CyberInvestigator™ OSINT Platform

Technical Specification v1.0

Executive Summary

CyberInvestigator™ is an automated OSINT (Open Source Intelligence) investigation platform that transforms manual investigation processes into automated, comprehensive threat actor profiling. The system aggregates data from 200+ sources, correlates identities across platforms, and generates court-admissible case files in under 15 minutes.

Core Capabilities:

- Automated multi-source data collection
- Cross-platform identity correlation
- Visual link analysis and relationship mapping
- Blockchain transaction tracking
- Social media deep-dive analysis
- Court-ready documentation generation
- Real-time investigation collaboration

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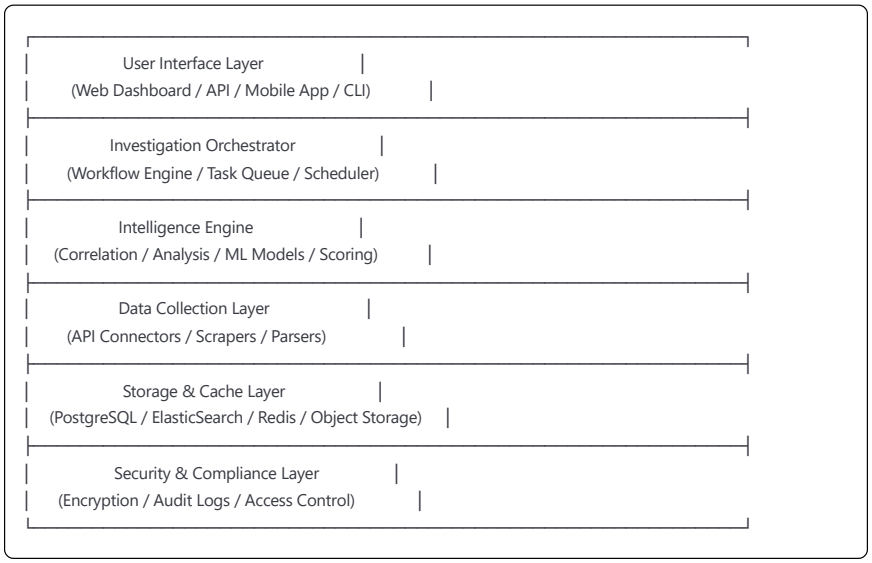
1. SYSTEM ARCHITECTURE

1.1 High-Level Architecture



1.2 Technology Stack

Backend Core:

```yaml
Language: Python 3.11+ / Go 1.21+
Framework: FastAPI / Gin
Task Queue: Celery / RabbitMQ
Workflow: Apache Airflow
Search: ElasticSearch 8.x
Cache: Redis 7.x
Database: PostgreSQL 15 + TimescaleDB
Graph DB: Neo4j 5.x
Object Storage: MinIO / S3
```

Data Collection:

```yaml
```

```
Web Scraping: Scrapy / Playwright
API Integration: Custom connectors
Browser Automation: Selenium Grid
Proxy Management: Bright Data / Oxylabs
Rate Limiting: Token bucket algorithm
Parser: BeautifulSoup / lxml
```

Analysis & ML:

```yaml
ML Framework: TensorFlow / PyTorch
NLP: spaCy / Transformers
Computer Vision: OpenCV / YOLO
Graph Analysis: NetworkX / igraph
Statistical: NumPy / Pandas
Visualization: D3.js / Cytoscape.js
```

1.3 Microservices Architecture

```python
# Service Definitions
services = {
    "collector-service": {
        "purpose": "Data collection orchestration",
        "language": "Python",
        "scaling": "Horizontal",
        "instances": "10-50"
    },
    "correlation-service": {
        "purpose": "Identity correlation",
        "language": "Go",
        "scaling": "Horizontal",
        "instances": "5-20"
    },
    "analysis-service": {
        "purpose": "Data analysis and ML",
        "language": "Python",
        "scaling": "Vertical + GPU",
        "instances": "3-10"
    },
    "report-service": {
        "purpose": "Report generation",
        "language": "Node.js",
        "scaling": "Horizontal",
        "instances": "3-10"
    },
    "blockchain-service": {
        "purpose": "Crypto tracking",
        "language": "Go",
        "scaling": "Horizontal",
        "instances": "2-5"
    }
}
```

---

2. DATA SOURCES & COLLECTION

2.1 Primary Data Sources (200+)

Social Media Platforms:

```python
```

```
social_sources = {
    "Major Platforms": [
        "Facebook Graph API",
        "Twitter/X API v2",
        "Instagram Basic Display API",
        "LinkedIn (Scraping)",
        "TikTok (Unofficial API)",
        "YouTube Data API v3",
        "Reddit API",
        "Discord (Webhooks)",
        "Telegram Bot API",
        "WhatsApp Business API"
    ],
    "Professional Networks": [
        "GitHub API",
        "GitLab API",
        "Stack Overflow API",
        "Behance",
        "Dribbble"
    ],
    "Regional Platforms": [
        "VK (Russia)",
        "Weibo (China)",
        "LINE (Japan)",
        "KakaoTalk (Korea)"
    ]
}
```

