Model Risk Management

2016 CAS ERM Seminar

October 6, 2016

Hsiu-Mei Chang, FCAS

AIG – Risk Director, ERM/ Model Risk Management

HsiuMei.Chang@aig.com

Disclaimer

The information, opinions, and recommendations contained in this presentation are my own and do not necessarily reflect the policies, procedures, or opinions of AIG.

Discussion Points

1. A comprehensive model management framework
2. Model governance
3. Model risk measurement
4. Analytic asset management

A Comprehensive Model Management Framework

Three phases of evolution

Model Governance

Policy to define roles & responsibilities

Accurate model inventory

Model development/implementation

Use/Implementation/Change controls

Model validation

Validation components:

Data/Assumptions

Correct application of theories

Conceptual soundness

Appropriate for business purpose

Benchmark/Challenger models

Model Risk Management

Model risks measured at the model level

Model network fully diagrammed

Model risk aggregation

Model risk reporting infrastructure

Model risk measurements:

Likelihood of model failure

Estimates of adverse financial impacts

Analytics Asset Management

Model returns measured

Model risk/return calculated

Strategic analytic resource allocation

Model Governance

Model Definition & Components

SR 11-7a / AAA Modeling 3rd Exposure Draft

Model Inputs - Data and assumptions; may be partially or wholly qualitative, or based on expert judgment

Model Processing - Transform inputs into estimates or forecasts of unknown quantifies

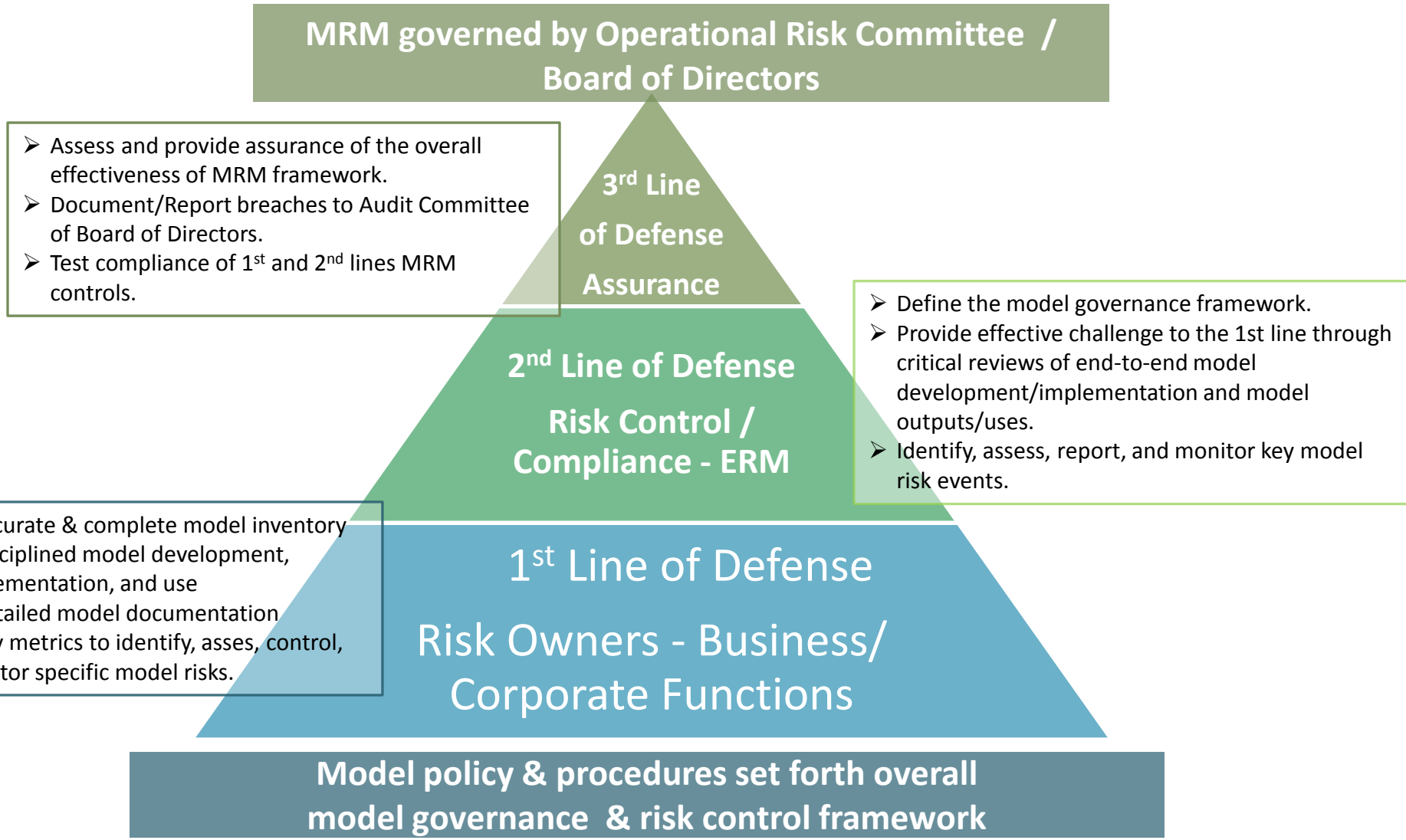
Model Outputs - Translate estimates into business information

