NORTHFIELD | modeling financial markets worldwide

Widely Distributed Investment Analytics

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Newport Seminar

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Northfield Online Analytics Services

NEXUS – Risk, Attribution, Optimization and Stress Testing

- **Single platform**, intuitive and relevant across various levels of investment management functions
- Use Portfolio **Optimization**, **Risk** Management and Performance **Attribution** as part of a single workflow
- Perform **Stress Tests** based on different economic and market Scenarios
- Seamlessly integrate your holdings, market, and descriptive data through Nexus **Data Loader**
- Use **Northfield OFX** connection to get positions data directly from custodians
- Analyze your portfolios, point in time or across, using Northfield multifactor **Risk Models** with full factor and security Risk Decomposition at both relative and absolute levels
- With **Northfield EE** model, cover millions of assets across different countries, currencies, and regions

SAAS – distributed framework for Northfield analytics online

- Both hosted by Northfield & an SDK
- Optimizer, risk model data and downstream analytics

What is SAAS?

online implementation of NISASP (Analytics Services Platform):

Connection Control Service [CCS]

- granular product access control
- NISASP configuration mode (peer to peer vs remote on SAAS vs hybrid)
- distribution – given an access key, download the NISASP API and/or SDK…

Data Access Toolkits:

- Risk Models [ARC, MDL, ACES]
- Portfolios, Benchmarks via OFX [DAT]

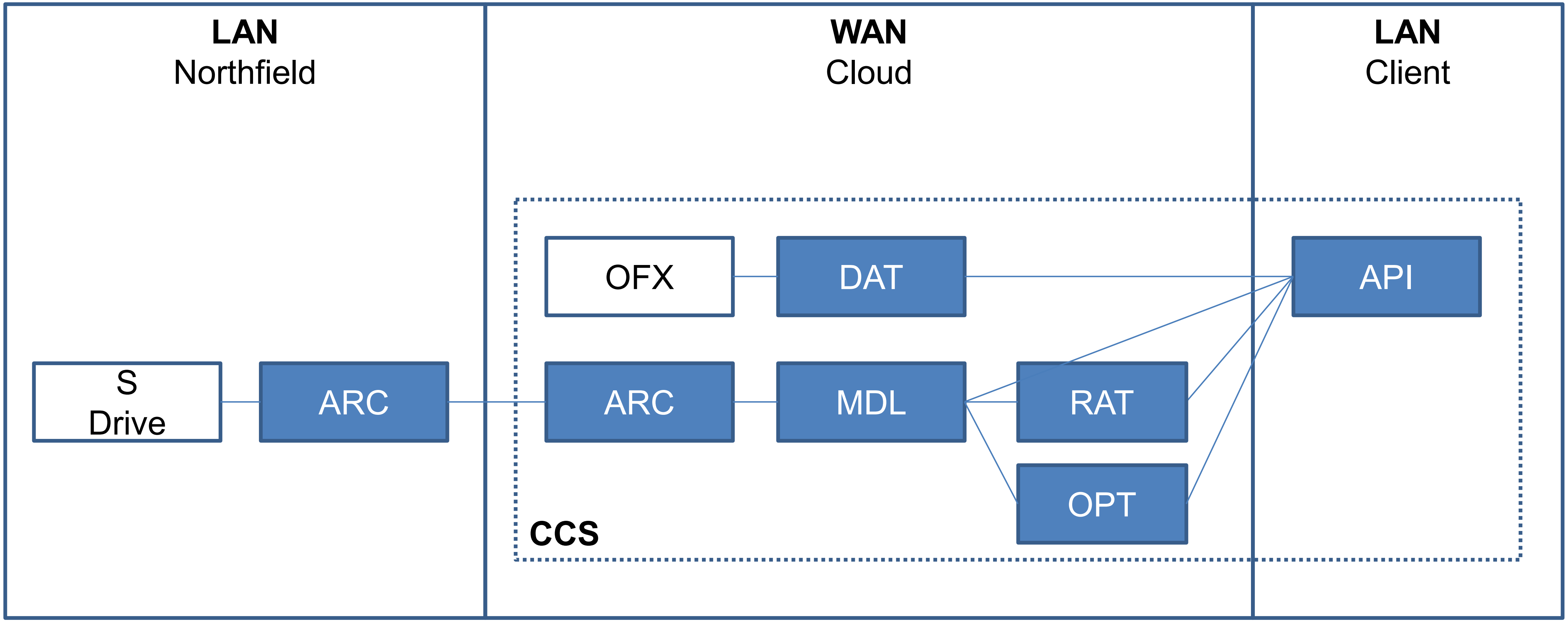
Risk Analytics Toolkit [RAT]