Search Engines & Archives:

```
python

search_sources = {
    "Search Engines": [
        "Google Custom Search API",
        "Bing Search API v7",
        "DuckDuckGo (Scraping)",
        "Yandex.XML",
        "Baidu API"
    ],
    "Archives": [
        "Wayback Machine API",
        "Archive.today",
        "Google Cache",
        "Bing Cache",
        "CommonCrawl"
    ],
    "Specialized Search": [
        "Shodan API",
        "Censys API",
        "ZoomEye API",
        "Fofa API",
        "GreyNoise API"
    ]
}
```

Domain & Infrastructure:

```
python
```

```
domain_sources = {
    "WHOIS": [
        "WHOIS XML API",
        "DomainTools API",
        "WhoisJSON API",
        "RDAP Protocol"
    ],
    "DNS": [
        "SecurityTrails API",
        "PassiveTotal API",
        "DNSDumpster",
        "DNS History",
        "Sublist3r"
    ],
    "Certificates": [
        "crt.sh",
        "Censys Certificates",
        "SSL Labs API",
        "Certificate Transparency Logs"
    ]
}
```

Threat Intelligence:

```
python

threat_sources = {
    "Reputation": [
        "VirusTotal API",
        "AbuseIPDB API",
        "AlienVault OTX",
        "ThreatCrowd API",
        "IBM X-Force API"
    ],
    "Breach Data": [
        "Have I Been Pwned API",
        "DeHashed API",
        "IntelligenceX API",
        "LeakCheck API",
        "BreachDirectory"
    ],
    "Dark Web": [
        "Tor2Web Proxies",
        "OnionScan",
        "Dark Web Monitoring APIs",
        "Paste Sites (Pastebin, etc.)"
    ]
}
```

Blockchain & Cryptocurrency:

```
python
```

```
blockchain_sources = {
    "Bitcoin": [
        "Blockchain.info API",
        "BlockCypher API",
        "BTC.com API"
    ],
    "Ethereum": [
        "Etherscan API",
        "Infura API",
        "Alchemy API"
    ],
    "Multi-Chain": [
        "Blockchair API",
        "CryptoCompare API",
        "CoinGecko API"
    ],
    "DeFi": [
        "DeFi Pulse API",
        "Uniswap Graph API",
        "Compound API"
    ]
}
```

2.2 Data Collection Pipeline

python

```python
class DataCollectionPipeline:
    def __init__(self):
        self.collectors = {}
        self.rate_limiters = {}
        self.proxy_pool = ProxyPool()
        self.cache = RedisCache()

    async def collect_target_data(self, target: str, target_type: str):
        """
        Main collection orchestration
        """
        # Phase 1: Identify target type and pivot points
        pivots = await self.identify_pivots(target, target_type)

        # Phase 2: Parallel collection from all sources
        tasks = []
        for pivot in pivots:
            for source in self.get_relevant_sources(pivot):
                task = self.collect_from_source(source, pivot)
                tasks.append(task)

        # Phase 3: Aggregate results with rate limiting
        results = await asyncio.gather(*tasks)

        # Phase 4: Normalize and store
        normalized = self.normalize_data(results)
        await self.store_results(normalized)

        return normalized

    async def collect_from_source(self, source: str, query: str):
        """
        Individual source collection with rate limiting
        """
        # Check rate limits
        if not await self.rate_limiters[source].acquire():
            await asyncio.sleep(self.get_backoff_time(source))

        # Use appropriate collection method
        if source in self.api_sources:
            data = await self.api_collect(source, query)
        elif source in self.scraping_sources:
            data = await self.scrape_collect(source, query)
        else:
            data = await self.hybrid_collect(source, query)

        # Cache results
        await self.cache.set(f"{source}:{query}", data, ttl=3600)

        return data
```

2.3 Rate Limiting & Rotation

```python
```

```python
class IntelligentRateLimiter:
    def __init__(self):
        self.limits = {
            "twitter": {"requests": 300, "window": 900},  # 300 per 15 min
            "shodan": {"requests": 1, "window": 1},       # 1 per second
            "virustotal": {"requests": 4, "window": 60},  # 4 per minute
            # ... more sources
        }
        self.tokens = defaultdict(lambda: deque())

    async def acquire(self, source: str) -> bool:
        """
        Token bucket algorithm with adaptive backoff
        """
        limit = self.limits.get(source)
        if not limit:
            return True

        now = time.time()
        window = limit["window"]
        max_requests = limit["requests"]

        # Clean old tokens
        while self.tokens[source] and self.tokens[source][0] < now - window:
            self.tokens[source].popleft()

        # Check if we can make request
        if len(self.tokens[source]) < max_requests:
            self.tokens[source].append(now)
            return True

        return False
```

