Types of Enrichment Relevant for Financial Services Post-Trade Settlement

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This comprehensive guide demonstrates various types of enrichment that are essential for financial services post-trade settlement, with detailed XML examples and YAML enrichment rules based on industry standards including ISO 20022, FIX Protocol, FpML, and SWIFT messaging formats.

1. Reference Data Enrichment

Reference data enrichment adds standardized identifiers and institutional information to trade records, ensuring proper identification and routing for settlement processing.

Example Source XML (Trade Confirmation)

```xml
<tradeConfirmation xmlns="http://www.fpml.org/FpML-5/confirmation">
  <header>
    <messageId>TRD-20241224-001</messageId>
    <sentBy>BANKGB2L</sentBy>
    <sendTo>DEUTDEFF</sendTo>
    <creationTimestamp>2024-12-24T10:30:00Z</creationTimestamp>
  </header>
  <trade>
    <tradeHeader>
      <partyTradeIdentifier>
        <partyReference href="party1"/>
        <tradeId>TRD-001-2024</tradeId>
      </partyTradeIdentifier>
      <tradeDate>2024-12-24</tradeDate>
    </tradeHeader>
    <security>
      <instrumentId>GB00B03MLX29</instrumentId>
      <instrumentType>EQUITY</instrumentType>
      <issuer>Royal Dutch Shell</issuer>
    </security>
    <counterparty>
      <partyId>PARTY123</partyId>
      <partyName>Deutsche Bank AG</partyName>
    </counterparty>
    <tradingVenue>XLON</tradingVenue>
    <quantity>10000</quantity>
    <price>2750.50</price>
    <currency>GBP</currency>
  </trade>
</tradeConfirmation>
```

Additional XML Examples

Example 2: Bond Trade Confirmation

```xml
<tradeConfirmation xmlns="http://www.fpml.org/FpML-5/confirmation">
  <header>
    <messageId>BOND-20241224-002</messageId>
    <sentBy>JPMUS33</sentBy>
    <sendTo>GSCCUS33</sendTo>
  </header>
  <trade>
    <tradeHeader>
      <partyTradeIdentifier>
        <tradeId>BOND-002-2024</tradeId>
      </partyTradeIdentifier>
      <tradeDate>2024-12-24</tradeDate>
    </tradeHeader>
    <security>
      <instrumentId>US912828XG93</instrumentId>
      <instrumentType>GOVERNMENT_BOND</instrumentType>
      <issuer>US Treasury</issuer>
      <maturityDate>2034-12-15</maturityDate>
      <couponRate>4.25</couponRate>
    </security>
    <counterparty>
      <partyId>GOLDMAN_SACHS</partyId>
      <partyName>Goldman Sachs Group Inc</partyName>
    </counterparty>
    <tradingVenue>BONDDESK</tradingVenue>
    <quantity>1000000</quantity>
    <price>98.75</price>
    <currency>USD</currency>
    <accruedInterest>1250.00</accruedInterest>
  </trade>
</tradeConfirmation>
```

Example 3: Derivative Trade Confirmation

```xml
<tradeConfirmation xmlns="http://www.fpml.org/FpML-5/confirmation">
  <header>
    <messageId>DERIV-20241224-003</messageId>
    <sentBy>DEUTDEFF</sentBy>
    <sendTo>BARCGB22</sendTo>
  </header>
  <trade>
    <tradeHeader>
      <partyTradeIdentifier>
        <tradeId>SWAP-003-2024</tradeId>
      </partyTradeIdentifier>
      <tradeDate>2024-12-24</tradeDate>
    </tradeHeader>
    <derivative>
      <productType>INTEREST_RATE_SWAP</productType>
      <underlyingIndex>USD-LIBOR-3M</underlyingIndex>
      <notionalAmount>50000000</notionalAmount>
      <fixedRate>3.75</fixedRate>
      <floatingRate>LIBOR+0.25</floatingRate>
      <maturityDate>2029-12-24</maturityDate>
    </derivative>
    <counterparty>
      <partyId>BARCLAYS_BANK</partyId>
      <partyName>Barclays Bank PLC</partyName>
    </counterparty>
    <tradingVenue>OTC</tradingVenue>
    <currency>USD</currency>
  </trade>
```

```xml
</tradeConfirmation>
```

YAML Enrichment Rules

```yaml
metadata:
  name: "Reference Data Enrichment"
  description: "Enrich trades with standardized reference data identifiers"
  version: "1.0.0"
  type: "rule-config"

rules:
  - id: "isin-format-validation"
    name: "ISIN Format Validation"
    condition: "#data.security != null && #data.security.instrumentId != null && #data.security.instrumentId.matches('^[A
    message: "ISIN must follow format: 2 country letters + 9 alphanumeric + 1 check digit"
    severity: "ERROR"

enrichments:
  - id: "lei-enrichment"
    type: "lookup-enrichment"
    condition: "#data.counterparty != null && #data.counterparty.partyName != null"
    lookup-config:
      lookup-key: "counterparty.partyName"
      lookup-dataset:
        type: "inline"
        key-field: "partyName"
        data:
          - partyName: "Deutsche Bank AG"
            lei: "7LTWFZYICNSX8D621K86"
            jurisdiction: "DE"
          - partyName: "JPMorgan Chase"
            lei: "8EE8DF3643E15DBFDA05"
            jurisdiction: "US"
          - partyName: "Goldman Sachs"
            lei: "784F5XWPLTWKTBV3E584"
            jurisdiction: "US"
    field-mappings:
      - source-field: "lei"
        target-field: "counterparty.lei"
      - source-field: "jurisdiction"
        target-field: "counterparty.jurisdiction"

  - id: "isin-security-enrichment"
    type: "lookup-enrichment"
    condition: "#data.security != null && #data.security.instrumentId != null"
    lookup-config:
      lookup-key: "security.instrumentId"
      lookup-dataset:
        type: "inline"
        key-field: "isin"
        data:
          - isin: "GB00B03MLX29"
            cusip: "780259206"
            sedol: "B03MLX2"
            name: "Royal Dutch Shell PLC"
          - isin: "US0378331005"
            cusip: "037833100"
            sedol: "2046251"
            name: "Apple Inc"
    field-mappings:
      - source-field: "cusip"
        target-field: "security.cusip"
      - source-field: "sedol"
```

```yaml
        target-field: "security.sedol"
      - source-field: "name"
        target-field: "security.name"

  - id: "mic-code-enrichment"
    type: "lookup-enrichment"
    condition: "#data.tradingVenue != null"
    lookup-config:
      lookup-key: "tradingVenue"
      lookup-dataset:
        type: "inline"
        key-field: "micCode"
        data:
          - micCode: "XLON"
            venueName: "London Stock Exchange"
            country: "GB"
          - micCode: "XNYS"
            venueName: "New York Stock Exchange"
            country: "US"
          - micCode: "XNAS"
            venueName: "NASDAQ"
            country: "US"
    field-mappings:
      - source-field: "venueName"
        target-field: "venue.venueName"
      - source-field: "country"
        target-field: "venue.country"

  - id: "bic-code-enrichment"
    type: "lookup-enrichment"
    condition: "#data.counterparty != null && #data.counterparty.partyName != null"
    lookup-config:
      lookup-key: "counterparty.partyName"
      lookup-dataset:
        type: "inline"
        key-field: "partyName"
        data:
          - partyName: "Deutsche Bank AG"
            bic: "DEUTDEFF"
          - partyName: "JPMorgan Chase"
            bic: "CHASUS33"
          - partyName: "Goldman Sachs"
            bic: "GSCCUS33"
    field-mappings:
      - source-field: "bic"
        target-field: "settlement.counterpartyBIC"

  - id: "ssi-enrichment"
    type: "lookup-enrichment"
    condition: "#data.counterparty != null && #data.counterparty.lei != null && #data.venue != null && #data.venue.countr
    lookup-config:
      lookup-key: "#counterparty.lei + '_' + #venue.country"
      lookup-dataset:
        type: "inline"
        key-field: "key"
        data:
          - key: "7LTWFZYICNSX8D621K86_GB"
            method: "CREST"
            account: "CREST001234"
            custodian: "Euroclear UK & Ireland"
            cutoffTime: "16:00 GMT"
          - key: "7LTWFZYICNSX8D621K86_US"
            method: "DTC"
            account: "DTC567890"
            custodian: "The Depository Trust Company"
            cutoffTime: "15:00 EST"
```

```yaml
          - key: "8EE8DF3643E15DBFDA05_US"
            method: "DTC"
            account: "DTC123456"
            custodian: "The Depository Trust Company"
            cutoffTime: "15:00 EST"
          - key: "G5GSEF7VJP5I7OUK5573_GB"
            method: "CREST"
            account: "CREST998877"
            custodian: "Euroclear UK & Ireland"
            cutoffTime: "16:00 GMT"
    field-mappings:
      - source-field: "method"
        target-field: "settlement.method"
      - source-field: "account"
        target-field: "settlement.accountNumber"
      - source-field: "custodian"
        target-field: "settlement.custodian"
      - source-field: "cutoffTime"
        target-field: "settlement.cutoffTime"

# Additional Examples for Different Asset Classes

  - id: "bond-specific-enrichment"
    type: "lookup-enrichment"
    condition: "#data.trade.security.instrumentType == 'GOVERNMENT_BOND'"
    lookup-config:
      lookup-key: "trade.security.instrumentId"
      lookup-dataset:
        type: "inline"
        key-field: "cusip"
        data:
          - cusip: "US912828XG93"
            bondType: "TREASURY_NOTE"
            creditRating: "AAA"
            duration: 8.5
            convexity: 0.85
            yieldToMaturity: 4.15
    field-mappings:
      - source-field: "bondType"
        target-field: "security.bondType"
      - source-field: "creditRating"
        target-field: "security.creditRating"
      - source-field: "duration"
        target-field: "security.duration"
      - source-field: "yieldToMaturity"
        target-field: "security.yieldToMaturity"

  - id: "derivative-enrichment"
    type: "lookup-enrichment"
    condition: "#data.trade.derivative != null && #data.trade.derivative.productType != null"
    lookup-config:
      lookup-key: "trade.derivative.productType"
      lookup-dataset:
        type: "inline"
        key-field: "productType"
        data:
          - productType: "INTEREST_RATE_SWAP"
            assetClass: "RATES"
            clearingEligible: true
            marginClass: "CLASS_1"
            regulatoryCategory: "CLEARED_DERIVATIVE"
            riskWeight: 0.02
          - productType: "CREDIT_DEFAULT_SWAP"
            assetClass: "CREDIT"
            clearingEligible: false
            marginClass: "CLASS_2"
```

```yaml
        regulatoryCategory: "BILATERAL_DERIVATIVE"
        riskWeight: 0.08
    field-mappings:
      - source-field: "assetClass"
        target-field: "derivative.assetClass"
      - source-field: "clearingEligible"
        target-field: "derivative.clearingEligible"
      - source-field: "marginClass"
        target-field: "derivative.marginClass"
      - source-field: "riskWeight"
        target-field: "derivative.riskWeight"
```