- scenario analysis
- expanded risk reports

Optimizer API [OPT]

- Northfield Optimizer as a distributed asynchronous web service

SaaS Component Overview



Why we care about SAAS

SAAS services can be quickly assembled into more complex applications and services…

applications

- Optimized Scenario Analysis - using OPT and RAT services
- any other desirable WUI application

analytics services

- RAMP – deliver previously defined risk reports on a schedule using MDL, DAT and RAT

data services – ACES (Asset Coverage Extension Service)

- risk model delivery and exceptions processing using MDL and integration with vendor web services like Refinitiv Datascope & CUSIP…
- deliver risk model record given client’s identifiers, resolve xref ID issues, model or proxy exceptions for as complete coverage as possible
- Live on saas.northinfo.com for all Northfield Risk Models

Why our clients (should) care about SAAS

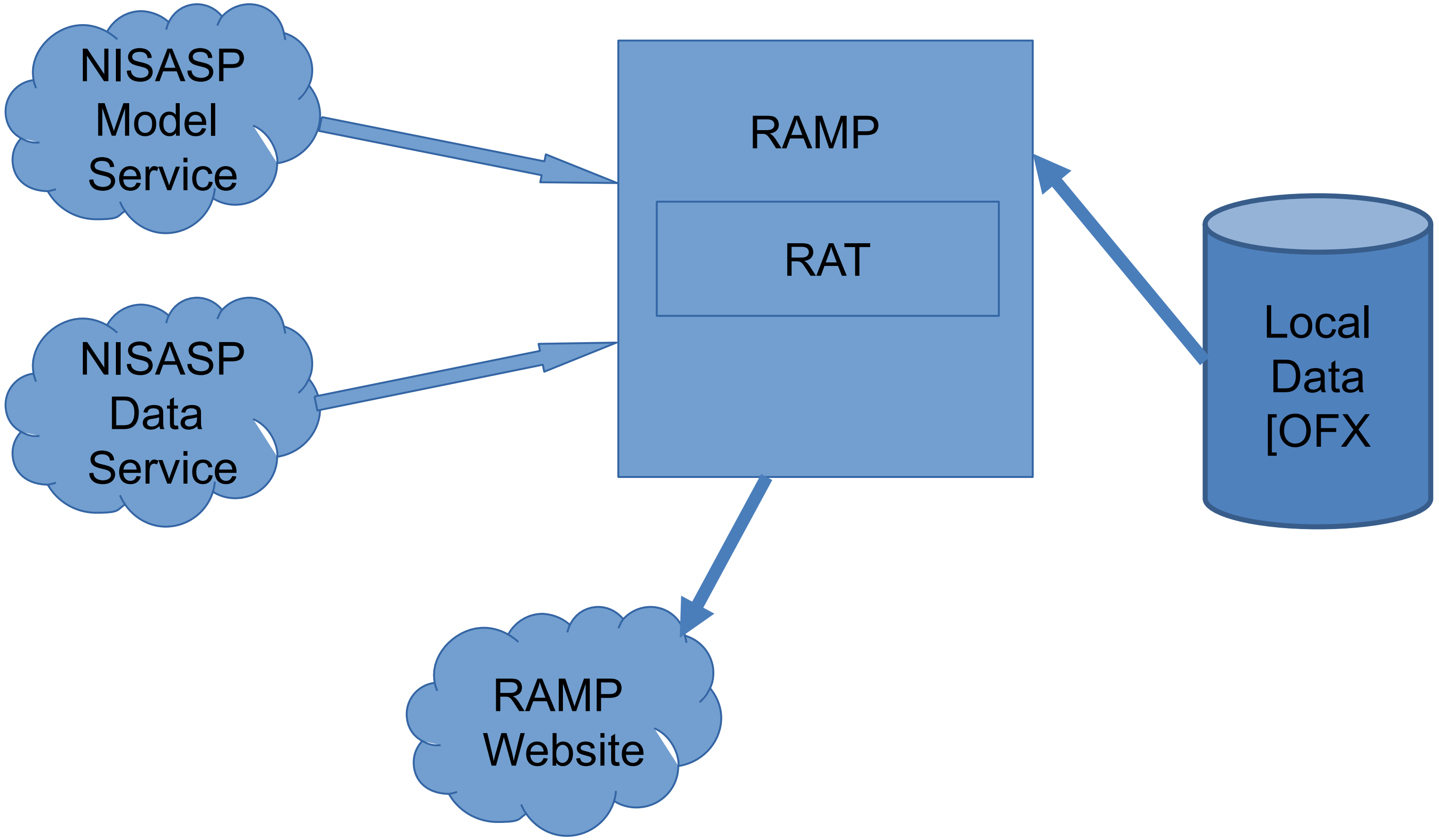
Full service to render software / data wrangling obsolete (RAMP)

