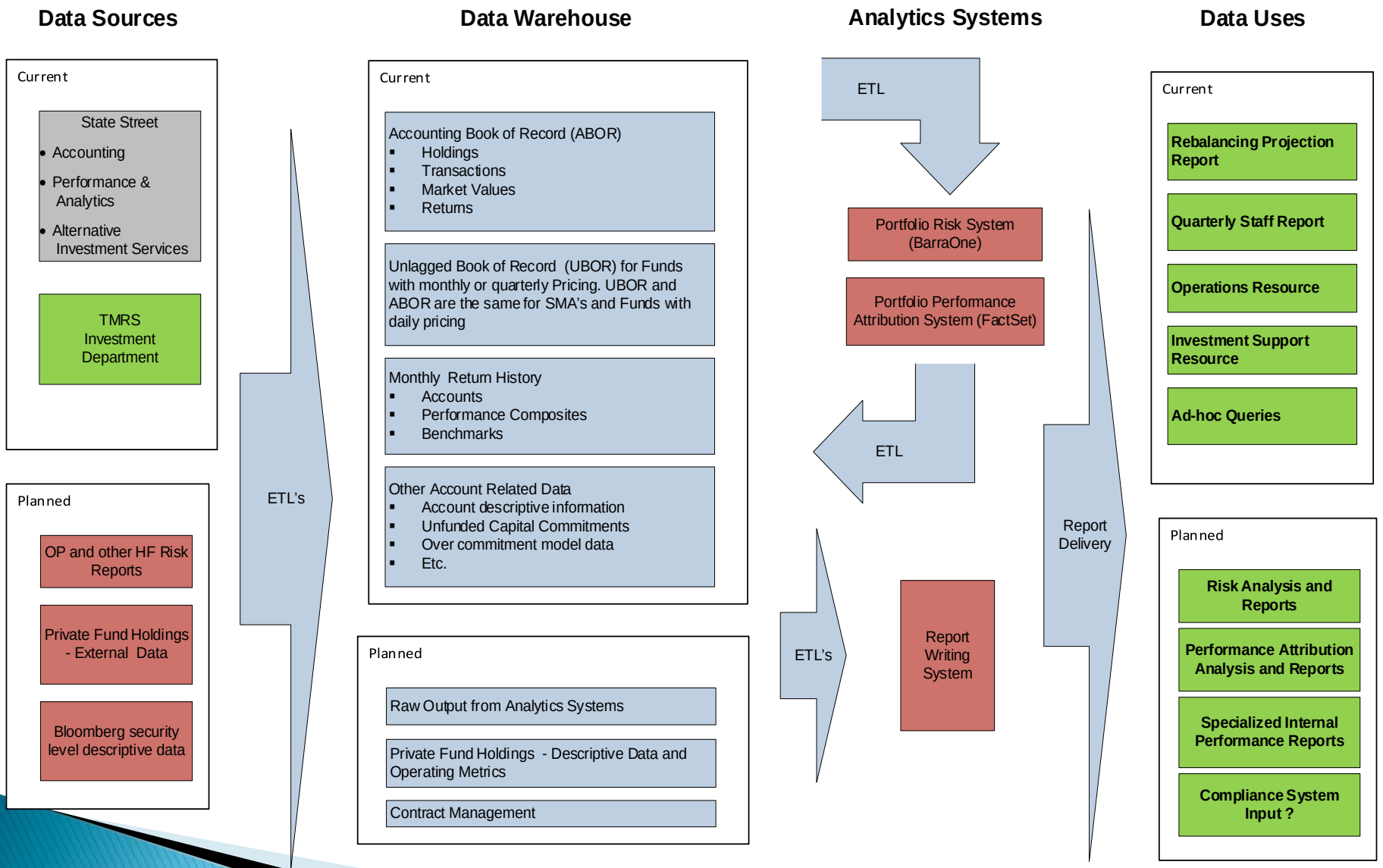
Conclusion

- Risk Management is developing necessary systems and resources to meet data management needs
  - Data is the foundation of everything we do
  - Data availability varies greatly across asset classes
  - Transparency and data technology will continue to advance rapidly
- Research is essential to maintaining best practice in Risk Management
- Resources for measuring, monitoring, and communicating risk have been established and will continue to evolve based on data availability and research advancements