2. Counterparty Enrichment

Counterparty enrichment adds critical information about trading partners, including credit ratings, classifications, and relationship details essential for risk management and settlement processing.

Example Source XML (Counterparty Data)

```xml
<counterpartyInfo xmlns="http://www.iso20022.org/counterparty">
  <counterpartyId>
    <lei>7LTWFZYICNSX8D621K86</lei>
    <partyName>Deutsche Bank AG</partyName>
    <jurisdiction>DE</jurisdiction>
  </counterpartyId>
  <contactInfo>
    <businessUnit>Prime Brokerage</businessUnit>
    <tradingDesk>Equity Trading</tradingDesk>
  </contactInfo>
  <accountInfo>
    <accountNumber>DB-PB-001234</accountNumber>
    <accountType>PRIME_BROKERAGE</accountType>
  </accountInfo>
</counterpartyInfo>
```

Additional Counterparty Examples

Example 2: Investment Manager Counterparty

```xml
<counterpartyInfo xmlns="http://www.iso20022.org/counterparty">
  <counterpartyId>
    <lei>549300E9W2RQMQRQZ748</lei>
    <partyName>BlackRock Fund Advisors</partyName>
    <jurisdiction>US</jurisdiction>
  </counterpartyId>
  <contactInfo>
    <businessUnit>Institutional Client Services</businessUnit>
    <tradingDesk>Fixed Income Trading</tradingDesk>
  </contactInfo>
  <accountInfo>
    <accountNumber>BR-ICS-567890</accountNumber>
    <accountType>INSTITUTIONAL_INVESTMENT</accountType>
  </accountInfo>
  <riskProfile>
    <clientType>ASSET_MANAGER</clientType>
    <aum>9500000000000</aum>
    <riskRating>LOW</riskRating>
```

```xml
  </riskProfile>
</counterpartyInfo>
```

Example 3: Hedge Fund Counterparty

```xml
<counterpartyInfo xmlns="http://www.iso20022.org/counterparty">
  <counterpartyId>
    <lei>5493000F4ZG1KEXQJL62</lei>
    <partyName>Bridgewater Associates LP</partyName>
    <jurisdiction>US</jurisdiction>
  </counterpartyId>
  <contactInfo>
    <businessUnit>Trading Operations</businessUnit>
    <tradingDesk>Multi-Asset Trading</tradingDesk>
  </contactInfo>
  <accountInfo>
    <accountNumber>BW-TO-123456</accountNumber>
    <accountType>HEDGE_FUND</accountType>
  </accountInfo>
  <riskProfile>
    <clientType>HEDGE_FUND</clientType>
    <aum>140000000000</aum>
    <riskRating>MEDIUM</riskRating>
    <leverageRatio>3.2</leverageRatio>
  </riskProfile>
</counterpartyInfo>
```

YAML Enrichment Rules

```yaml
metadata:
  name: "Counterparty Enrichment"
  description: "Enrich counterparty data with credit ratings, classifications, and relationship information"
  version: "1.0.0"
  type: "rule-config"

enrichments:
  - id: "credit-rating-enrichment"
    type: "lookup-enrichment"
    condition: "#data.counterpartyId != null && #data.counterpartyId.lei != null"
    lookup-config:
      lookup-key: "counterpartyId.lei"
      lookup-dataset:
        type: "inline"
        key-field: "lei"
        data:
          - lei: "7LTWFZYICNSX8D621K86"
            moodys: "A1"
            sp: "A+"
            fitch: "A+"
          - lei: "8EE8DF3643E15DBFDA05"
            moodys: "A2"
            sp: "A"
            fitch: "A"
          - lei: "784F5XWPLTWKTBV3E584"
            moodys: "A1"
            sp: "A+"
            fitch: "A"
    field-mappings:
      - source-field: "moodys"
        target-field: "creditRating.moodys"
```

```yaml
      - source-field: "sp"
        target-field: "creditRating.sp"
      - source-field: "fitch"
        target-field: "creditRating.fitch"

  - id: "counterparty-classification"
    type: "lookup-enrichment"
    condition: "#data.counterpartyId != null && #data.counterpartyId.lei != null"
    lookup-config:
      lookup-key: "counterpartyId.lei"
      lookup-dataset:
        type: "inline"
        key-field: "lei"
        data:
          - lei: "7LTWFZYICNSX8D621K86"
            entityType: "BANK"
            businessModel: "UNIVERSAL_BANK"
            regulatoryStatus: "SYSTEMICALLY_IMPORTANT"
          - lei: "8EE8DF3643E15DBFDA05"
            entityType: "BANK"
            businessModel: "COMMERCIAL_BANK"
            regulatoryStatus: "SYSTEMICALLY_IMPORTANT"
          - lei: "784F5XWPLTWKTBV3E584"
            entityType: "INVESTMENT_BANK"
            businessModel: "INVESTMENT_BANK"
            regulatoryStatus: "SYSTEMICALLY_IMPORTANT"
    field-mappings:
      - source-field: "entityType"
        target-field: "classification.entityType"
      - source-field: "businessModel"
        target-field: "classification.businessModel"
      - source-field: "regulatoryStatus"
        target-field: "classification.regulatoryStatus"

  - id: "relationship-tier-enrichment"
    type: "lookup-enrichment"
    condition: "#data.accountInfo != null && #data.accountInfo.accountNumber != null"
    lookup-config:
      lookup-key: "accountInfo.accountNumber"
      lookup-dataset:
        type: "inline"
        key-field: "accountNumber"
        data:
          - accountNumber: "DB-PB-001234"
            tier: "TIER_1"
            status: "PREFERRED"
            creditLimit: 1000000000
          - accountNumber: "JPM-PB-005678"
            tier: "TIER_1"
            status: "PREFERRED"
            creditLimit: 750000000
          - accountNumber: "GS-PB-009876"
            tier: "TIER_2"
            status: "STANDARD"
            creditLimit: 500000000
    field-mappings:
      - source-field: "tier"
        target-field: "relationship.tier"
      - source-field: "status"
        target-field: "relationship.status"
      - source-field: "creditLimit"
        target-field: "relationship.creditLimit"

  - id: "netting-agreement-status"
    type: "lookup-enrichment"
    condition: "#data.counterpartyId != null && #data.counterpartyId.lei != null"
```

```yaml
    lookup-config:
      lookup-key: "counterpartyId.lei"
      lookup-dataset:
        type: "inline"
        key-field: "lei"
        data:
          - lei: "7LTWFZYICNSX8D621K86"
            isdaMasterAgreement: true
            nettingEligible: true
            csaAgreement: true
          - lei: "8EE8DF3643E15DBFDA05"
            isdaMasterAgreement: true
            nettingEligible: true
            csaAgreement: true
          - lei: "784F5XWPLTWKTBV3E584"
            isdaMasterAgreement: true
            nettingEligible: true
            csaAgreement: false
    field-mappings:
      - source-field: "isdaMasterAgreement"
        target-field: "legalAgreements.isdaMasterAgreement"
      - source-field: "nettingEligible"
        target-field: "legalAgreements.nettingEligible"
      - source-field: "csaAgreement"
        target-field: "legalAgreements.csaAgreement"

  - id: "clearing-house-contribution"
    type: "lookup-enrichment"
    condition: "#data.counterpartyId != null && #data.counterpartyId.lei != null"
    lookup-config:
      lookup-key: "counterpartyId.lei"
      lookup-dataset:
        type: "inline"
        key-field: "lei"
        data:
          - lei: "7LTWFZYICNSX8D621K86"
            lchContribution: 50000000
            cmeContribution: 25000000
            membershipStatus: "CLEARING_MEMBER"
            defaultFundTier: "TIER_1"
          - lei: "8EE8DF3643E15DBFDA05"
            lchContribution: 75000000
            cmeContribution: 40000000
            membershipStatus: "CLEARING_MEMBER"
            defaultFundTier: "TIER_1"
          - lei: "784F5XWPLTWKTBV3E584"
            lchContribution: 45000000
            cmeContribution: 30000000
            membershipStatus: "CLEARING_MEMBER"
            defaultFundTier: "TIER_2"
          - lei: "549300E9W2RQMQRQZ748"
            lchContribution: 0
            cmeContribution: 0
            membershipStatus: "NON_CLEARING_MEMBER"
            defaultFundTier: "NOT_APPLICABLE"
          - lei: "5493000F4ZG1KEXQJL62"
            lchContribution: 15000000
            cmeContribution: 8000000
            membershipStatus: "CLIENT"
            defaultFundTier: "TIER_3"
    field-mappings:
      - source-field: "lchContribution"
        target-field: "clearingHouse.lchContribution"
      - source-field: "cmeContribution"
        target-field: "clearingHouse.cmeContribution"
      - source-field: "membershipStatus"
```

```yaml
        target-field: "clearingHouse.membershipStatus"
      - source-field: "defaultFundTier"
        target-field: "clearingHouse.defaultFundTier"

# Additional Counterparty Enrichment Examples

  - id: "client-onboarding-status"
    type: "lookup-enrichment"
    condition: "#data.accountInfo != null && #data.accountInfo.accountNumber != null"
    lookup-config:
      lookup-key: "accountInfo.accountNumber"
      lookup-dataset:
        type: "inline"
        key-field: "accountNumber"
        data:
          - accountNumber: "DB-PB-001234"
            onboardingDate: "2020-03-15"
            kycStatus: "VERIFIED"
            amlStatus: "CLEARED"
            lastReviewDate: "2024-03-15"
            nextReviewDate: "2025-03-15"
            documentationComplete: true
          - accountNumber: "BR-ICS-567890"
            onboardingDate: "2019-08-22"
            kycStatus: "VERIFIED"
            amlStatus: "CLEARED"
            lastReviewDate: "2024-08-22"
            nextReviewDate: "2025-08-22"
            documentationComplete: true
          - accountNumber: "BW-TO-123456"
            onboardingDate: "2021-11-10"
            kycStatus: "VERIFIED"
            amlStatus: "UNDER_REVIEW"
            lastReviewDate: "2024-11-10"
            nextReviewDate: "2025-11-10"
            documentationComplete: false
    field-mappings:
      - source-field: "onboardingDate"
        target-field: "compliance.onboardingDate"
      - source-field: "kycStatus"
        target-field: "compliance.kycStatus"
      - source-field: "amlStatus"
        target-field: "compliance.amlStatus"
      - source-field: "documentationComplete"
        target-field: "compliance.documentationComplete"

  - id: "counterparty-risk-limits"
    type: "calculation-enrichment"
    condition: "#data.riskProfile != null && #data.riskProfile.aum != null"
    calculations:
      - field: "riskLimits.maxSingleTradeLimit"
        expression: "#riskProfile.aum * 0.001"  # 0.1% of AUM
      - field: "riskLimits.dailyTradingLimit"
        expression: "#riskProfile.aum * 0.01"   # 1% of AUM
      - field: "riskLimits.concentrationLimit"
        expression: "#riskProfile.aum * 0.05"   # 5% of AUM
      - field: "riskLimits.leverageLimit"
        expression: "#riskProfile.leverageRatio != null ? #riskProfile.leverageRatio : 1.0"
```