Access to applications without data / deployment hassle (Apps)

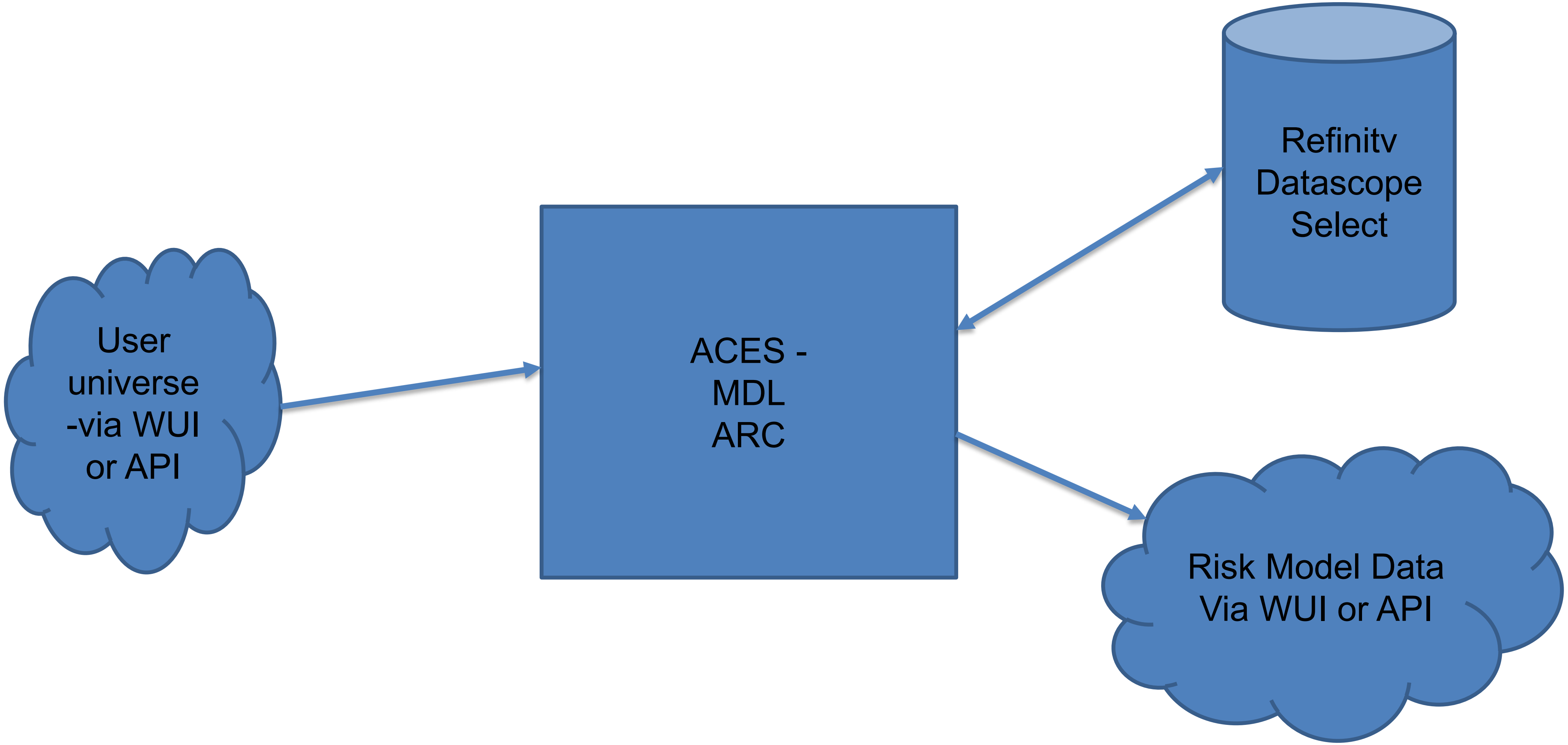
Architecture / Development Environment agnostic access to all our tools and data for integration.