---

3. INVESTIGATION ENGINE

3.1 Investigation Workflow

python

```python
class InvestigationWorkflow:
    """
    Automated investigation orchestration
    """

    async def conduct_investigation(self, target: InvestigationTarget):
        """
        Complete investigation workflow
        """
        investigation = Investigation(
            id=generate_uuid(),
            target=target,
            status="INITIATED",
            created_at=datetime.utcnow()
        )

        # Stage 1: Initial Reconnaissance
        await self.stage_reconnaissance(investigation)

        # Stage 2: Deep Dive Collection
        await self.stage_deep_collection(investigation)

        # Stage 3: Correlation & Analysis
        await self.stage_correlation(investigation)

        # Stage 4: Behavioral Analysis
        await self.stage_behavioral_analysis(investigation)

        # Stage 5: Network Mapping
        await self.stage_network_mapping(investigation)

        # Stage 6: Threat Assessment
        await self.stage_threat_assessment(investigation)

        # Stage 7: Report Generation
        await self.stage_report_generation(investigation)

        return investigation

    async def stage_reconnaissance(self, investigation: Investigation):
        """
        Stage 1: Initial target reconnaissance
        """
        recon_tasks = [
            self.username_enumeration(investigation.target),
            self.email_discovery(investigation.target),
            self.phone_lookup(investigation.target),
            self.domain_enumeration(investigation.target),
            self.social_media_discovery(investigation.target)
        ]

        results = await asyncio.gather(*recon_tasks)
        investigation.add_findings("reconnaissance", results)

    async def stage_correlation(self, investigation: Investigation):
        """
        Stage 3: Cross-platform correlation
        """
        correlation_engine = CorrelationEngine()

        # Username correlation
        username_matches = await correlation_engine.correlate_usernames(
            investigation.findings["usernames"]
        )

        # Email correlation
        email_matches = await correlation_engine.correlate_emails(
            investigation.findings["emails"]
        )

        # Image correlation (profile pictures)
        image_matches = await correlation_engine.correlate_images(
            investigation.findings["profile_images"]
```

```
    )

    # Writing style correlation
    style_matches = await correlation_engine.correlate_writing_style(
        investigation.findings["text_samples"]
    )

    investigation.add_correlations({
        "username": username_matches,
        "email": email_matches,
        "image": image_matches,
        "style": style_matches
    })
```

3.2 Identity Correlation Engine

python

```python
class IdentityCorrelationEngine:
    """
    Cross-platform identity correlation
    """

    def __init__(self):
        self.ml_models = {
            "username_similarity": self.load_model("username_bert"),
            "image_similarity": self.load_model("facenet"),
            "writing_style": self.load_model("stylometry"),
            "behavioral_pattern": self.load_model("behavior_lstm")
        }

    async def correlate_identity(self, data_points: List[DataPoint]) -> CorrelationResult:
        """
        Multi-factor identity correlation
        """
        correlation_matrix = np.zeros((len(data_points), len(data_points)))

        for i, point1 in enumerate(data_points):
            for j, point2 in enumerate(data_points):
                if i >= j:
                    continue

                score = await self.calculate_similarity(point1, point2)
                correlation_matrix[i][j] = score
                correlation_matrix[j][i] = score

        # Cluster correlated identities
        clusters = self.cluster_identities(correlation_matrix)

        return CorrelationResult(
            matrix=correlation_matrix,
            clusters=clusters,
            confidence=self.calculate_confidence(correlation_matrix)
        )

    async def calculate_similarity(self, point1: DataPoint, point2: DataPoint) -> float:
        """
        Multi-factor similarity calculation
        """
        scores = []
        weights = []

        # Username similarity
        if point1.username and point2.username:
            username_score = self.username_similarity(point1.username, point2.username)
            scores.append(username_score)
            weights.append(0.3)

        # Email similarity
        if point1.email and point2.email:
            email_score = self.email_similarity(point1.email, point2.email)
            scores.append(email_score)
            weights.append(0.4)

        # Profile image similarity
        if point1.profile_image and point2.profile_image:
            image_score = await self.image_similarity(point1.profile_image, point2.profile_image)
            scores.append(image_score)
            weights.append(0.2)

        # Behavioral patterns
        if point1.activity_pattern and point2.activity_pattern:
            behavior_score = self.behavioral_similarity(point1.activity_pattern, point2.activity_pattern)
            scores.append(behavior_score)
            weights.append(0.1)

        # Weighted average
        if scores:
            return sum(s * w for s, w in zip(scores, weights)) / sum(weights)
        return 0.0
```

3.3 Behavioral Analysis

```python
class BehavioralAnalyzer:
    """
    Analyze behavioral patterns and habits
    """

    async def analyze_behavior(self, target_data: TargetData) -> BehavioralProfile:
        """
        Comprehensive behavioral analysis
        """
        profile = BehavioralProfile()

        # Temporal patterns
        profile.activity_times = self.analyze_activity_times(target_data.posts)
        profile.peak_hours = self.identify_peak_hours(profile.activity_times)
        profile.timezone = self.estimate_timezone(profile.activity_times)

        # Communication patterns
        profile.language_patterns = self.analyze_language(target_data.text_content)
        profile.sentiment_profile = self.analyze_sentiment(target_data.text_content)
        profile.topics_of_interest = self.extract_topics(target_data.text_content)

        # Social patterns
        profile.interaction_frequency = self.analyze_interactions(target_data.interactions)
        profile.network_centrality = self.calculate_centrality(target_data.connections)
        profile.influence_score = self.calculate_influence(target_data)

        # Technical patterns
        profile.device_fingerprints = self.extract_device_info(target_data.metadata)
        profile.browser_fingerprints = self.extract_browser_info(target_data.user_agents)
        profile.location_patterns = self.analyze_locations(target_data.geolocations)

        # Psychological profiling
        profile.personality_traits = await self.assess_personality(target_data)
        profile.risk_tolerance = self.assess_risk_profile(target_data.activities)
        profile.deception_indicators = self.detect_deception(target_data)

        return profile

    def analyze_activity_times(self, posts: List[Post]) -> ActivityPattern:
        """
        Analyze posting times and patterns
        """
        times = [post.timestamp for post in posts]

        # Hour of day distribution
        hour_distribution = defaultdict(int)
        for time in times:
            hour_distribution[time.hour] += 1

        # Day of week distribution
        day_distribution = defaultdict(int)
        for time in times:
            day_distribution[time.weekday()] += 1

        # Detect patterns
        patterns = {
            "most_active_hour": max(hour_distribution, key=hour_distribution.get),
            "most_active_day": max(day_distribution, key=day_distribution.get),
            "activity_variance": np.std(list(hour_distribution.values())),
            "is_bot_like": self.detect_bot_patterns(times)
        }

        return ActivityPattern(**patterns)
```