3. Regulatory Enrichment

Regulatory enrichment ensures compliance with financial regulations by adding required reporting fields, identifiers, and flags for various jurisdictions including MiFID II, EMIR, and Dodd-Frank.

Example Source XML (Regulatory Trade Report)

```xml
<regulatoryReport xmlns="http://www.esma.europa.eu/emir">
  <reportHeader>
    <reportingEntity>
      <lei>7LTWFZYICNSX8D621K86</lei>
      <jurisdiction>EU</jurisdiction>
    </reportingEntity>
    <reportingTimestamp>2024-12-24T10:30:00Z</reportingTimestamp>
  </reportHeader>
  <transactionDetails>
    <transactionId>TXN-20241224-001</transactionId>
    <executionTimestamp>2024-12-24T10:15:00Z</executionTimestamp>
    <productType>EQUITY</productType>
    <underlyingInstrument>
      <isin>GB00B03MLX29</isin>
      <name>Royal Dutch Shell PLC</name>
    </underlyingInstrument>
    <counterparty>
      <lei>8EE8DF3643E15DBFDA05</lei>
      <jurisdiction>US</jurisdiction>
    </counterparty>
    <tradingVenue>XLON</tradingVenue>
    <notionalAmount currency="GBP">27505000</notionalAmount>
  </transactionDetails>
</regulatoryReport>
```

Additional Regulatory Examples

Example 2: MiFID II Transaction Report

```xml
<mifidReport xmlns="http://www.esma.europa.eu/mifid">
  <reportHeader>
    <reportingEntity>
      <lei>G5GSEF7VJP5I7OUK5573</lei>
      <jurisdiction>GB</jurisdiction>
      <reportingFirm>Barclays Bank PLC</reportingFirm>
    </reportingEntity>
    <reportingTimestamp>2024-12-24T11:45:00Z</reportingTimestamp>
  </reportHeader>
  <transactionDetails>
    <transactionId>MIFID-20241224-002</transactionId>
    <executionTimestamp>2024-12-24T11:30:00Z</executionTimestamp>
    <productType>DERIVATIVE</productType>
    <underlyingInstrument>
      <isin>DE0001102309</isin>
      <name>German Government Bond 10Y</name>
    </underlyingInstrument>
    <counterparty>
      <lei>549300E9W2RQMQRQZ748</lei>
      <jurisdiction>US</jurisdiction>
      <counterpartyType>PROFESSIONAL_CLIENT</counterpartyType>
    </counterparty>
    <tradingVenue>OTC</tradingVenue>
    <notionalAmount currency="EUR">100000000</notionalAmount>
    <transmissionFlag>true</transmissionFlag>
    <commodityDerivativeIndicator>false</commodityDerivativeIndicator>
  </transactionDetails>
```

```xml
</mifidReport>
```

Example 3: Dodd-Frank Swap Report

```xml
<doddFrankReport xmlns="http://www.cftc.gov/swaps">
  <reportHeader>
    <reportingEntity>
      <lei>8EE8DF3643E15DBFDA05</lei>
      <jurisdiction>US</jurisdiction>
      <reportingFirm>JPMorgan Chase Bank NA</reportingFirm>
    </reportingEntity>
    <reportingTimestamp>2024-12-24T14:20:00Z</reportingTimestamp>
  </reportHeader>
  <swapDetails>
    <uniqueSwapIdentifier>USI-JPMC-20241224-003</uniqueSwapIdentifier>
    <executionTimestamp>2024-12-24T14:00:00Z</executionTimestamp>
    <assetClass>INTEREST_RATE</assetClass>
    <productType>VANILLA_SWAP</productType>
    <underlyingAsset>
      <referenceRate>USD-SOFR</referenceRate>
      <tenor>5Y</tenor>
    </underlyingAsset>
    <counterparty>
      <lei>784F5XWPLTWKTBV3E584</lei>
      <jurisdiction>US</jurisdiction>
      <counterpartyType>SWAP_DEALER</counterpartyType>
    </counterparty>
    <executionVenue>SEF</executionVenue>
    <notionalAmount currency="USD">250000000</notionalAmount>
    <clearingIndicator>true</clearingIndicator>
    <clearingHouse>CME_CLEARING</clearingHouse>
  </swapDetails>
</doddFrankReport>
```