- All tools available, hosted on saas.northinfo.com, via JAVA API or RESTful Web Service (JSON) API – any box with a web connection can, given the right authorization key, access our tools and data from any language;
- There's also a JAVA software development kit for local installations of the CCS, OPT and MDL services, supporting WIN64, OSX, Linux and AWS.

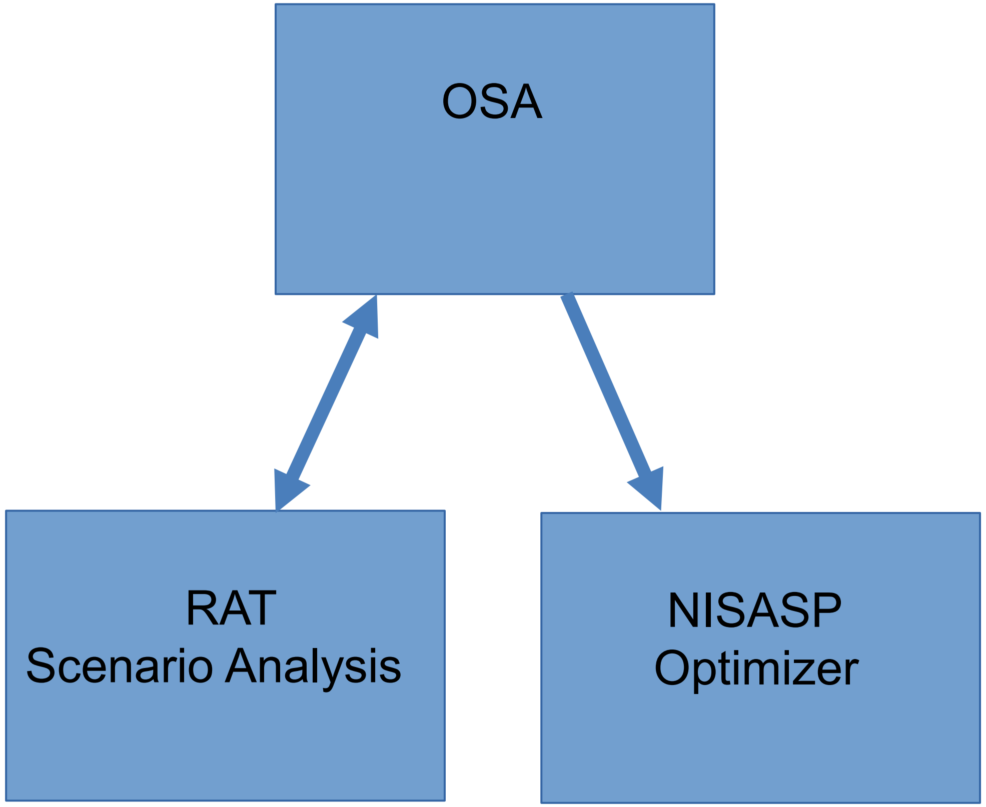
RAMP Architecture



ACES Architecture



Optimized Scenario Analysis



Why Nexus?