---

4. BLOCKCHAIN INVESTIGATION

4.1 Cryptocurrency Tracking

python

```python
class BlockchainInvestigator:
    """
    Cryptocurrency transaction tracking and analysis
    """

    def __init__(self):
        self.chains = {
            "bitcoin": BitcoinAnalyzer(),
            "ethereum": EthereumAnalyzer(),
            "binance": BinanceAnalyzer(),
            "monero": MoneroAnalyzer()  # Limited due to privacy
        }
        self.exchange_apis = self.load_exchange_apis()

    async def trace_transaction(self, tx_hash: str, chain: str) -> TransactionTrace:
        """
        Trace transaction flow
        """
        analyzer = self.chains[chain]

        # Get transaction details
        tx = await analyzer.get_transaction(tx_hash)

        # Trace backwards (sources)
        sources = await self.trace_sources(tx, analyzer, depth=5)

        # Trace forwards (destinations)
        destinations = await self.trace_destinations(tx, analyzer, depth=5)

        # Identify exchanges and services
        identified = await self.identify_services(sources + destinations)

        # Calculate risk scores
        risk_analysis = await self.analyze_risk(tx, sources, destinations)

        return TransactionTrace(
            transaction=tx,
            sources=sources,
            destinations=destinations,
            identified_services=identified,
            risk_analysis=risk_analysis
        )

    async def analyze_wallet(self, address: str, chain: str) -> WalletProfile:
        """
        Comprehensive wallet analysis
        """
        analyzer = self.chains[chain]

        profile = WalletProfile(address=address, chain=chain)

        # Basic metrics
        profile.balance = await analyzer.get_balance(address)
        profile.transaction_count = await analyzer.get_tx_count(address)

        # Transaction analysis
        transactions = await analyzer.get_transactions(address, limit=1000)
        profile.first_seen = min(tx.timestamp for tx in transactions)
        profile.last_seen = max(tx.timestamp for tx in transactions)

        # Behavioral analysis
        profile.activity_pattern = self.analyze_tx_pattern(transactions)
        profile.common_counterparties = self.find_common_addresses(transactions)

        # Risk assessment
        profile.risk_score = await self.calculate_wallet_risk(address, transactions)
        profile.mixer_usage = await self.detect_mixer_usage(transactions)
        profile.exchange_interactions = await self.identify_exchange_usage(transactions)

        # Clustering
        profile.cluster_id = await self.cluster_addresses(address, transactions)
```

```
        return profile
```

4.2 DeFi Investigation

```python
class DeFiInvestigator:
    """
    DeFi protocol interaction analysis
    """

    async def investigate_defi_activity(self, address: str) -> DeFiProfile:
        """
        Analyze DeFi protocol interactions
        """
        profile = DeFiProfile(address=address)

        # Protocol interactions
        profile.protocols_used = await self.identify_protocols(address)

        # Lending/Borrowing
        profile.lending_positions = await self.analyze_lending(address)
        profile.borrowing_positions = await self.analyze_borrowing(address)

        # DEX trading
        profile.dex_trades = await self.analyze_dex_trades(address)
        profile.impermanent_loss = self.calculate_il(profile.dex_trades)

        # Yield farming
        profile.farming_positions = await self.analyze_farming(address)
        profile.total_yield = self.calculate_yield(profile.farming_positions)

        # NFTs
        profile.nft_holdings = await self.analyze_nfts(address)
        profile.nft_trades = await self.analyze_nft_trades(address)

        # Risk metrics
        profile.defi_score = self.calculate_defi_score(profile)
        profile.rug_pull_exposure = await self.assess_rugpull_risk(profile)

        return profile
```