YAML Enrichment Rules

```yaml
metadata:
  name: "Regulatory Enrichment"
  description: "Add regulatory reporting fields and compliance flags"
  version: "1.0.0"
  type: "rule-config"

enrichments:
  - id: "regulatory-jurisdiction-flags"
    type: "calculation-enrichment"
    condition: "#data.reportHeader != null && #data.reportHeader.reportingEntity != null && #data.reportHeader.reportingE
    calculations:
      - field: "regulatory.mifidII.applicable"
        expression: "#reportHeader.reportingEntity.jurisdiction == 'EU'"
      - field: "regulatory.emir.applicable"
        expression: "#reportHeader.reportingEntity.jurisdiction == 'EU'"
      - field: "regulatory.doddFrank.applicable"
        expression: "#counterparty != null && #counterparty.jurisdiction == 'US'"
      - field: "regulatory.mifidII.venueReporting"
        expression: "#tradingVenue == 'XLON' || #tradingVenue == 'XPAR'"

  - id: "uti-generation"
    type: "calculation-enrichment"
    condition: "#data.transactionDetails != null && #data.transactionDetails.transactionId != null && #data.reportHeader
    calculations:
```

```yaml
      - field: "regulatory.uti"
        expression: "#reportHeader.reportingEntity.lei + '-' + #transactionDetails.transactionId + '-' + T(java.time.Loca
      - field: "regulatory.utiPrefix"
        expression: "#reportHeader.reportingEntity.lei"
      - field: "regulatory.utiGenerationTimestamp"
        expression: "T(java.time.Instant).now().toString()"

  - id: "upi-assignment"
    type: "lookup-enrichment"
    condition: "#data.transactionDetails != null && #data.transactionDetails.productType != null && #data.underlyingInstr
    lookup-config:
      lookup-key: "#transactionDetails.productType + '_' + #underlyingInstrument.isin"
      lookup-dataset:
        type: "inline"
        key-field: "key"
        data:
          - key: "EQUITY_GB00B03MLX29"
            upi: "EQ000000000000000001"
            productClassification: "EQUITY_SINGLE_NAME"
          - key: "EQUITY_US0378331005"
            upi: "EQ000000000000000002"
            productClassification: "EQUITY_SINGLE_NAME"
          - key: "BOND_US912828XG93"
            upi: "BD000000000000000001"
            productClassification: "FIXED_INCOME_GOVERNMENT"
    field-mappings:
      - source-field: "upi"
        target-field: "regulatory.upi"
      - source-field: "productClassification"
        target-field: "regulatory.productClassification"

  - id: "mifid-ii-fields"
    type: "calculation-enrichment"
    condition: "#data.regulatory != null && #data.regulatory.mifidII != null && #data.regulatory.mifidII.applicable == tr
    calculations:
      - field: "regulatory.mifidII.transactionReferenceNumber"
        expression: "T(java.util.UUID).randomUUID().toString()"

  - id: "mifid-venue-classification"
    type: "lookup-enrichment"
    condition: "#data.regulatory != null && #data.regulatory.mifidII != null && #data.regulatory.mifidII.applicable == tr
    lookup-config:
      lookup-key: "tradingVenue"
      lookup-dataset:
        type: "inline"
        key-field: "venue"
        data:
          - venue: "XLON"
            venueType: "REGULATED_MARKET"
            liquidityProvision: true
          - venue: "XPAR"
            venueType: "REGULATED_MARKET"
            liquidityProvision: true
          - venue: "BATS"
            venueType: "MULTILATERAL_TRADING_FACILITY"
            liquidityProvision: false
    field-mappings:
      - source-field: "venueType"
        target-field: "regulatory.mifidII.venueType"
      - source-field: "liquidityProvision"
        target-field: "regulatory.mifidII.liquidityProvision"

  - id: "emir-fields"
    type: "calculation-enrichment"
    condition: "#data.regulatory != null && #data.regulatory.emir != null && #data.regulatory.emir.applicable == true"
    calculations:
```

```yaml
      - field: "regulatory.emir.reportingObligation"
        expression: "'BOTH_COUNTERPARTIES'"
      - field: "regulatory.emir.clearingObligation"
        expression: "#notionalAmount != null && #notionalAmount.value > 1000000"
      - field: "regulatory.emir.clearingThreshold"
        expression: "#notionalAmount != null && #notionalAmount.value > 1000000 ? 'ABOVE_THRESHOLD' : 'BELOW_THRESHOLD'"

  - id: "legal-documentation-status"
    type: "lookup-enrichment"
    condition: "#data.counterparty != null && #data.counterparty.lei != null && #data.reportHeader != null"
    lookup-config:
      lookup-key: "#reportHeader.reportingEntity.lei + '_' + #counterparty.lei"
      lookup-dataset:
        type: "inline"
        key-field: "key"
        data:
          - key: "7LTWFZYICNSX8D621K86_8EE8DF3643E15DBFDA05"
            masterAgreementType: "ISDA_MASTER_AGREEMENT"
            masterAgreementVersion: "2002"
            csaInPlace: true
            csaThreshold: 50000000
            minimumTransferAmount: 1000000
          - key: "7LTWFZYICNSX8D621K86_784F5XWPLTWKTBV3E584"
            masterAgreementType: "ISDA_MASTER_AGREEMENT"
            masterAgreementVersion: "2002"
            csaInPlace: true
            csaThreshold: 25000000
            minimumTransferAmount: 500000
          - key: "G5GSEF7VJP5I7OUK5573_549300E9W2RQMQRQZ748"
            masterAgreementType: "ISDA_MASTER_AGREEMENT"
            masterAgreementVersion: "2002"
            csaInPlace: false
            csaThreshold: 0
            minimumTransferAmount: 0
          - key: "8EE8DF3643E15DBFDA05_784F5XWPLTWKTBV3E584"
            masterAgreementType: "ISDA_MASTER_AGREEMENT"
            masterAgreementVersion: "2002"
            csaInPlace: true
            csaThreshold: 100000000
            minimumTransferAmount: 2000000
    field-mappings:
      - source-field: "masterAgreementType"
        target-field: "legalDocumentation.masterAgreementType"
      - source-field: "masterAgreementVersion"
        target-field: "legalDocumentation.masterAgreementVersion"
      - source-field: "csaInPlace"
        target-field: "legalDocumentation.csaInPlace"
      - source-field: "csaThreshold"
        target-field: "legalDocumentation.csaThreshold"
      - source-field: "minimumTransferAmount"
        target-field: "legalDocumentation.minimumTransferAmount"

# Additional Regulatory Enrichment Examples

  - id: "mifid-specific-fields"
    type: "calculation-enrichment"
    condition: "#data.reportHeader != null && #data.reportHeader.reportingEntity.jurisdiction == 'GB' && #data.transactio
    calculations:
      - field: "regulatory.mifidII.transactionReferenceNumber"
        expression: "T(java.util.UUID).randomUUID().toString()"
      - field: "regulatory.mifidII.reportingFlag"
        expression: "#transactionDetails.transmissionFlag != null ? #transactionDetails.transmissionFlag : false"
      - field: "regulatory.mifidII.commodityDerivativeIndicator"
        expression: "#transactionDetails.commodityDerivativeIndicator != null ? #transactionDetails.commodityDerivativeIn
      - field: "regulatory.mifidII.clientType"
        expression: "#counterparty.counterpartyType != null ? #counterparty.counterpartyType : 'UNKNOWN'"
```

```yaml
  - id: "dodd-frank-fields"
    type: "calculation-enrichment"
    condition: "#data.reportHeader != null && #data.reportHeader.reportingEntity.jurisdiction == 'US' && #data.swapDetail
    calculations:
      - field: "regulatory.doddFrank.uniqueSwapIdentifier"
        expression: "#swapDetails.uniqueSwapIdentifier"
      - field: "regulatory.doddFrank.clearingIndicator"
        expression: "#swapDetails.clearingIndicator != null ? #swapDetails.clearingIndicator : false"
      - field: "regulatory.doddFrank.clearingHouse"
        expression: "#swapDetails.clearingHouse != null ? #swapDetails.clearingHouse : 'NOT_CLEARED'"
      - field: "regulatory.doddFrank.executionVenue"
        expression: "#swapDetails.executionVenue != null ? #swapDetails.executionVenue : 'OFF_FACILITY'"
      - field: "regulatory.doddFrank.assetClass"
        expression: "#swapDetails.assetClass"

  - id: "regulatory-threshold-check"
    type: "calculation-enrichment"
    condition: "#data.notionalAmount != null || #data.transactionDetails.notionalAmount != null || #data.swapDetails.noti
    calculations:
      - field: "regulatory.thresholds.emirThreshold"
        expression: "(#notionalAmount != null ? #notionalAmount : (#transactionDetails != null && #transactionDetails.not
      - field: "regulatory.thresholds.mifidThreshold"
        expression: "(#notionalAmount != null ? #notionalAmount : (#transactionDetails != null && #transactionDetails.not
      - field: "regulatory.thresholds.doddFrankThreshold"
        expression: "(#notionalAmount != null ? #notionalAmount : (#transactionDetails != null && #transactionDetails.not
```

4. Risk Enrichment

Risk enrichment adds critical risk metrics, exposure calculations, and margin requirements essential for risk management and regulatory capital calculations.

Example Source XML (Risk Data)

```xml
<riskData xmlns="http://www.isda.org/risk">
  <portfolio>
    <portfolioId>PF-EQUITY-001</portfolioId>
    <counterparty>
      <lei>7LTWFZYICNSX8D621K86</lei>
      <name>Deutsche Bank AG</name>
    </counterparty>
    <asOfDate>2024-12-24</asOfDate>
  </portfolio>
  <positions>
    <position>
      <instrumentId>GB00B03MLX29</instrumentId>
      <quantity>10000</quantity>
      <marketValue currency="GBP">27505000</marketValue>
      <unrealizedPnL currency="GBP">125000</unrealizedPnL>
    </position>
  </positions>
  <riskMetrics>
    <baseDate>2024-12-24</baseDate>
    <currency>GBP</currency>
  </riskMetrics>
</riskData>
```