Model Use Examples

1. Asset/Liability valuation
    - Financial reporting
    - Budget/Business Planning
    - Baseline scenario analysis - systemic insurance risk drivers (e.g., underwriting cycles, mortality, morbidity, and catastrophe risks), macroeconomic risk drivers (e.g., Interest rate, currency, commodity price risk)
2. Products pricing
    - Overall profitability
    - Effective risk segmentation
    - Marketing strategies, product (re)designs
3. Capital management
    - Cost effective financing and risk transfer/hedging strategies
    - Aggregation/concentration risk mitigation
    - Stress scenario analysis – liquidity risk management
    - Portfolio optimization reflecting efficient capital use/allocation

Model Governance

3 Lines of Defense



Model Risk Management

Model Risk & Causes

1. Model risk - Potential adverse consequences from decisions based on incorrect models or misuse of model outputs.
2. Causes of model risk
   - Intrinsic – data deficiencies, estimation uncertainty, complexity of model process, business applications, new models, inadequate testing
   - Extrinsic – model implementation/use controls, systematic risk drivers (e.g., (e.g., uncertainty in volatility / correlation, unexpected movements in interest rates).

Model Risk Management

Costly Model Risk Events

Examples of costly model errors

- Model-related errors
  - Bank of America (2014) – data/process error causes $4B reduction in reported capital
  - London Whale (2012) – models error caused $5.8B of trading losses
  - Banamex (2002) Modeling teams destroy approximately 5 years worth of default data due to faulty data processing. Computer literature suggests that the value of 100 megabytes of data is valued at approximately $1 million,
  - Between 2001 and 2012 SEC public registrants announced over 12,000 financial restatements, most due to data processing and/or model errors

Other costly model errors with Model tie-ins

- Operational errors
  - S&P and Moody's (2008) – errors in models for rating complex debt products. Huge reputational damage
  - Knight Capital Group (2012) – trading software malfunction led to more than $450M losses
  - Goldman Sachs (2013) – software glitch caused erroneous flood of stock option orders, creating significant trading losses
- Basic model errors
  - Long Term Capital Management (1998) – over reliance on short term history to calibrate models, use of VaR. Resulted in bankruptcy
  - 2008-2009 financial crisis – CDO default models ignored dependence on rising national housing prices

The revenue loss from other undiscovered and unreported models deficiencies cannot be estimated, but must be huge

Model Risk Management

Model Risk Quantification - Challenges

1. All risk measurement is hard
2. Model "failure" criteria hard to fully define
3. Apples & oranges problems
4. Direct and indirect effects

But we can take inspiration from some (unlikely) heroes:

- Simon Kuznets – inventor of GDP
- Frank Knight – "If you can't measure it, measure it anyway", Economic Freedom; Toward a Theory of Measurement, Walter Block, 1991

Practitioners need to maintain an inventor/entrepreneurial attitude. Read Frank Knight's "Risk, Uncertainty, & Profit".