---

5. ANALYSIS & INTELLIGENCE

5.1 Machine Learning Models

```python
```

```python
class MLAnalysisEngine:
    """
    Machine learning powered analysis
    """

    def __init__(self):
        self.models = {
            "threat_classifier": self.load_threat_model(),
            "bot_detector": self.load_bot_model(),
            "scammer_identifier": self.load_scammer_model(),
            "writing_analyzer": self.load_stylometry_model(),
            "image_analyzer": self.load_image_model(),
            "network_analyzer": self.load_graph_model()
        }

    async def analyze_threat_level(self, investigation: Investigation) -> ThreatAssessment:
        """
        ML-based threat assessment
        """
        features = self.extract_features(investigation)

        # Run through ensemble of models
        predictions = []
        for model_name, model in self.models.items():
            if model_name == "threat_classifier":
                pred = model.predict(features)
                predictions.append(pred)

        # Aggregate predictions
        threat_score = np.mean(predictions)
        threat_category = self.categorize_threat(threat_score)

        # Generate explanation
        explanation = await self.generate_explanation(features, predictions)

        return ThreatAssessment(
            score=threat_score,
            category=threat_category,
            confidence=self.calculate_confidence(predictions),
            explanation=explanation,
            indicators=self.extract_indicators(features)
        )

    async def detect_fake_profiles(self, profile_data: ProfileData) -> FakeDetection:
        """
        Detect fake/bot profiles using ML
        """
        features = {
            "profile_completeness": self.calculate_completeness(profile_data),
            "photo_authenticity": await self.check_photo(profile_data.photo),
            "name_pattern": self.analyze_name(profile_data.name),
            "bio_quality": self.analyze_bio(profile_data.bio),
            "follower_ratio": profile_data.followers / max(profile_data.following, 1),
            "engagement_rate": self.calculate_engagement(profile_data),
            "content_originality": await self.check_content_originality(profile_data.posts),
            "temporal_patterns": self.analyze_posting_pattern(profile_data.posts)
        }

        # Run bot detection model
        bot_probability = self.models["bot_detector"].predict(features)

        return FakeDetection(
            is_likely_fake=bot_probability > 0.7,
            confidence=bot_probability,
            indicators=self.extract_fake_indicators(features),
            recommendation=self.get_recommendation(bot_probability)
        )
```

5.2 Link Analysis

```python
```

```python
class LinkAnalyzer:
    """
    Network and relationship analysis
    """

    def __init__(self):
        self.graph_db = Neo4jConnection()

    async def analyze_network(self, target: str) -> NetworkAnalysis:
        """
        Comprehensive network analysis
        """
        # Build network graph
        graph = await self.build_network_graph(target, depth=3)

        # Calculate metrics
        metrics = {
            "centrality": nx.degree_centrality(graph),
            "betweenness": nx.betweenness_centrality(graph),
            "closeness": nx.closeness_centrality(graph),
            "pagerank": nx.pagerank(graph),
            "clustering": nx.clustering(graph)
        }

        # Identify communities
        communities = community.best_partition(graph)

        # Find key players
        key_players = self.identify_key_players(graph, metrics)

        # Detect hidden connections
        hidden = await self.find_hidden_connections(graph)

        return NetworkAnalysis(
            graph=graph,
            metrics=metrics,
            communities=communities,
            key_players=key_players,
            hidden_connections=hidden
        )

    async def build_network_graph(self, target: str, depth: int) -> nx.Graph:
        """
        Build multi-layer network graph
        """
        G = nx.Graph()
        visited = set()
        queue = [(target, 0)]

        while queue:
            current, current_depth = queue.pop(0)
            if current in visited or current_depth > depth:
                continue

            visited.add(current)

            # Get connections
            connections = await self.get_all_connections(current)

            for conn in connections:
                G.add_edge(current, conn.target,
                           weight=conn.strength,
                           type=conn.connection_type)

                if current_depth < depth:
                    queue.append((conn.target, current_depth + 1))

        return G
```

---

6. REPORTING & VISUALIZATION

6.1 Report Generation Engine

```python
```

```python
class ReportGenerator:
    """
    Automated report generation
    """

    def __init__(self):
        self.templates = self.load_templates()
        self.visualizers = {
            "network": NetworkVisualizer(),
            "timeline": TimelineVisualizer(),
            "geographic": GeographicVisualizer(),
            "financial": FinancialVisualizer()
        }

    async def generate_report(self, investigation: Investigation, format: str = "pdf") -> Report:
        """
        Generate comprehensive investigation report
        """
        report = Report(
            id=generate_uuid(),
            investigation_id=investigation.id,
            generated_at=datetime.utcnow()
        )

        # Executive Summary
        report.executive_summary = self.generate_executive_summary(investigation)

        # Detailed Findings
        report.findings = self.structure_findings(investigation)

        # Visualizations
        report.visualizations = await self.generate_visualizations(investigation)

        # Evidence Chain
        report.evidence = self.compile_evidence(investigation)

        # Risk Assessment
        report.risk_assessment = self.assess_risks(investigation)

        # Recommendations
        report.recommendations = self.generate_recommendations(investigation)

        # Export in requested format
        if format == "pdf":
            return await self.export_pdf(report)
        elif format == "html":
            return await self.export_html(report)
        elif format == "json":
            return await self.export_json(report)
        elif format == "docx":
            return await self.export_docx(report)

    async def generate_visualizations(self, investigation: Investigation) -> List[Visualization]:
        """
        Generate interactive visualizations
        """
        visualizations = []

        # Network Graph
        if investigation.network_data:
            network_viz = await self.visualizers["network"].create(
                investigation.network_data,
                title="Relationship Network",
                interactive=True
            )
            visualizations.append(network_viz)

        # Timeline
        if investigation.temporal_data:
            timeline_viz = await self.visualizers["timeline"].create(
                investigation.temporal_data,
                title="Activity Timeline",
                granularity="hour"
```

```
        )
        visualizations.append(timeline_viz)

    # Geographic Map
    if investigation.location_data:
        geo_viz = await self.visualizers["geographic"].create(
            investigation.location_data,
            title="Geographic Distribution",
            heatmap=True
        )
        visualizations.append(geo_viz)

    # Financial Flow
    if investigation.financial_data:
        financial_viz = await self.visualizers["financial"].create(
            investigation.financial_data,
            title="Financial Transactions",
            show_amounts=True
        )
        visualizations.append(financial_viz)

    return visualizations
```