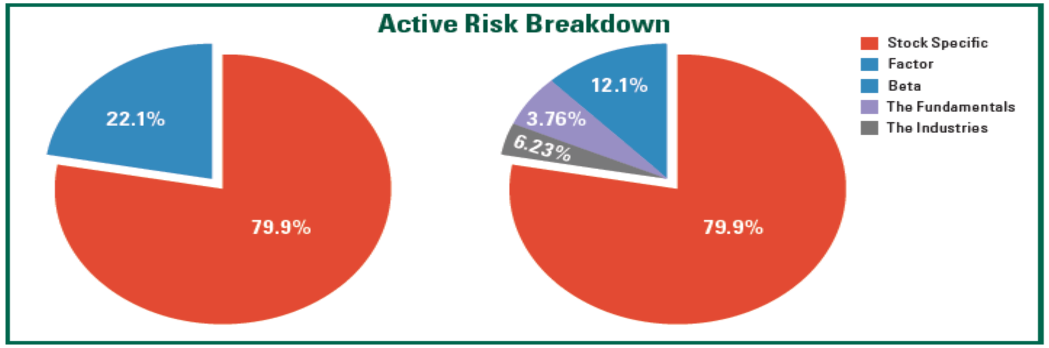
- Northfield proprietary analytics and tools under one platform.
- Nexus delivers a unified approach to managing and monitoring the investment management process.
- It offers consistent risk and attribution measures across different asset classes through multi asset class risk factors and correlation/covariance matrix.
- It provides a systematic portfolio construction solution through tried and tested Northfield Optimizer with realistic risk and market constraints.
- Risk factors include fundamental, macro, market, style, sector, region and currency.
- Northfield Risk Models deliver a complementary analysis with multiple levels of granularity.

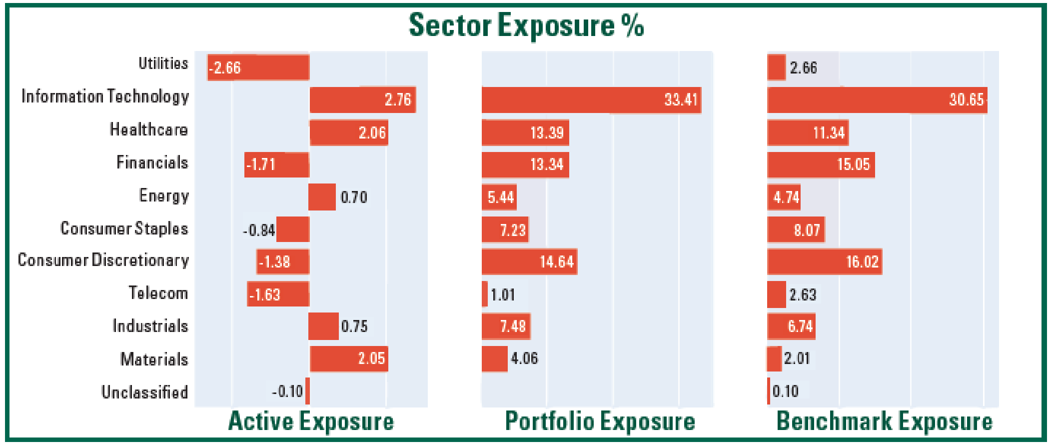
What is Nexus?

Unified System	• Replace multiple systems with a single platform, intuitive and relevant across various levels of investment management functions
Data Integration	• Seamlessly integrate your holdings, market, and descriptive data through **Nexus Data Loader** • Use **Northfield OFX** connection to get positions data directly from custodians
Integrated Workflow	• Use **Portfolio Optimization**, **Risk Management** and **Performance Attribution** as part of a single workflow • Perform **Stress Tests** based on different economic and market Scenarios • Manage and access portfolios and benchmarks across different modules
Multi-Asset Coverage	• With **Northfield EE** model, cover millions of assets across different countries, currencies, and regions • Analyze global **Equities**, Corporate and Sovereign **Bonds**, U.S. **Municipal Bonds**, U.S. **Mortgage/Asset Backed** securities, global **Collateralized Instruments**, **Derivatives** instruments, **Private Equity/Debt**, **Infrastructure**, **Real Estate**, **ETFs**, **Mutual Funds** and **Hedge Funds**.
Comprehensive Anaytics	• Analyze your portfolios, point in time or across, using Northfield multifactor **Risk Models** with full factor and security **Risk Decomposition** at both relative and absolute levels • Reports include **Tracking Error**, **Total Risk**, **VAR**, **CVAR**, and **Active Risk** • Compare and contrast analytics for different strategies and across different markets • Customize reporting and use custom/third party risk models using **Nexus API**