Model Risk Management

Model Risk Quantification - Challenges

1. Risk is a psychic concept, i.e. it is “perceived”
2. Technical risk analytics requires assumptions about underlying preferences – typically expressed through a utility function. Such analysis is usually used to:
   - Rationalize behavior we observe
   - Provide guidance/control over our own behavior
3. The theoretical foundation for the existence of utility functions is the ability of the agent to rank order preferences over a choice set

Thus, we do not necessarily need utility functions to create an institutional model risk framework – but we *do* need preference ordering

Model Risk Management

Model Risk Quantification - Framework

1. Enumerate bad outcomes
2. Identify preference rank ordering
3. Associate models with bad outcomes
4. Enumerate modes of failure by model type
5. Associate failure modes with bad outcome likelihood

Risk must be based on somebody's preferences

Model Risk Management

Model Risk Quantification - Framework

1. Enumerate bad outcomes
   - Any model failure that could impact revenue, profitability, market share, stock price, reputation, or survival
2. Identify preference rank ordering
   - No ranking is necessary, the only bad outcome is a negative impact on stock price
3. Associate models with bad outcome potential
   - For different model classes, how likely are failures to affect stock prices?
5. Associate failure modes with bad outcome likelihood
   - For each model class, how likely are different failure modes to affect stock prices?

With enough data such a framework may be feasible, but it still must reflect somebody's preferences

Model Risk Management

Model Risk Quantification - Framework

1. Enumerate bad outcomes
   - Losses (of different types), revenue drag, reputational damage, regulatory censure, etc.
2. Identify preference rank ordering, e.g.
   - Don't fail CCAR
   - Prevent headline "OpRisk" losses
   - Enhance margins
   - Additional criteria
3. Associate models with bad outcome potential
4. Enumerate modes of failure for model types
5. Associate failure modes with bad outcome likelihood