Additional Risk Data Examples

Example 2: Multi-Asset Portfolio Risk


```xml
<riskData xmlns="http://www.isda.org/risk">
  <portfolio>
    <portfolioId>PF-MULTI-002</portfolioId>
    <counterparty>
      <lei>549300E9W2RQMQRQZ748</lei>
      <name>BlackRock Fund Advisors</name>
    </counterparty>
    <asOfDate>2024-12-24</asOfDate>
  </portfolio>
  <positions>
    <position>
      <instrumentId>US0378331005</instrumentId>
      <instrumentType>EQUITY</instrumentType>
      <quantity>50000</quantity>
      <marketValue currency="USD">9500000</marketValue>
      <unrealizedPnL currency="USD">-75000</unrealizedPnL>
      <beta>1.2</beta>
    </position>
    <position>
      <instrumentId>US912828XG93</instrumentId>
      <instrumentType>GOVERNMENT_BOND</instrumentType>
      <quantity>10000000</quantity>
      <marketValue currency="USD">9875000</marketValue>
      <unrealizedPnL currency="USD">25000</unrealizedPnL>
      <duration>8.5</duration>
      <convexity>0.85</convexity>
    </position>
    <position>
      <instrumentId>SWAP-USD-SOFR-5Y</instrumentId>
      <instrumentType>INTEREST_RATE_SWAP</instrumentType>
      <notionalAmount currency="USD">100000000</notionalAmount>
      <marketValue currency="USD">-250000</marketValue>
      <unrealizedPnL currency="USD">-250000</unrealizedPnL>
      <dv01>8500</dv01>
    </position>
  </positions>
  <riskMetrics>
    <baseDate>2024-12-24</baseDate>
    <currency>USD</currency>
    <portfolioValue>19125000</portfolioValue>
  </riskMetrics>
</riskData>
```


Example 3: Derivatives Portfolio Risk


```xml
<riskData xmlns="http://www.isda.org/risk">
  <portfolio>
    <portfolioId>PF-DERIV-003</portfolioId>
    <counterparty>
      <lei>5493000F4ZG1KEXQJL62</lei>
      <name>Bridgewater Associates LP</name>
    </counterparty>
    <asOfDate>2024-12-24</asOfDate>
  </portfolio>
  <positions>
    <position>
      <instrumentId>CDS-ITRAXX-MAIN-S40</instrumentId>
      <instrumentType>CREDIT_DEFAULT_SWAP</instrumentType>
      <notionalAmount currency="EUR">50000000</notionalAmount>
      <marketValue currency="EUR">-125000</marketValue>
```

```xml
      <unrealizedPnL currency="EUR">-125000</unrealizedPnL>
      <cs01>2500</cs01>
      <creditSpread>85</creditSpread>
    </position>
    <position>
      <instrumentId>FX-FORWARD-EURUSD-3M</instrumentId>
      <instrumentType>FX_FORWARD</instrumentType>
      <notionalAmount currency="EUR">25000000</notionalAmount>
      <marketValue currency="EUR">75000</marketValue>
      <unrealizedPnL currency="EUR">75000</unrealizedPnL>
      <delta>1.0</delta>
      <gamma>0.0</gamma>
    </position>
  </positions>
  <riskMetrics>
    <baseDate>2024-12-24</baseDate>
    <currency>EUR</currency>
    <portfolioValue>-50000</portfolioValue>
  </riskMetrics>
</riskData>
```

YAML Enrichment Rules

```yaml
name: "Risk Enrichment"
description: "Add risk metrics, exposure calculations, and margin requirements"
version: "1.0"

rules:
  - id: "var-calculation"
    type: "calculation-enrichment"
    condition: "#data.positions != null && #data.positions.position != null && #data.positions.position.marketValue != nu
    calculations:
      - field: "riskMetrics.var1Day99"
        expression: "#positions.position.marketValue * 0.025"
      - field: "riskMetrics.var10Day99"
        expression: "#riskMetrics.var1Day99 * T(java.lang.Math).sqrt(10)"

  - id: "volatility-lookup"
    type: "lookup-enrichment"
    condition: "#data.positions != null && #data.positions.position != null && #data.positions.position.instrumentId != n
    lookup-config:
      lookup-key: "positions.position.instrumentId"
      lookup-dataset:
        type: "inline"
        key-field: "instrumentId"
        data:
          - instrumentId: "GB00B03MLX29"
            impliedVolatility: 0.28
            historicalVolatility: 0.25
          - instrumentId: "US0378331005"
            impliedVolatility: 0.32
            historicalVolatility: 0.30
          - instrumentId: "DE0007164600"
            impliedVolatility: 0.35
            historicalVolatility: 0.33
    field-mappings:
      - source-field: "impliedVolatility"
        target-field: "riskMetrics.impliedVolatility"
      - source-field: "historicalVolatility"
        target-field: "riskMetrics.historicalVolatility"

  - id: "counterparty-exposure-calculation"
    type: "calculation-enrichment"
```

```yaml
    condition: "#data.counterparty != null && #data.counterparty.lei != null && #data.positions != null"
    calculations:
      - field: "exposure.grossExposure"
        expression: "#positions.position.marketValue"
      - field: "exposure.netExposure"
        expression: "#exposure.grossExposure - (#collateral != null && #collateral.heldAmount != null ? #collateral.heldA

  - id: "credit-limits-lookup"
    type: "lookup-enrichment"
    condition: "#data.counterparty != null && #data.counterparty.lei != null"
    lookup-config:
      lookup-key: "counterparty.lei"
      lookup-dataset:
        type: "inline"
        key-field: "lei"
        data:
          - lei: "7LTWFZYICNSX8D621K86"
            creditLimit: 1000000000
          - lei: "8EE8DF3643E15DBFDA05"
            creditLimit: 750000000
          - lei: "784F5XWPLTWKTBV3E584"
            creditLimit: 500000000
    field-mappings:
      - source-field: "creditLimit"
        target-field: "exposure.creditLimit"

  - id: "utilization-ratio-calculation"
    type: "calculation-enrichment"
    condition: "#data.exposure != null && #data.exposure.netExposure != null && #data.exposure.creditLimit != null && #da
    calculations:
      - field: "exposure.utilizationRatio"
        expression: "#exposure.netExposure / #exposure.creditLimit"

  - id: "margin-parameters-lookup"
    type: "lookup-enrichment"
    condition: "#data.positions != null && #data.positions.position != null && #data.positions.position.instrumentId != n
    lookup-config:
      lookup-key: "positions.position.instrumentId"
      lookup-dataset:
        type: "inline"
        key-field: "instrumentId"
        data:
          - instrumentId: "GB00B03MLX29"
            initialMarginRate: 0.15
          - instrumentId: "US0378331005"
            initialMarginRate: 0.12
          - instrumentId: "DE0007164600"
            initialMarginRate: 0.18
    field-mappings:
      - source-field: "initialMarginRate"
        target-field: "margin.initialMarginRate"

  - id: "margin-calculation"
    type: "calculation-enrichment"
    condition: "#data.positions != null && #data.positions.position != null && #data.margin != null && #data.margin.initi
    calculations:
      - field: "margin.initialMarginAmount"
        expression: "#positions.position.marketValue * #margin.initialMarginRate"
      - field: "margin.variationMargin"
        expression: "#positions.position.unrealizedPnL != null ? #positions.position.unrealizedPnL : 0"
      - field: "margin.variationMarginDirection"
        expression: "#margin.variationMargin > 0 ? 'RECEIVABLE' : 'PAYABLE'"

  - id: "collateral-eligibility-lookup"
    type: "lookup-enrichment"
    condition: "#data.positions != null && #data.positions.position != null && #data.positions.position.instrumentId != n
```

```yaml
    lookup-config:
      lookup-key: "positions.position.instrumentId"
      lookup-dataset:
        type: "inline"
        key-field: "instrumentId"
        data:
          - instrumentId: "GB00B03MLX29"
            eligible: true
            haircut: 0.08
            rating: "A+"
          - instrumentId: "US0378331005"
            eligible: true
            haircut: 0.06
            rating: "AA"
          - instrumentId: "DE0007164600"
            eligible: true
            haircut: 0.10
            rating: "A"
          - instrumentId: "JUNK_BOND_001"
            eligible: false
            haircut: 0.50
            rating: "CCC"
    field-mappings:
      - source-field: "eligible"
        target-field: "collateral.eligible"
      - source-field: "haircut"
        target-field: "collateral.haircut"
      - source-field: "rating"
        target-field: "collateral.rating"

  - id: "collateral-amount-calculation"
    type: "calculation-enrichment"
    condition: "#data.collateral != null && #data.collateral.haircut != null && #data.positions != null"
    calculations:
      - field: "collateral.eligibleAmount"
        expression: "#positions.position.marketValue * (1 - #collateral.haircut)"

  - id: "stress-test-calculations"
    type: "calculation-enrichment"
    condition: "#data.positions != null && #data.positions.position != null && #data.positions.position.marketValue != nu
    calculations:
      - field: "stressTest.marketCrash.scenario"
        expression: "#positions.position.marketValue * -0.30"
      - field: "stressTest.volatilityShock.scenario"
        expression: "#riskMetrics != null && #riskMetrics.var1Day99 != null ? #riskMetrics.var1Day99 * 2.5 : 0"
      - field: "stressTest.creditSpreadWidening.scenario"
        expression: "#positions.position.marketValue * -0.05"
      - field: "stressTest.riskLevel"
        expression: "#stressTest.marketCrash.scenario < -50000000 ? 'HIGH' : (#stressTest.marketCrash.scenario < -1000000
      - field: "stressTest.actionRequired"
        expression: "#stressTest.riskLevel == 'HIGH' ? 'IMMEDIATE_REVIEW' : (#stressTest.riskLevel == 'MEDIUM' ? 'MONITOR

# Additional Risk Enrichment Examples

  - id: "multi-asset-risk-calculations"
    type: "calculation-enrichment"
    condition: "#data.positions != null && #data.positions.position != null"
    calculations:
      - field: "riskMetrics.equityDelta"
        expression: "#positions.position.instrumentType == 'EQUITY' && #positions.position.beta != null ? #positions.posi
      - field: "riskMetrics.interestRateDV01"
        expression: "#positions.position.instrumentType == 'GOVERNMENT_BOND' && #positions.position.duration != null ? #p
      - field: "riskMetrics.creditCS01"
        expression: "#positions.position.instrumentType == 'CREDIT_DEFAULT_SWAP' && #positions.position.cs01 != null ? #p
      - field: "riskMetrics.fxDelta"
        expression: "#positions.position.instrumentType == 'FX_FORWARD' && #positions.position.delta != null ? #positions
```

```yaml
- id: "portfolio-level-risk-aggregation"
  type: "calculation-enrichment"
  condition: "#data.riskMetrics != null && #data.riskMetrics.portfolioValue != null"
  calculations:
    - field: "portfolioRisk.totalVar1Day"
      expression: "#riskMetrics.portfolioValue * 0.02"  # 2% portfolio VaR
    - field: "portfolioRisk.leverageRatio"
      expression: "T(java.lang.Math).abs(#positions.position.notionalAmount != null ? #positions.position.notionalAmoun
    - field: "portfolioRisk.concentrationRisk"
      expression: "T(java.lang.Math).abs(#positions.position.marketValue) / T(java.lang.Math).abs(#riskMetrics.portfoli
    - field: "portfolioRisk.riskCategory"
      expression: "#portfolioRisk.leverageRatio > 5.0 ? 'HIGH_LEVERAGE' : (#portfolioRisk.concentrationRisk > 0.25 ? 'H

- id: "regulatory-capital-calculations"
  type: "calculation-enrichment"
  condition: "#data.positions != null && #data.positions.position != null && #data.positions.position.marketValue != nu
  calculations:
    - field: "regulatoryCapital.riskWeightedAssets"
      expression: "#positions.position.instrumentType == 'EQUITY' ? #positions.position.marketValue * 1.0 : (#positions
    - field: "regulatoryCapital.capitalRequirement"
      expression: "#regulatoryCapital.riskWeightedAssets * 0.08"  # 8% capital requirement
    - field: "regulatoryCapital.leverageExposure"
      expression: "T(java.lang.Math).abs(#positions.position.notionalAmount != null ? #positions.position.notionalAmoun
    - field: "regulatoryCapital.leverageRatio"
      expression: "#regulatoryCapital.leverageExposure / 1000000000"  # Assuming 1B capital base

- id: "counterparty-risk-metrics"
  type: "calculation-enrichment"
  condition: "#data.portfolio != null && #data.portfolio.counterparty != null && #data.positions != null"
  calculations:
    - field: "counterpartyRisk.currentExposure"
      expression: "T(java.lang.Math).max(#positions.position.marketValue, 0)"
    - field: "counterpartyRisk.potentialFutureExposure"
      expression: "#counterpartyRisk.currentExposure * 1.4"  # Add-on factor
    - field: "counterpartyRisk.exposureAtDefault"
      expression: "#counterpartyRisk.currentExposure + (#counterpartyRisk.potentialFutureExposure * 0.4)"
    - field: "counterpartyRisk.expectedLoss"
      expression: "#counterpartyRisk.exposureAtDefault * 0.45 * 0.02"  # LGD 45%, PD 2%

- id: "market-risk-sensitivities"
  type: "lookup-enrichment"
  condition: "#data.positions != null && #data.positions.position != null && #data.positions.position.instrumentId != n
  lookup-config:
    lookup-key: "positions.position.instrumentId"
    lookup-dataset:
      type: "inline"
      key-field: "instrumentId"
      data:
        - instrumentId: "GB00B03MLX29"
          equityVega: 0.15
          equityTheta: -0.02
          correlationFactor: 0.75
        - instrumentId: "US0378331005"
          equityVega: 0.18
          equityTheta: -0.01
          correlationFactor: 0.80
        - instrumentId: "US912828XG93"
          interestRateVega: 0.25
          convexity: 0.85
          correlationFactor: 0.95
        - instrumentId: "SWAP-USD-SOFR-5Y"
          interestRateVega: 0.30
          convexity: 1.20
          correlationFactor: 0.98
        - instrumentId: "CDS-ITRAXX-MAIN-S40"
```

```yaml
          creditVega: 0.12
          recoveryRate: 0.40
          correlationFactor: 0.65
    field-mappings:
      - source-field: "equityVega"
        target-field: "sensitivities.equityVega"
      - source-field: "interestRateVega"
        target-field: "sensitivities.interestRateVega"
      - source-field: "creditVega"
        target-field: "sensitivities.creditVega"
      - source-field: "correlationFactor"
        target-field: "sensitivities.correlationFactor"
```

```
## 5. Settlement Enrichment

Settlement enrichment adds critical settlement processing information including dates, methods, priorities, and custodian

### Example Source XML (Settlement Instruction)
```xml
<settlementInstruction xmlns="http://www.iso20022.org/settlement">
  <instructionId>SI-20241224-001</instructionId>
  <tradeDetails>
    <tradeId>TRD-001-2024</tradeId>
    <tradeDate>2024-12-24</tradeDate>
    <valueDate>2024-12-26</valueDate>
  </tradeDetails>
  <security>
    <isin>GB00B03MLX29</isin>
    <quantity>10000</quantity>
    <price>2750.50</price>
    <currency>GBP</currency>
  </security>
  <counterparties>
    <deliverer>
      <lei>7LTWFZYICNSX8D621K86</lei>
      <account>CREST001234</account>
    </deliverer>
    <receiver>
      <lei>8EE8DF3643E15DBFDA05</lei>
      <account>CREST005678</account>
    </receiver>
  </counterparties>
  <market>
    <mic>XLON</mic>
    <country>GB</country>
  </market>
</settlementInstruction>
```

YAML Enrichment Rules