Risk

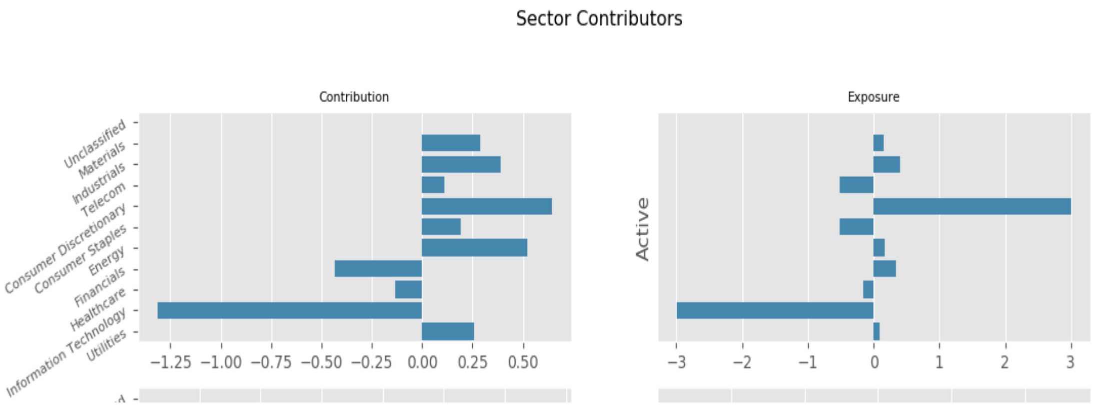
- The system is built on Northfield's state of the art Risk Models covering millions of securities across all asset classes, investment horizons, geographies, currencies, and regions.
- Interactive reporting lets users drill down and sum up at different levels of risk contribution.
- In addition to an intuitive user experience, it includes a dynamic **REST API** offering automation and scale for seamless data integration and reporting.
- Risk breakdown at factor, sector, industry and security level.
- Security level risk can be aggregated using any custom attribute.
- Reports include **Tracking Error**, **Total Risk**, **VaR**, **CVaR**, and **Active Risk**





Attribution

- Offers risk model/factor based as well as Brinson attribution.
- Decompose return into factor, stock specific, industry and sectors.
- Return decomposition for active, portfolio and benchmark.
- Both ex-ante and ex-post risk decomposition is available.
- Use any Northfield risk model as well as any custom model.
- Reports include factor stratification and factor performance over time.
- Factor returns data goes back to the 1990s for most of Northfield risk models



Attribution Report

Summary | Return Decomposition | Factor Decomposition | Factor Stratification | Sector Stratification | Security Contribution | Risk Decomposition | Exceptions