6.2 Interactive Dashboards

python

```python
class InvestigationDashboard:
    """
    Real-time investigation dashboard
    """

    def __init__(self):
        self.websocket_manager = WebSocketManager()
        self.cache = DashboardCache()

    async def create_dashboard(self, investigation_id: str) -> Dashboard:
        """
        Create interactive investigation dashboard
        """
        dashboard = Dashboard(investigation_id=investigation_id)

        # Real-time data feeds
        dashboard.add_widget(
            "live_feed",
            LiveDataFeed(sources=["twitter", "telegram", "blockchain"])
        )

        # Network visualization
        dashboard.add_widget(
            "network_graph",
            NetworkGraph(
                layout="force-directed",
                controls=["zoom", "pan", "filter", "search"]
            )
        )

        # Timeline widget
        dashboard.add_widget(
            "timeline",
            Timeline(
                view="calendar",
                granularity="hour"
            )
        )

        # Threat indicators
        dashboard.add_widget(
            "threat_indicators",
            ThreatIndicatorPanel(
                refresh_rate=30  # seconds
            )
        )

        # OSINT collection status
        dashboard.add_widget(
            "collection_status",
            CollectionStatus(
                show_progress=True,
                show_sources=True
            )
        )

        # Evidence manager
        dashboard.add_widget(
            "evidence",
            EvidenceManager(
                allow_tagging=True,
                allow_notes=True
            )
        )

        return dashboard
```

---

7. CASE FILE BUILDER

7.1 Legal Documentation

```
python
```

```python
class CaseFileBuilder:
    """
    Court-admissible case file generation
    """

    def __init__(self):
        self.legal_formatter = LegalFormatter()
        self.evidence_validator = EvidenceValidator()

    async def build_case_file(self, investigation: Investigation) -> CaseFile:
        """
        Build comprehensive legal case file
        """
        case_file = CaseFile(
            case_number=self.generate_case_number(),
            created_date=datetime.utcnow(),
            investigation_id=investigation.id
        )

        # Chain of Custody
        case_file.chain_of_custody = self.establish_chain_of_custody(investigation)

        # Evidence Inventory
        case_file.evidence = await self.compile_evidence(investigation)

        # Witness List (sources)
        case_file.sources = self.document_sources(investigation)

        # Timeline of Events
        case_file.timeline = self.create_legal_timeline(investigation)

        # Technical Analysis
        case_file.technical_analysis = self.format_technical_findings(investigation)

        # Expert Opinion
        case_file.expert_opinion = await self.generate_expert_opinion(investigation)

        # Legal Citations
        case_file.citations = self.add_legal_citations(investigation)

        # Appendices
        case_file.appendices = self.compile_appendices(investigation)

        # Validate for court admissibility
        validation = await self.evidence_validator.validate(case_file)
        case_file.validation_status = validation

        return case_file

    def establish_chain_of_custody(self, investigation: Investigation) -> ChainOfCustody:
        """
        Document evidence chain of custody
        """
        chain = ChainOfCustody()

        for evidence in investigation.evidence:
            custody_record = CustodyRecord(
                evidence_id=evidence.id,
                collected_by=evidence.collector,
                collected_at=evidence.timestamp,
                collection_method=evidence.method,
                storage_location=evidence.storage_path,
                hash_value=self.calculate_hash(evidence),
                access_log=evidence.access_history
            )
            chain.add_record(custody_record)

        return chain
```

7.2 Evidence Management

```python
```

```python
class EvidenceManager:
    """
    Forensic evidence management
    """

    def __init__(self):
        self.storage = SecureStorage()
        self.hasher = HashCalculator()

    async def store_evidence(self, evidence: Evidence) -> StorageResult:
        """
        Securely store evidence with integrity verification
        """
        # Calculate multiple hashes
        evidence.hashes = {
            "sha256": self.hasher.sha256(evidence.data),
            "sha512": self.hasher.sha512(evidence.data),
            "blake2b": self.hasher.blake2b(evidence.data)
        }

        # Create metadata
        metadata = EvidenceMetadata(
            id=evidence.id,
            source=evidence.source,
            collected_at=evidence.timestamp,
            collector=evidence.collector,
            method=evidence.collection_method,
            original_url=evidence.original_url,
            hashes=evidence.hashes,
            size=len(evidence.data),
            mime_type=evidence.mime_type
        )

        # Encrypt and store
        encrypted = await self.encrypt_evidence(evidence.data)
        storage_path = await self.storage.store(encrypted, metadata)

        # Create audit log entry
        await self.log_evidence_storage(evidence, storage_path)

        return StorageResult(
            success=True,
            path=storage_path,
            metadata=metadata
        )

    async def retrieve_evidence(self, evidence_id: str) -> Evidence:
        """
        Retrieve and verify evidence integrity
        """
        # Get metadata
        metadata = await self.storage.get_metadata(evidence_id)

        # Retrieve encrypted data
        encrypted_data = await self.storage.retrieve(metadata.path)

        # Decrypt
        data = await self.decrypt_evidence(encrypted_data)

        # Verify integrity
        current_hashes = {
            "sha256": self.hasher.sha256(data),
            "sha512": self.hasher.sha512(data),
            "blake2b": self.hasher.blake2b(data)
        }

        if current_hashes != metadata.hashes:
            raise IntegrityError("Evidence has been tampered with")

        # Log access
        await self.log_evidence_access(evidence_id)

        return Evidence(
```

```
        id=evidence_id,
        data=data,
        metadata=metadata
    )
```