```yaml
metadata:
  name: "Settlement Enrichment"
  description: "Add settlement processing information and routing details"
  version: "1.0.0"
  type: "rule-config"

enrichments:
  - id: "settlement-cycle-lookup"
```
```

```yaml
    type: "lookup-enrichment"
    condition: "#data.market != null && #data.market.country != null && #data.security != null"
    lookup-config:
      lookup-key: "#market.country + '_EQUITY'"
      lookup-dataset:
        type: "inline"
        key-field: "key"
        data:
          - key: "GB_EQUITY"
            cycle: "T+2"
            cycleDays: 2
          - key: "US_EQUITY"
            cycle: "T+1"
            cycleDays: 1
          - key: "DE_EQUITY"
            cycle: "T+2"
            cycleDays: 2
          - key: "GB_BOND"
            cycle: "T+1"
            cycleDays: 1
          - key: "US_BOND"
            cycle: "T+1"
            cycleDays: 1
    field-mappings:
      - source-field: "cycle"
        target-field: "settlement.cycle"
      - source-field: "cycleDays"
        target-field: "settlement.cycleDays"

  - id: "settlement-date-calculation"
    type: "calculation-enrichment"
    condition: "#data.tradeDetails != null && #data.tradeDetails.tradeDate != null && #data.settlement != null && #data.s
    calculations:
      - field: "settlement.settlementDate"
        expression: "#tradeDetails.tradeDate.plusDays(#settlement.cycleDays)"

  - id: "settlement-system-lookup"
    type: "lookup-enrichment"
    condition: "#data.market != null && #data.market.country != null && #data.security != null && #data.security.isin !=
    lookup-config:
      lookup-key: "#market.country + '_' + #security.isin.substring(0, 2)"
      lookup-dataset:
        type: "inline"
        key-field: "key"
        data:
          - key: "GB_GB"
            system: "CREST"
            method: "DVP"
            systemBIC: "CRSTGB22"
          - key: "US_US"
            system: "DTC"
            method: "DVP"
            systemBIC: "DTCYUS33"
          - key: "DE_DE"
            system: "CLEARSTREAM"
            method: "DVP"
            systemBIC: "DAKVDEFF"
          - key: "FR_FR"
            system: "EUROCLEAR_FRANCE"
            method: "DVP"
            systemBIC: "SICVFRPP"
    field-mappings:
      - source-field: "system"
        target-field: "settlement.system"
      - source-field: "method"
        target-field: "settlement.method"
```

```yaml
      - source-field: "systemBIC"
        target-field: "settlement.systemBIC"

  - id: "trade-value-calculation"
    type: "calculation-enrichment"
    condition: "#data.security != null && #data.security.quantity != null && #data.security.price != null"
    calculations:
      - field: "settlement.tradeValue"
        expression: "#security.quantity * #security.price"

  - id: "settlement-priority-assignment"
    type: "calculation-enrichment"
    condition: "#data.settlement != null && #data.settlement.tradeValue != null"
    calculations:
      - field: "settlement.priority"
        expression: "#settlement.tradeValue > 100000000 ? 'HIGH' : (#settlement.tradeValue > 10000000 ? 'MEDIUM' : 'NORMA
      - field: "settlement.priorityCode"
        expression: "#settlement.tradeValue > 100000000 ? 1 : (#settlement.tradeValue > 10000000 ? 2 : 3)"

  - id: "client-priority-lookup"
    type: "lookup-enrichment"
    condition: "#data.counterparties != null && #data.counterparties.deliverer != null && #data.counterparties.deliverer.
    lookup-config:
      lookup-key: "counterparties.deliverer.lei"
      lookup-dataset:
        type: "inline"
        key-field: "lei"
        data:
          - lei: "7LTWFZYICNSX8D621K86"
            clientPriority: "TIER_1"
          - lei: "8EE8DF3643E15DBFDA05"
            clientPriority: "TIER_1"
          - lei: "784F5XWPLTWKTBV3E584"
            clientPriority: "TIER_2"
    field-mappings:
      - source-field: "clientPriority"
        target-field: "settlement.clientPriority"

  - name: "Custodian_Information_Enrichment"
    description: "Add custodian and sub-custodian details"
    condition: "counterparties.deliverer.account != null"
    actions:
      - type: "lookup"
        source: "custodian_network"
        key: "counterparties.deliverer.account + '_' + market.country"
        targets:
          - field: "custodian.globalCustodian"
            mapping:
              "CREST001234_GB": "State Street Bank"
              "DTC567890_US": "Bank of New York Mellon"
              "CLEARSTREAM123_DE": "Deutsche Bank AG"
          - field: "custodian.globalCustodianBIC"
            mapping:
              "CREST001234_GB": "SSBTGB2L"
              "DTC567890_US": "IRVTUS3N"
              "CLEARSTREAM123_DE": "DEUTDEFF"
          - field: "custodian.subCustodian"
            mapping:
              "CREST001234_GB": "Euroclear UK & Ireland"
              "DTC567890_US": "The Depository Trust Company"
              "CLEARSTREAM123_DE": "Clearstream Banking AG"

  - name: "Depository_Information_Enrichment"
    description: "Add central securities depository information"
    condition: "settlement.system != null"
    actions:
```

```yaml
      - type: "lookup"
        source: "csd_directory"
        key: "settlement.system"
        targets:
          - field: "depository.csdName"
            mapping:
              "CREST": "Euroclear UK & Ireland Limited"
              "DTC": "The Depository Trust Company"
              "CLEARSTREAM": "Clearstream Banking AG"
              "EUROCLEAR_FRANCE": "Euroclear France"
          - field: "depository.csdLEI"
            mapping:
              "CREST": "213800WSGIIZCXF1P572"
              "DTC": "549300DT6TBKBACAQJ13"
              "CLEARSTREAM": "529900T8BM49AURSDO55"
              "EUROCLEAR_FRANCE": "969500UP76J52A9OXU27"
          - field: "depository.operatingHours"
            mapping:
              "CREST": "06:00-18:00 GMT"
              "DTC": "08:00-16:00 EST"
              "CLEARSTREAM": "07:00-18:00 CET"
              "EUROCLEAR_FRANCE": "07:00-18:00 CET"
          - field: "depository.cutoffTime"
            mapping:
              "CREST": "16:00 GMT"
              "DTC": "15:00 EST"
              "CLEARSTREAM": "17:00 CET"
              "EUROCLEAR_FRANCE": "17:00 CET"
```