Return Decomposition

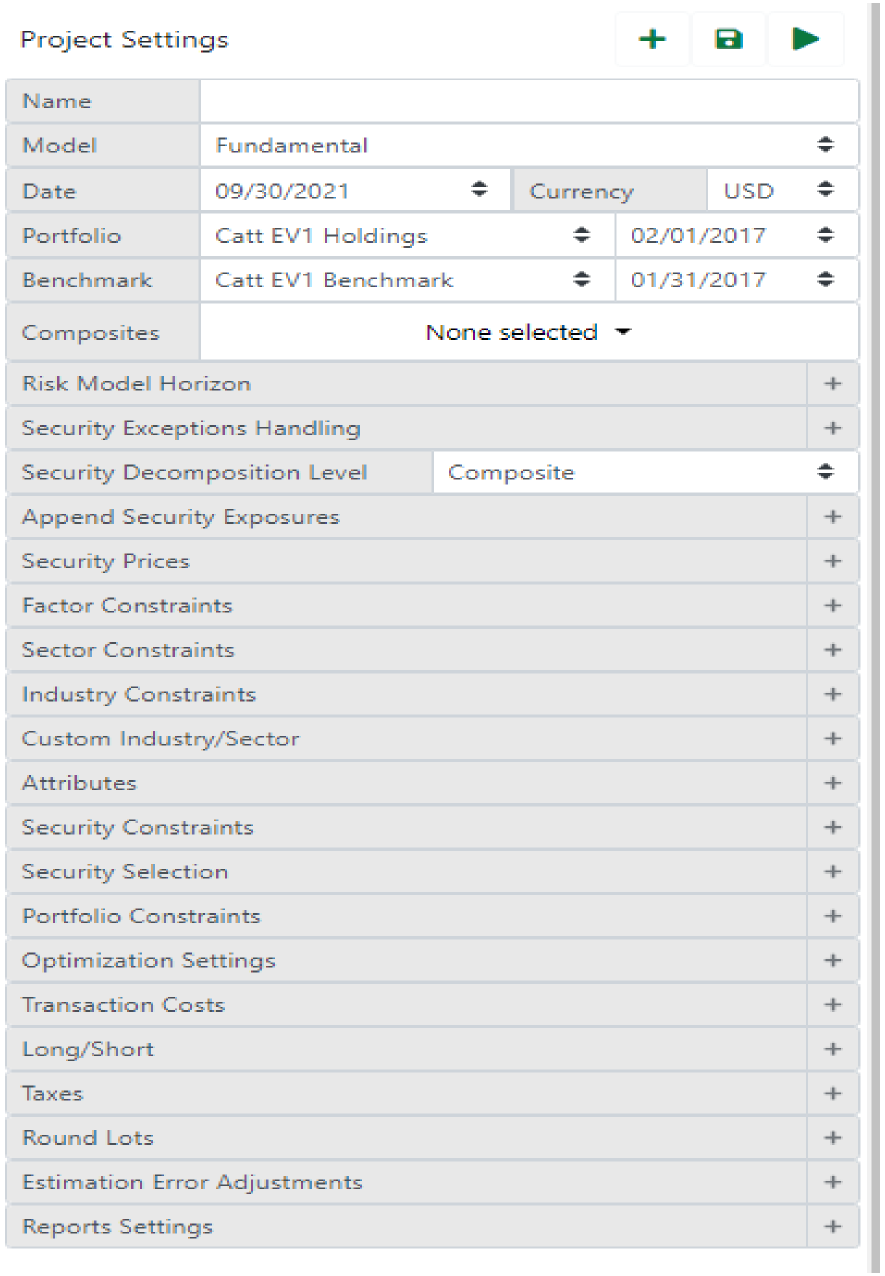
		Factor	Date	Active Contribution	%	Portfolio Contribution	%	Benchmark Contribution	%
1	+	Factor Model Specific		-0.2591	-51.4093	15.7456	113.0184	15.9925	117.8501
2	+	Stock Specific		0.7578	150.3460	-1.7867	-12.8245	-2.6018	-19.1729
3		Interaction		0.0054	1.0633	-0.0270	-0.1939	0.1795	1.3228
4	+	Total		0.5040	100.0000	13.9319	100.0000	13.5702	100.0000

Group Decomposition

		Factor	Date	Active Contribution	%	Portfolio Contribution	%	Benchmark Contribution	%
1	+	Beta		0.1196	-46.1747	21.3204	135.4055	21.2009	132.5676
2	+	The Fundamentals		0.1351	-52.1563	-4.6118	-29.2896	-4.7410	-29.6449
3	+	The Industries		-0.5140	198.3597	-0.1128	-0.7164	0.4002	2.5027
4		Interaction		0.0001	-0.0287	-0.8502	-5.3995	-0.8677	-5.4255
5	+	Total		-0.2591	100.0000	15.7456	100.0000	15.9925	100.0000