Section IV

APPENDICES

TMRS Investment Data Warehouse Conceptual Schematic



Global Industry Standards Organizations

Risk Management

- **COSO (Committee of Sponsoring Organizations of the Treadway Commission)** is a joint initiative of five private sector organizations (listed below) and is dedicated to providing thought leadership through the development of frameworks and guidance on enterprise risk management, internal control and fraud deterrence.
  - American Accounting Association
  - American Institute of Certified Public Accountants
  - Financial Executives International
  - The Association of Accountants and Financial Professionals in Business
  - The Institute of Internal Auditors
- **IIA (The Institute of Internal Auditors)** is an international professional association. It is the internal audit profession's recognized authority and principal educator. Generally, members work in internal auditing, risk management, governance, internal control, information technology audit, education, and security.

Data Management

- **ARMA International** is a not-for-profit professional association and the authority on governing information as a strategic asset. Originally, ARMA was the acronym for the Association of Records Managers and Administrators, established in 1955. Its members include records and information managers, information governance professionals, archivists, corporate librarians, imaging specialists, legal professionals, IT managers, consultants, and educators, all of whom work in a wide variety of industries, including government, legal, healthcare, financial services, and petroleum in the United States, Canada, and more than 30 other countries around the globe.
- **ISO (Internal Organization of Standardization)** is an independent, non-governmental international organization with a membership of 162 national standards bodies. Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards.
- **ANSI (American National Standards Institute)** is a 501(c)3 private, not-for-profit organization that facilitates the development of American National Standards (ANS) by accrediting the procedures of standards developing organizations (SDOs). ANSI is the official U.S. representative to the International Organization for Standardization (ISO) and, via the U.S. National Committee, the International Electrotechnical Commission (IEC)

Definitions

- **Data terminology**: Data, Records, Documents, Information, Content, and possibly others are all used in the industry to refer to information created or consumed in the operation of an enterprise. To avoid confusion, the TMRS Investment Department has adopted the following terms and definitions:
  - **Data Mananagement**[1] to refer to the most comprehensive scope of information created or used in the operation of the Department
  - **Records** to refer to any information, including documents, that serves an evidentiary role in operating activities of the Investment Department. (Note: There are numerous other data categories necessary for supporting the operating activities of the Investment Department ranging from contact information to analytical systems feeds and outputs.)
  - **Metadata** to refer to information used to indicate context and apply appropriate rules for managing records.
- **Data Warehouse** (DW), is a system used for reporting and data analysis, and is considered a core component of business intelligence. DWs are central repositories of integrated data from one or more disparate sources. They store current and historical data in one single place and are used for input to analytical systems and creating analytical reports. The typical Extract, Transform, Load (ETL)-based data warehouse uses staging, data integration, and access layers to house its key functions. The staging layer or staging database stores raw data extracted from each of the disparate source data systems. The integration layer integrates the disparate data sets by transforming the data from the staging layer often storing this transformed data in an operational data store database. The integrated data are then moved to yet another database, often called the data warehouse database.
- **State Street Associates (SSA)** is a partnership between State Street and renowned academics at Harvard Business School and MIT's Sloan School of Management. Since 1999, it has bridged the academic and practitioner worlds of finance, drawing on State Street's deep information resources. SSA research directors and staff have published more than 120 articles in peer-reviewed finance journals and provided advisory services to hundreds of large institutional investors around the world, focusing on topics including asset allocation, risk management, manager evaluation and hedging.

1. Data Management was chosen over the currently prevalent term Content Management because, in our case, we feel it more directly communicates intended meaning to stakeholders