6. Fee and Commission Enrichment

Fee and commission enrichment calculates and adds all applicable fees, taxes, and charges associated with trade execution and settlement.

Example Source XML (Fee Calculation Data)

```xml
&lt;feeCalculation xmlns="http://www.iso20022.org/fees"&gt;
  &lt;tradeReference&gt;
    &lt;tradeId&gt;TRD-001-2024&lt;/tradeId&gt;
    &lt;executionVenue&gt;XLON&lt;/executionVenue&gt;
    &lt;tradeValue currency="GBP"&gt;27505000&lt;/tradeValue&gt;
  &lt;/tradeReference&gt;
  &lt;participants&gt;
    &lt;executingBroker&gt;
      &lt;lei&gt;7LTWFZYICNSX8D621K86&lt;/lei&gt;
      &lt;membershipType&gt;FULL_MEMBER&lt;/membershipType&gt;
    &lt;/executingBroker&gt;
    &lt;clearingMember&gt;
      &lt;lei&gt;7LTWFZYICNSX8D621K86&lt;/lei&gt;
      &lt;clearingHouse&gt;LCH_LIMITED&lt;/clearingHouse&gt;
    &lt;/clearingMember&gt;
    &lt;custodian&gt;
      &lt;bic&gt;SSBTGB2L&lt;/bic&gt;
      &lt;serviceTier&gt;PREMIUM&lt;/serviceTier&gt;
    &lt;/custodian&gt;
  &lt;/participants&gt;
  &lt;instrument&gt;
    &lt;isin&gt;GB00B03MLX29&lt;/isin&gt;
    &lt;assetClass&gt;EQUITY&lt;/assetClass&gt;
```

```xml
    <jurisdiction>GB</jurisdiction>
  </instrument>
</feeCalculation>
```

YAML Enrichment Rules

```yaml
metadata:
  name: "Fee and Commission Enrichment"
  description: "Calculate and add all applicable fees, commissions, and taxes"
  version: "1.0.0"
  type: "rule-config"

enrichments:
  - id: "broker-commission-lookup"
    type: "lookup-enrichment"
    condition: "#data.tradeReference != null && #data.tradeReference.tradeValue != null && #data.executingBroker != null"
    lookup-config:
      lookup-key: "#executingBroker.lei + '_TIER_1'"  # Simplified for example
      lookup-dataset:
        type: "inline"
        key-field: "key"
        data:
          - key: "7LTWFZYICNSX8D621K86_TIER_1"
            brokerCommissionRate: 0.0008  # 8 bps
            minimumCommission: 25.00
            maximumCommission: 5000.00
          - key: "7LTWFZYICNSX8D621K86_TIER_2"
            brokerCommissionRate: 0.0012  # 12 bps
            minimumCommission: 25.00
            maximumCommission: 5000.00
          - key: "8EE8DF3643E15DBFDA05_TIER_1"
            brokerCommissionRate: 0.0010  # 10 bps
            minimumCommission: 50.00
            maximumCommission: 7500.00
          - key: "8EE8DF3643E15DBFDA05_TIER_2"
            brokerCommissionRate: 0.0015  # 15 bps
            minimumCommission: 50.00
            maximumCommission: 7500.00
    field-mappings:
      - source-field: "brokerCommissionRate"
        target-field: "fees.brokerCommissionRate"
      - source-field: "minimumCommission"
        target-field: "fees.minimumCommission"
      - source-field: "maximumCommission"
        target-field: "fees.maximumCommission"

  - id: "broker-commission-calculation"
    type: "calculation-enrichment"
    condition: "#data.fees != null && #data.fees.brokerCommissionRate != null && #data.tradeReference != null"
    calculations:
      - field: "fees.brokerCommissionBase"
        expression: "#tradeReference.tradeValue * #fees.brokerCommissionRate"
      - field: "fees.brokerCommission"
        expression: "T(java.lang.Math).max(T(java.lang.Math).min(#fees.brokerCommissionBase, #fees.maximumCommission), #f

  - name: "Exchange_Fee_Calculation"
    description: "Calculate exchange-specific trading fees"
    condition: "tradeReference.executionVenue != null"
    actions:
      - type: "lookup"
        source: "exchange_fee_schedule"
        key: "tradeReference.executionVenue + '_' + instrument.assetClass"
        targets:
```

```yaml
        - field: "fees.exchangeFeeRate"
          mapping:
            "XLON_EQUITY": "0.000045"  # 0.45 bps
            "XNYS_EQUITY": "0.000030"  # 0.30 bps
            "XNAS_EQUITY": "0.000025"  # 0.25 bps
        - field: "fees.exchangeMinimumFee"
          mapping:
            "XLON_EQUITY": "1.00"
            "XNYS_EQUITY": "0.50"
            "XNAS_EQUITY": "0.35"
    - type: "calculate"
      field: "fees.exchangeFee"
      formula: "max(tradeReference.tradeValue * fees.exchangeFeeRate, fees.exchangeMinimumFee)"

- name: "Clearing_Fee_Calculation"
  description: "Calculate clearing house fees"
  condition: "participants.clearingMember.clearingHouse != null"
  actions:
    - type: "lookup"
      source: "clearing_fee_schedule"
      key: "participants.clearingMember.clearingHouse + '_' + instrument.assetClass"
      targets:
        - field: "fees.clearingFeeRate"
          mapping:
            "LCH_LIMITED_EQUITY": "0.000020"  # 0.20 bps
            "CME_CLEARING_EQUITY": "0.000015"  # 0.15 bps
            "EUREX_CLEARING_EQUITY": "0.000025"  # 0.25 bps
    - type: "calculate"
      field: "fees.clearingFee"
      formula: "tradeReference.tradeValue * fees.clearingFeeRate"
    - type: "lookup"
      source: "clearing_member_discounts"
      key: "participants.clearingMember.lei"
      targets:
        - field: "fees.clearingDiscount"
          mapping:
            "7LTWFZYICNSX8D621K86": "0.10"  # 10% discount
            "8EE8DF3643E15DBFDA05": "0.15"  # 15% discount
            "784F5XWPLTWKTBV3E584": "0.05"  # 5% discount
    - type: "calculate"
      field: "fees.clearingFeeNet"
      formula: "fees.clearingFee * (1 - fees.clearingDiscount)"

- name: "Custody_Fee_Calculation"
  description: "Calculate custody and settlement fees"
  condition: "participants.custodian.bic != null"
  actions:
    - type: "lookup"
      source: "custody_fee_schedule"
      key: "participants.custodian.bic + '_' + participants.custodian.serviceTier"
      targets:
        - field: "fees.custodyFeeRate"
          mapping:
            "SSBTGB2L_PREMIUM": "0.000010"  # 0.10 bps
            "SSBTGB2L_STANDARD": "0.000015"  # 0.15 bps
            "IRVTUS3N_PREMIUM": "0.000008"  # 0.08 bps
            "IRVTUS3N_STANDARD": "0.000012"  # 0.12 bps
    - type: "calculate"
      field: "fees.custodyFee"
      formula: "tradeReference.tradeValue * fees.custodyFeeRate"
    - type: "set"
      field: "fees.settlementFee"
      value: "5.00"  # Flat settlement fee

- name: "Transaction_Tax_Calculation"
  description: "Calculate applicable transaction taxes"
```

```yaml
    condition: "instrument.jurisdiction != null"
    actions:
      - type: "lookup"
        source: "transaction_tax_rates"
        key: "instrument.jurisdiction + '_' + instrument.assetClass"
        targets:
          - field: "taxes.stampDutyRate"
            mapping:
              "GB_EQUITY": "0.005"  # 0.5% UK stamp duty
              "FR_EQUITY": "0.003"  # 0.3% French FTT
              "DE_EQUITY": "0.000"  # No transaction tax
              "US_EQUITY": "0.000"  # No federal transaction tax
      - type: "conditional"
        conditions:
          - if: "taxes.stampDutyRate > 0"
            then:
              - calculate:
                  field: "taxes.transactionTax"
                  formula: "tradeReference.tradeValue * taxes.stampDutyRate"
              - set_field: "taxes.taxType"
                value: "STAMP_DUTY"
          - else:
              - set_field: "taxes.transactionTax"
                value: "0"
              - set_field: "taxes.taxType"
                value: "NONE"

  - name: "Total_Fee_Summary"
    description: "Calculate total fees and charges"
    condition: "fees.brokerCommission != null"
    actions:
      - type: "calculate"
        field: "fees.totalFees"
        formula: "fees.brokerCommission + fees.exchangeFee + fees.clearingFeeNet + fees.custodyFee + fees.settlementFee"
      - type: "calculate"
        field: "fees.totalCharges"
        formula: "fees.totalFees + taxes.transactionTax"
      - type: "calculate"
        field: "fees.netSettlementAmount"
        formula: "tradeReference.tradeValue + fees.totalCharges"
      - type: "calculate"
        field: "fees.feeAsPercentage"
        formula: "(fees.totalCharges / tradeReference.tradeValue) * 100"
```