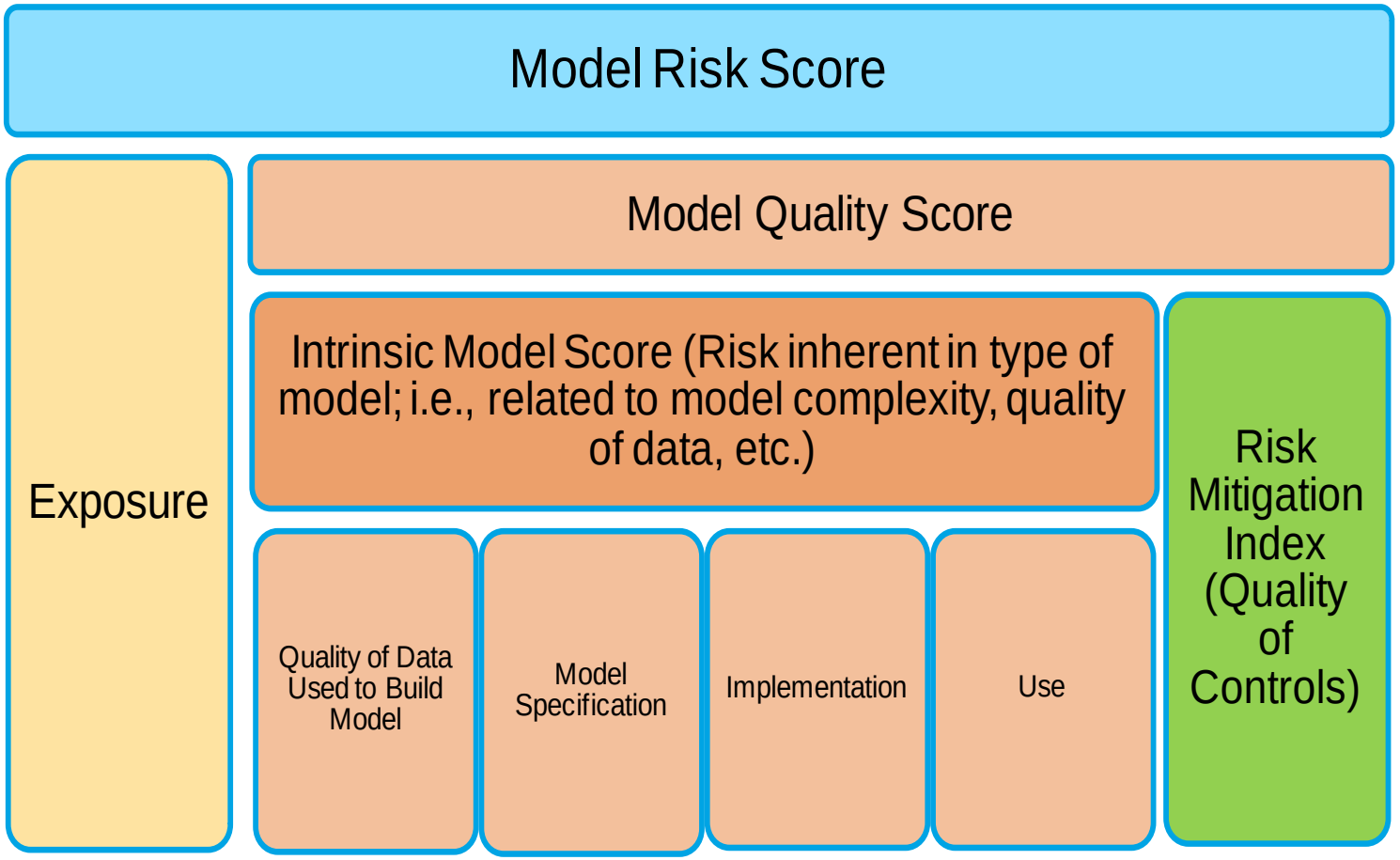
Management/BU developed

Risk Analytics developed

These components, along with their probability measures and weightings comprise the framework

Model Risk Management

Model Risk Quantification - Framework



To harvest risk component data from the validation process requires that process to be highly structured

Model Risk Management

Model Risk Quantification - Limitations

1. Model-to-model effects
   - Risk propagation (amplification, neutral transmission, or mitigation) within a system
2. Exposure attribution
3. Weak link to financial metrics
4. Redundant analyses/findings
5. Poor subject matter expertise matching
   - All validators need to be data quality experts?

All of these issues are significantly ameliorated by elevating the unit of observation to the model stream level

Analytic Asset Management

Why is this important?

1. Profitability and market share (and ultimately firm survival) will depend critically on it
2. Regulatory expectations (requirements) in this area continue to grow*
3. They are essential for a comprehensive and integrated model management framework

> *"Model risk should be managed like other types of risk. Banks should identify the sources of risk and assess the magnitude… Banks should consider risk from individual models and in the aggregate.",*
> *SR Letter 11-7 Model Risk, page 4.*

*In rare but actual cases, failure to meet regulatory expectations and survival can become intertwined.

Analytic Asset Management

What is a model stream?

1. A group of models *and their infrastructure* related by
   - Function
   - Dependence (nesting)
   - Common data sources
   - Common platform
2. The stream includes all movements of data and calculated values
3. It includes data transfer/processing/transformation components as well as models
4. It is wing-to-wing: data sources to final use/reporting

Risk measurement at the stream level can directly embed data quality risks and model risks adjusted for interdependencies