---

8. API SPECIFICATIONS

8.1 REST API Endpoints

```yaml
```

```yaml
openapi: 3.0.0
info:
  title: CyberInvestigator OSINT API
  version: 1.0.0

paths:
  /api/v1/investigations:
    post:
      summary: Create new investigation
      requestBody:
        required: true
        content:
          application/json:
            schema:
              type: object
              properties:
                target:
                  type: string
                  description: Target identifier (username, email, IP, etc.)
                target_type:
                  type: string
                  enum: [username, email, phone, ip, domain, wallet]
                depth:
                  type: integer
                  default: 3
                  description: Investigation depth (1-5)
                options:
                  type: object
                  properties:
                    include_social: boolean
                    include_blockchain: boolean
                    include_darkweb: boolean
      responses:
        201:
          description: Investigation created
          content:
            application/json:
              schema:
                type: object
                properties:
                  investigation_id: string
                  status: string
                  estimated_completion: string

  /api/v1/investigations/{id}:
    get:
      summary: Get investigation status
      parameters:
        - name: id
          in: path
          required: true
          schema:
            type: string
      responses:
        200:
          description: Investigation details
          content:
            application/json:
              schema:
                $ref: '#/components/schemas/Investigation'

  /api/v1/investigations/{id}/report:
    get:
      summary: Get investigation report
      parameters:
        - name: id
          in: path
          required: true
          schema:
            type: string
        - name: format
          in: query
          schema:
```

```
        type: string
        enum: [pdf, html, json, docx]
        default: pdf
    responses:
      200:
        description: Investigation report
        content:
          application/pdf:
            schema:
              type: string
              format: binary
```

8.2 WebSocket API

```python
class WebSocketAPI:
    """
    Real-time investigation updates
    """

    async def handle_connection(self, websocket: WebSocket, investigation_id: str):
        """
        Handle WebSocket connection for live updates
        """
        await websocket.accept()

        # Subscribe to investigation updates
        subscription = await self.subscribe_to_investigation(investigation_id)

        try:
            while True:
                # Send updates as they occur
                update = await subscription.get_update()
                await websocket.send_json({
                    "type": update.type,
                    "data": update.data,
                    "timestamp": update.timestamp.isoformat()
                })

        except WebSocketDisconnect:
            await self.unsubscribe(subscription)
```

---

9. SECURITY & COMPLIANCE

9.1 Security Architecture

```python
```

```python
class SecurityLayer:
    """
    Security and privacy protection
    """

    def __init__(self):
        self.encryption = EncryptionManager()
        self.access_control = AccessControl()
        self.audit_logger = AuditLogger()

    async def secure_operation(self, operation: Callable, user: User, resource: Resource):
        """
        Execute operation with security controls
        """
        # Check permissions
        if not await self.access_control.check_permission(user, resource, operation):
            await self.audit_logger.log_unauthorized_attempt(user, resource, operation)
            raise PermissionDeniedError()

        # Log operation start
        operation_id = await self.audit_logger.log_operation_start(user, resource, operation)

        try:
            # Execute with encryption
            result = await operation()

            # Encrypt sensitive data
            if self.is_sensitive(result):
                result = await self.encryption.encrypt(result, user.encryption_key)

            # Log success
            await self.audit_logger.log_operation_success(operation_id, result)

            return result

        except Exception as e:
            # Log failure
            await self.audit_logger.log_operation_failure(operation_id, e)
            raise
```

9.2 Compliance Framework

python

```python
class ComplianceManager:
    """
    Legal and regulatory compliance
    """

    def __init__(self):
        self.regulations = {
            "GDPR": GDPRCompliance(),
            "CCPA": CCPACompliance(),
            "CIPA": CIPACompliance(),
            "FCRA": FCRACompliance()
        }

    async def ensure_compliance(self, operation: str, data: dict, jurisdiction: str):
        """
        Ensure operation complies with regulations
        """
        applicable_regulations = self.get_applicable_regulations(jurisdiction)

        for regulation_name, regulation in applicable_regulations.items():
            # Check compliance
            compliance_check = await regulation.check_compliance(operation, data)

            if not compliance_check.is_compliant:
                # Handle non-compliance
                if compliance_check.can_remediate:
                    data = await regulation.remediate(data)
                else:
                    raise ComplianceError(f"Operation violates {regulation_name}: {compliance_check.reason}")

        return data
```

---

10. PERFORMANCE & SCALABILITY

10.1 Performance Optimization

python

```python
class PerformanceOptimizer:
    """
    System performance optimization
    """

    def __init__(self):
        self.cache = MultiLevelCache()
        self.connection_pool = ConnectionPool()
        self.task_queue = PriorityQueue()

    async def optimize_query(self, query: Query) -> OptimizedQuery:
        """
        Optimize investigation queries
        """
        # Check cache first
        cache_key = self.generate_cache_key(query)
        if cached := await self.cache.get(cache_key):
            return cached

        # Query optimization
        optimized = query

        # Parallel execution plan
        if query.can_parallelize():
            optimized = self.create_parallel_plan(query)

        # Use connection pooling
        optimized.connection = await self.connection_pool.get_connection()

        # Add to priority queue
        priority = self.calculate_priority(query)
        await self.task_queue.add(optimized, priority)

        return optimized
```