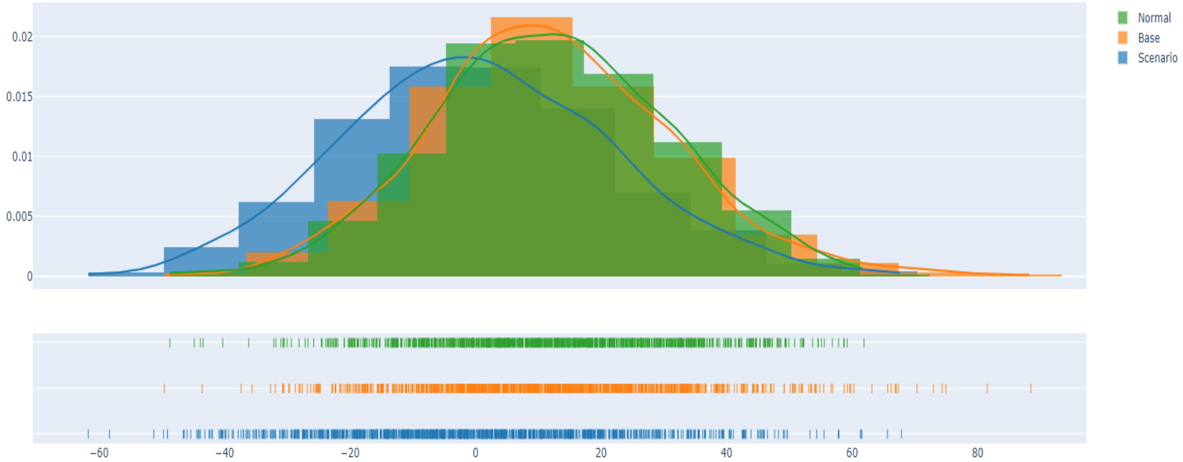
Optimization

- State of the art Northfield open optimizer available online.
- Use any Northfield risk model or custom risk model.
- Over 400 settings and constraints available.
- Use security as well as portfolio level constraints, including sector, industry or custom attributes.
- Provide global min/max as well as security level min/max constraints.
- Include Northfield supplied transaction costs as well as market impact model.
- Use optimal portfolio as input in other Nexus modules.
- Limit security universe to benchmark securities with one click.
- User Tax aware optimization to implement tax loss harvesting strategies.
- Use factor constraints with other settings to create realistic factor portfolios.
- Make optimizer calls using Nexus REST API, as part of internal automated portfolio construction process.



FASST – Scenario Analysis/Stress Testing

- FASST – A new approach to risk assessments using numerical simulations.
- Extending the approach suggested in Meucci (2008, “Fully Flexible Views: Theory and Practice”) which combines Monte Carlo simulations with the flexibility to overlay complex explicit scenarios.
- Using current factor exposures of a given portfolio and historical factor returns, we generate random sampling to get a range of possible outcomes.
- Bootstrapping - Rather than using the actual sequence of events we will be using many sequences of randomized events drawn from an historic set of experiences.
- We overlay different scenarios/shocks by favoring periods of severe events during drawing of randomized sampling above.



Annualized Cumulative Stats

	Scenario	Base	Normal
Mean	0.3706	11.9852	12.0576
Standard Deviation	21.2422	19.4229	18.6139
Skew	0.1668	0.3029	-0.0193
Kurtosis	2.9188	3.4499	2.8426
Excess Kurtosis	-0.0812	0.4499	-0.1574
Value at Risk	-6.9456	-5.8885	-5.6206
Conditional Value at Risk	-8.6839	-7.5053	-7.1700
Value at Risk - T5	-8.5118	-5.5635	-5.3091
Conditional Value at Risk - T5	-10.6414	-8.2383	-7.8725

Future Developments

- CAtt - Attributing performance to the signals and constraints that drive optimization-based investment strategies.
- Expected Life:
    1. Based on options (contingent claims) analysis.
    2. The literature in this area begins with Merton (1974), where it is posed that the equity of a firm can be viewed as a European call option on the firm's assets, with a strike price equal to the face value of the firm's debt.
    3. With asset volatility and correlations estimated via risk model, we can use our preferred structural model to estimate the default probability of a firm.
- PWER - A Unified Approach to Monitoring and Evaluating Investment Managers.

Summarizing Nexus

- **Unified System** – Replace multiple systems with a single platform, intuitive and relevant across various levels of investment management functions.
- **Data Integration** – Seamlessly integrate your holdings, market, and descriptive data through Nexus Data Loader and Northfield partnership with DiFi.
- **Integrated workflow** – Use Portfolio Optimization, Risk Management, Performance Attribution and Stress Testing as part of a single workflow.
- **Multi-Asset Coverage** – With Northfield EE model, cover millions of assets across different countries, currencies, and regions.
- **Comprehensive Analytics** – Reports include Tracking Error, Total Risk, VAR, CVAR, and Active Risk.