Analytic Asset Management

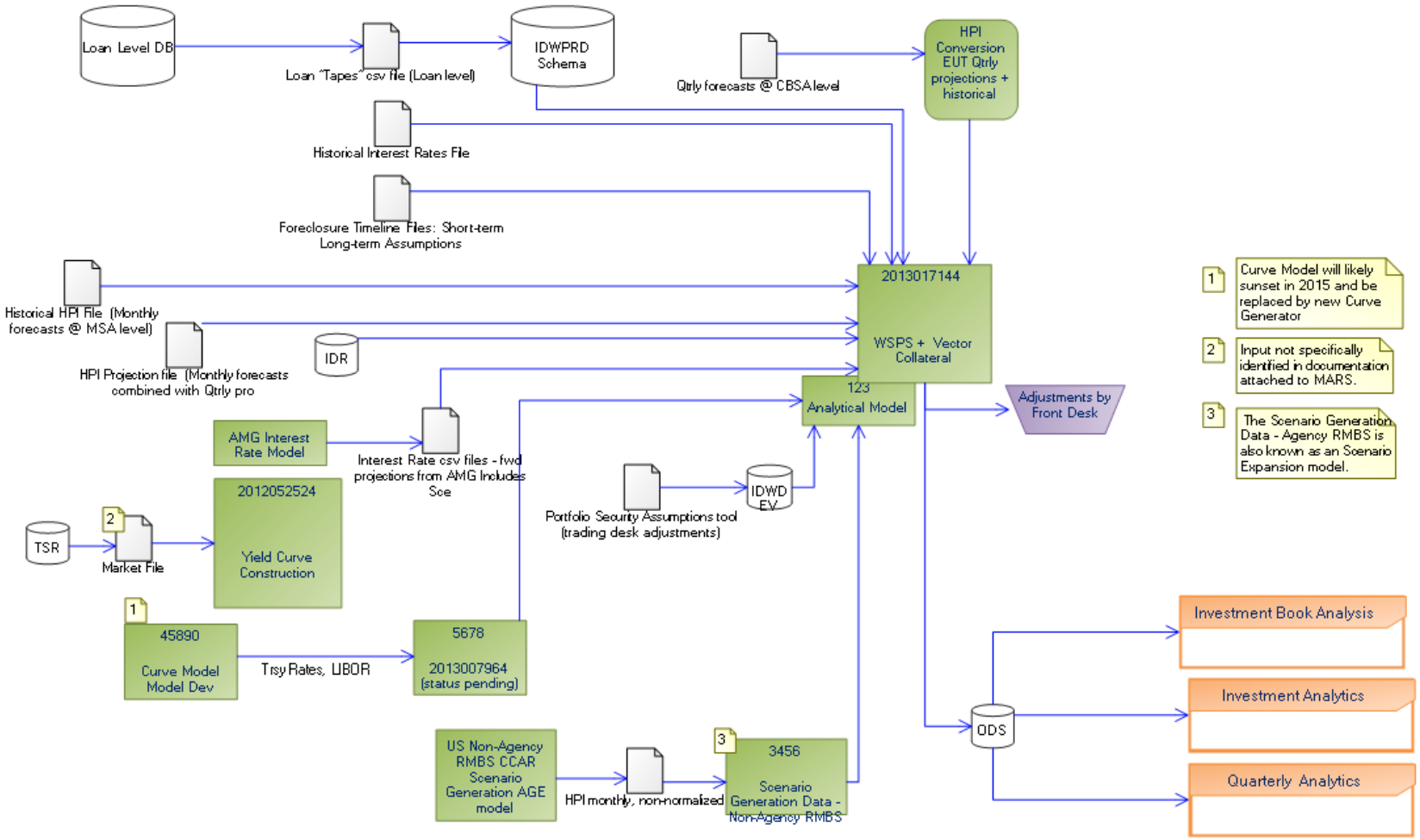
Considerations of a model stream

1. Product outlook
    - Core/non-core, growth/stable/shrinking
    - Profitability, competitive positions
    - Performance volatility
    - Product evolution (dynamism, segmentation)
2. Tactical objectives
    - Improve risk segmentation, predictive accuracy
    - improve implementation infrastructure - more controlled production application, ease of use, more automated data capture
    - Interconnectivity of related models
3. Economic assessments
    - Known deficiencies
    - Key costs and effected margins
    - Tail loss avoidance
    - Product differentiation, pricing power, demand elasticity, client services
    - Potential impact – risk/reward trade offs, combined ratio effect, etc.

Strategic and tactical action based on this information *is* model risk management

Analytic Asset Management

A Diagram View of an Illustrative Stream



Analytic Asset Management

A Strategic View of the Overall Information Processing Complex

1. **Model based view**
   - Wing-to-wing independent validation (data, performance, controllership, technology)
   - Risk score (based on comprehensive model risk assessment framework)

Basic underlying analysis

2. **Stream based view**
   - Assessment based on use/scope/corporate function
   - Clear executive ownership
   - Includes an appropriate measurable definition of model exposure alternatives