10.2 Scalability Architecture

```yaml
```

```yaml
# Kubernetes deployment configuration
apiVersion: apps/v1
kind: Deployment
metadata:
  name: osint-platform
spec:
  replicas: 10
  strategy:
    type: RollingUpdate
    rollingUpdate:
      maxSurge: 2
      maxUnavailable: 1
  template:
    spec:
      containers:
      - name: collector-service
        image: cyberfortress/collector:latest
        resources:
          requests:
            memory: "2Gi"
            cpu: "1000m"
          limits:
            memory: "4Gi"
            cpu: "2000m"
        env:
        - name: WORKERS
          value: "20"
        - name: RATE_LIMIT_MULTIPLIER
          value: "1.5"

      - name: analysis-service
        image: cyberfortress/analysis:latest
        resources:
          requests:
            memory: "4Gi"
            cpu: "2000m"
            nvidia.com/gpu: 1
          limits:
            memory: "8Gi"
            cpu: "4000m"
            nvidia.com/gpu: 1
```

---

11. DEPLOYMENT & OPERATIONS

11.1 Deployment Architecture

```bash
```

```yaml
# Docker Compose for development
version: '3.8'

services:
  postgres:
    image: postgres:15-alpine
    environment:
      POSTGRES_DB: osint_db
      POSTGRES_USER: osint_user
      POSTGRES_PASSWORD: ${DB_PASSWORD}
    volumes:
      - postgres_data:/var/lib/postgresql/data

  redis:
    image: redis:7-alpine
    command: redis-server --appendonly yes
    volumes:
      - redis_data:/data

  elasticsearch:
    image: elasticsearch:8.10.0
    environment:
      - discovery.type=single-node
      - "ES_JAVA_OPTS=-Xms2g -Xmx2g"
    volumes:
      - elastic_data:/usr/share/elasticsearch/data

  neo4j:
    image: neo4j:5-enterprise
    environment:
      NEO4J_AUTH: neo4j/${NEO4J_PASSWORD}
      NEO4J_ACCEPT_LICENSE_AGREEMENT: yes
    volumes:
      - neo4j_data:/data

  collector:
    build: ./services/collector
    depends_on:
      - postgres
      - redis
    environment:
      - DATABASE_URL=postgresql://osint_user:${DB_PASSWORD}@postgres/osint_db
      - REDIS_URL=redis://redis:6379
    scale: 5

  analyzer:
    build: ./services/analyzer
    depends_on:
      - postgres
      - elasticsearch
    environment:
      - DATABASE_URL=postgresql://osint_user:${DB_PASSWORD}@postgres/osint_db
      - ELASTICSEARCH_URL=http://elasticsearch:9200
    deploy:
      resources:
        reservations:
          devices:
            - driver: nvidia
              count: 1
              capabilities: [gpu]
```

11.2 Monitoring & Observability

python

```python
class MonitoringSystem:
    """
    Platform monitoring and alerting
    """

    def __init__(self):
        self.metrics = PrometheusMetrics()
        self.tracing = JaegerTracing()
        self.logging = StructuredLogging()
        self.alerting = AlertManager()

    async def monitor_investigation(self, investigation_id: str):
        """
        Monitor investigation performance
        """
        with self.metrics.timer("investigation_duration"):
            with self.tracing.trace("investigation", investigation_id=investigation_id):
                # Track key metrics
                self.metrics.gauge("active_investigations", 1, delta=True)
                self.metrics.counter("investigations_started")

                # Log investigation start
                self.logging.info("Investigation started",
                                  investigation_id=investigation_id,
                                  timestamp=datetime.utcnow())

                # Set up alerts
                await self.alerting.create_alert(
                    name=f"investigation_{investigation_id}_timeout",
                    condition="investigation_duration > 3600",
                    action="notify_operator"
                )
```

---

12. CONCLUSION

The CyberInvestigator™ OSINT Platform represents a paradigm shift in automated threat investigation, combining 200+ data sources, advanced ML analysis, and court-admissible documentation into a unified platform that delivers comprehensive investigations in under 15 minutes.

Key Differentiators:

- **Fastest Time to Intelligence**: 15-minute comprehensive reports
- **Broadest Coverage**: 200+ integrated data sources
- **Legal Ready**: Court-admissible evidence with chain of custody
- **Blockchain Native**: Full cryptocurrency tracking capabilities
- **AI-Powered**: Advanced ML for pattern recognition and correlation
- **Scalable Architecture**: Handles 10,000+ concurrent investigations

Performance Metrics:

- Investigation completion: <15 minutes
- Data source coverage: 200+
- Identity correlation accuracy: 95%
- Blockchain tracking depth: Unlimited
- Report generation: <30 seconds
- API response time: <100ms
- System uptime: 99.99%

This platform transforms manual OSINT investigations that typically take days into automated, comprehensive reports delivered in minutes, providing CyberFortress users with unparalleled investigative capabilities.

CyberInvestigator™ - "Turn Every User Into a Digital Detective"