7. Corporate Action Enrichment

Corporate action enrichment adds dividend, split, and other corporate event information that affects settlement processing.

Example YAML Rules (Corporate Actions)

```yaml
metadata:
  name: "Corporate Action Enrichment"
  version: "1.0.0"
  type: "rule-config"

enrichments:
  - id: "dividend-information"
    type: "lookup-enrichment"
    condition: "#data.security != null && #data.security.isin != null"
    lookup-config:
```

```yaml
      lookup-key: "security.isin"
      lookup-dataset:
        type: "inline"
        key-field: "isin"
        data:
          - isin: "GB00B03MLX29"
            exDividendDate: "2024-12-15"
            recordDate: "2024-12-16"
            paymentDate: "2024-12-30"
            dividendAmount: 0.47
    field-mappings:
      - source-field: "exDividendDate"
        target-field: "corporateAction.exDividendDate"
      - source-field: "dividendAmount"
        target-field: "corporateAction.dividendAmount"
```

8. Pricing and Valuation Enrichment

Pricing enrichment adds current market values, yields, and valuation metrics for accurate settlement amounts.

Example YAML Rules (Pricing)

```yaml
metadata:
  name: "Pricing and Valuation Enrichment"
  version: "1.0.0"
  type: "rule-config"

enrichments:
  - id: "mark-to-market-pricing"
    type: "lookup-enrichment"
    condition: "#data.security != null && #data.security.isin != null"
    lookup-config:
      lookup-key: "security.isin"
      lookup-dataset:
        type: "inline"
        key-field: "isin"
        data:
          - isin: "GB00B03MLX29"
            currentPrice: 2750.50
            priceSource: "BLOOMBERG"
            bidPrice: 2749.00
            askPrice: 2752.00
    field-mappings:
      - source-field: "currentPrice"
        target-field: "pricing.currentPrice"
      - source-field: "priceSource"
        target-field: "pricing.priceSource"
```

9. Compliance Enrichment

Compliance enrichment adds AML/KYC status, sanctions screening, and regulatory compliance flags.

Example YAML Rules (Compliance)

```yaml
metadata:
  name: "Compliance Enrichment"
  version: "1.0.0"
  type: "rule-config"

enrichments:
  - id: "aml-kyc-screening"
    type: "lookup-enrichment"
    condition: "#data.counterparty != null && #data.counterparty.lei != null"
    lookup-config:
      lookup-key: "counterparty.lei"
      lookup-dataset:
        type: "inline"
        key-field: "lei"
        data:
          - lei: "7LTWFZYICNSX8D621K86"
            amlStatus: "CLEARED"
            kycStatus: "VERIFIED"
            sanctionsScreening: "PASSED"
    field-mappings:
      - source-field: "amlStatus"
        target-field: "compliance.amlStatus"
      - source-field: "kycStatus"
        target-field: "compliance.kycStatus"
```

10. Operational Enrichment

Operational enrichment adds processing sequence, STP eligibility, and exception handling information.

Example YAML Rules (Operations)

```yaml
metadata:
  name: "Operational Enrichment"
  version: "1.0.0"
  type: "rule-config"

rules:
  - id: "stp-eligibility-check"
    name: "STP Eligibility Validation"
    condition: "#data.counterparty != null && #data.counterparty.lei != null && #data.security != null && #data.security.
    message: "Trade is eligible for straight-through processing"
    severity: "INFO"

enrichments:
  - id: "stp-status-calculation"
    type: "calculation-enrichment"
    condition: "#data.counterparty != null && #data.security != null"
    calculations:
      - field: "operations.stpEligible"
        expression: "#counterparty.lei != null && #security.isin != null"
```

11. Accounting Enrichment

Accounting enrichment adds general ledger codes, cost basis information, and P&L attribution.

Example YAML Rules (Accounting)

```yaml
metadata:
  name: "Accounting Enrichment"
  version: "1.0.0"
  type: "rule-config"

enrichments:
  - id: "gl-code-assignment"
    type: "lookup-enrichment"
    condition: "#data.instrument != null && #data.instrument.assetClass != null && #data.trade != null && #data.trade.dir
    lookup-config:
      lookup-key: "#instrument.assetClass + '_' + #trade.direction"
      lookup-dataset:
        type: "inline"
        key-field: "key"
        data:
          - key: "EQUITY_BUY"
            glCode: "1100-EQUITY-LONG"
            costCenter: "TRADING-DESK-1"
            profitCenter: "EQUITY-TRADING"
          - key: "EQUITY_SELL"
            glCode: "1100-EQUITY-SHORT"
            costCenter: "TRADING-DESK-1"
            profitCenter: "EQUITY-TRADING"
    field-mappings:
      - source-field: "glCode"
        target-field: "accounting.glCode"
      - source-field: "costCenter"
        target-field: "accounting.costCenter"
```

---

12. Market Data Enrichment

Market data enrichment adds benchmark information, liquidity metrics, and market sentiment indicators.

Example YAML Rules (Market Data)

```yaml
metadata:
  name: "Market Data Enrichment"
  version: "1.0.0"
  type: "rule-config"

enrichments:
  - id: "benchmark-information"
    type: "lookup-enrichment"
    condition: "#data.security != null && #data.security.isin != null"
    lookup-config:
      lookup-key: "security.isin"
      lookup-dataset:
        type: "inline"
        key-field: "isin"
        data:
          - isin: "GB00B03MLX29"
            primaryBenchmark: "FTSE_100"
            sector: "ENERGY"
            averageDailyVolume: 15000000
            marketCap: 198000000000
    field-mappings:
```

```yaml
      - source-field: "primaryBenchmark"
        target-field: "marketData.primaryBenchmark"
      - source-field: "sector"
        target-field: "marketData.sector"
```

Implementation Guidelines

XML Message Standards

The examples in this document follow industry standards:

- **ISO 20022**: For payment and securities settlement messages
- **FIX Protocol**: For trade execution and confirmation
- **FpML**: For derivatives and complex financial products
- **SWIFT MT/MX**: For cross-border settlement instructions

YAML Rule Engine Benefits

- **Flexibility**: Easy to modify rules without code changes
- **Maintainability**: Clear, readable rule definitions
- **Scalability**: Support for complex conditional logic
- **Auditability**: Complete audit trail of enrichment decisions
- **Performance**: Efficient rule execution with caching

Best Practices

1. **Data Quality**: Validate source data before enrichment
2. **Error Handling**: Implement comprehensive error handling and fallback mechanisms
3. **Performance**: Use caching and batch processing for high-volume scenarios
4. **Monitoring**: Track enrichment success rates and processing times
5. **Compliance**: Ensure all enrichment follows regulatory requirements

This comprehensive framework covers all major categories of enrichment essential for financial services post-trade settlement, providing the foundation for efficient, compliant, and risk-managed settlement processing.