Supports the development of a strategy

3. **Meta view**
   - Explicit mapping of all system components: data, applications, models, reports & other uses
   - Typically will lie between “model” and “block” based views
   - Assessment throws off - aggregated model risk measure, risk-based data quality measure, explicit tactical remediation plans

Enables the implementation of the strategy

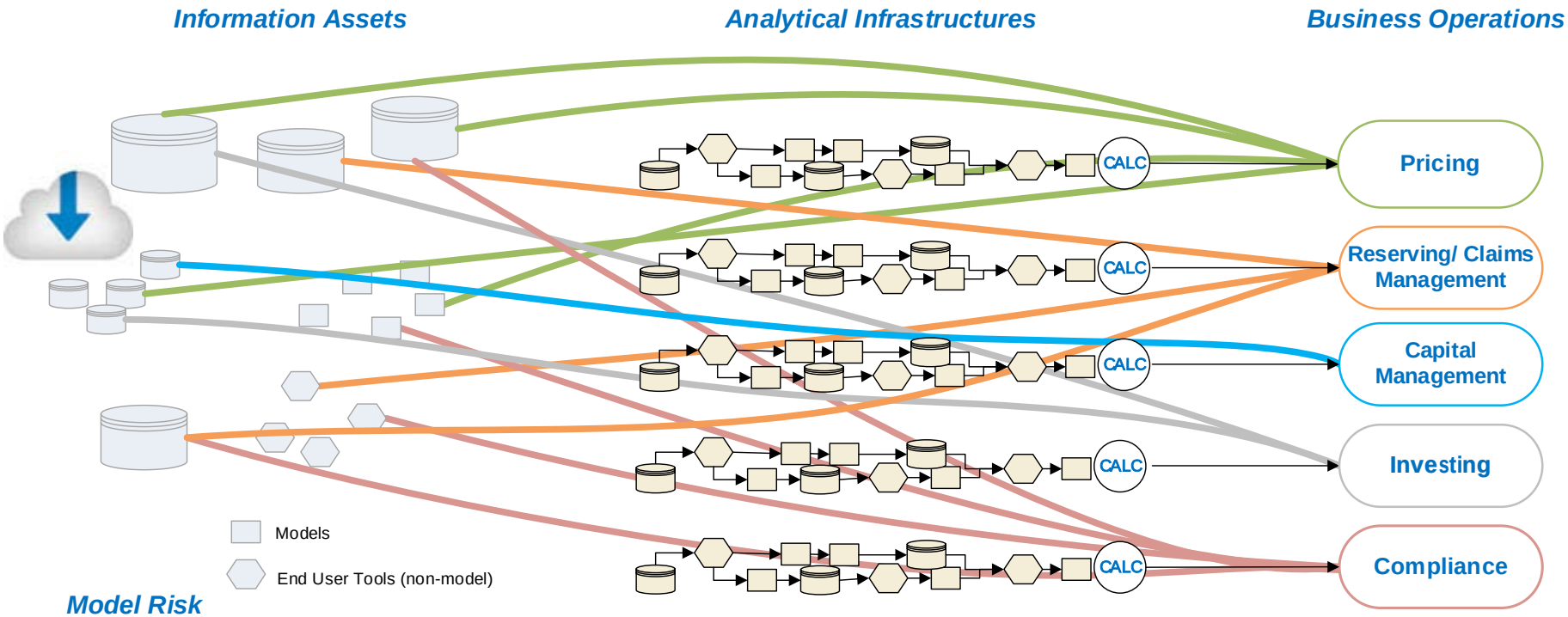
Analytic Asset Management

Concept of an Integrated Objective Environment (IOE)

1. Models are typically embedded in systems/processes that include data sources, inter-related models, platforms, and other model-delivery systems – *they all contribute to risk and to return*
2. Effective model validation requires some consideration of this broader context/infrastructure anyway – putting structure on this part of the process will increase efficiency
3. Business strategic planning to enhance analytic capabilities is typically done at the stream level – this planning is also critical contextual input for the validators
4. Model risk measures aggregated to the stream level will be more meaningful and more actionable

Analytic Asset Management
IOE Framework

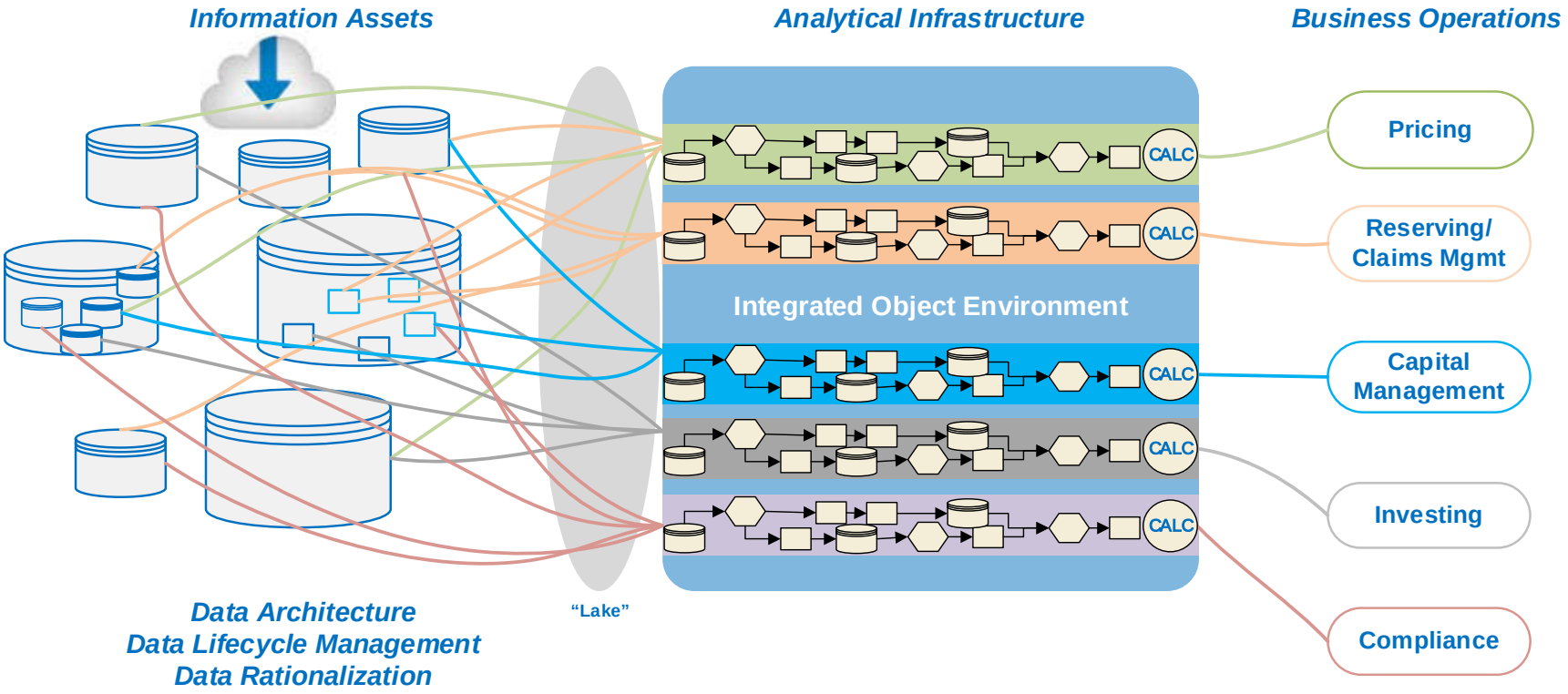
1. Each business line has its own infrastructure, sometimes linked, but not explicit or visible.
2. Development of calculations are soloed and independently managed.
3. Data & calc lineages are not easily determined.
4. Analytic infrastructures require forensic analysis to determine components and assess
5. controllership, performance gaps and outputs.



Model Risk
Data Governance, Standards, Quality & Risk
Database Rationalization

Analytic Asset Management
IOE Framework - The Analytics "Supply Chain and Factory"

1. Analytical linkages established and maintained data, models, platforms, end uses.
2. Makes the infrastructure "streams" visible with insight into cost, controls, and profitability.
3. Contains its own embedded analytic & reporting capabilities for management.
4. Surgical approach to scale and to extension.




Thank
You