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IBM-NJ-EVENT SCHEDULER APP, Phase 1 — Problem Understanding & Requirements

1.0 Executive Summary and Business Case Justification

1.1 Project Overview and Strategic Intent

This document serves as the Phase 1 Submission for the IBM-NJ-Event Scheduler App project, detailing the foundational Problem Understanding and Comprehensive Requirements Specification. The initiative is strategically crucial for modernizing resource and personnel scheduling practices within the IBM New Jersey (NJ) branch. The current environment is characterized by systemic fragmentation, reliance on disparate manual tools (such as spreadsheets and legacy calendar systems), and an inherent inability to manage resource complexity at enterprise scale.

The objective of this project is to implement a unified, intelligent, constraint-based scheduling platform. This transition is not merely an IT upgrade; it represents a fundamental shift from reactive administrative task management to predictive, optimization-driven resource allocation. This strategic realignment supports the broader IBM commitment to utilizing advanced technologies, including AI and optimization algorithms, to enhance operational efficiency and reduce institutional risk, particularly in high-volume environments. The proposed solution will deliver substantial Return on Investment (ROI) by mitigating massive hidden financial losses associated with inefficient scheduling and ensuring strict compliance with evolving labor regulations.

1.2 High-Level Solution Scope (MVP)

The initial phase of development focuses on delivering a Minimum Viable Product (MVP) that provides immediate, measurable value and justifies further investment. The core of the MVP is the Intelligent Scheduling Core (ISC), designed to automate conflict detection and resolution. Phase 1 deliverables encompass essential event creation and modification capabilities, mandatory integration for real-time calendar synchronization, robust Role-Based Access Control (RBAC), and, most critically, automated

compliance checks against predefined regulatory constraints.

By prioritizing these functionalities, the MVP directly addresses the most critical pain points identified in the analysis: excessive administrative burden on managers, chronic resource conflicts, and the growing financial exposure due to compliance failures. This foundational approach establishes the architecture necessary for future phases involving advanced predictive analytics and full integration with corporate Foundation Models.

2.0 Problem Statement

2.1 Current State Analysis: Systemic Deficiencies in Manual Scheduling

The existing resource and event scheduling processes at IBM NJ are reliant upon fragmented, manual, and often redundant workflows. This methodology is ill-suited for a large-scale, complex enterprise operating under dynamic conditions. The combination of legacy calendar systems, informal communication channels, and basic spreadsheets limits enterprise-wide visibility and introduces high levels of human error. This inefficiency carries significant, yet often overlooked, financial consequences, classifying poor scheduling as a major source of hidden profit loss.

2.1.1 Quantification of Productivity Loss and Financial Impact

Poor scheduling practices constitute a "silent profit killer" within the corporate structure. Comprehensive research across service businesses indicates that organizations relying on suboptimal scheduling models forfeit, on average, **23% of their annual revenue** to pervasive, hidden inefficiencies. For a business unit the size of IBM NJ, this translates into a multi-million dollar annual operational hemorrhaging.

This substantial financial drain is composed of several compounding factors:

- **Direct Labor Waste:** This is the most visible but commonly underestimated cost component. Inefficient task sequencing, overstaffing of tasks that require fewer personnel, and significant idle time (where employees are paid but not productive) contribute to a severe decline in productivity. Furthermore, rushed or poor scheduling frequently necessitates unplanned overtime, inflating labor costs by 50% above regular rates. In extreme cases involving last-minute coverage gaps, businesses have reported labor cost premiums reaching up to 150%.
- **Administrative Burden and Opportunity Cost:** Managers are currently diverted from strategic, value-adding activities by repetitive scheduling tasks. Workplace productivity studies demonstrate that managers spend an alarming average of **12 hours per week** solely on resolving scheduling conflicts and manually making adjustments. The cumulative labor hours of highly compensated managerial staff consumed by these tasks represents a substantial opportunity cost,

directly limiting their ability to engage in team development, strategic planning, or critical client

engagement.

- **Compounding Financial Risk:** The instability and error rate inherent in manual scheduling result in downstream effects that dramatically increase costs. Loss of customer satisfaction or service disruption caused by poor resource allocation requires substantial investment to recover. The financial ripple effect is brutal: replacing a customer whose annual value is $5,000 may require acquiring 5 to 7 new customers to cover the high costs associated with client acquisition, magnifying the initial scheduling problem into a potentially $50,000+ annual loss when all downstream consequences are calculated. The analysis clearly establishes that resolving scheduling inefficiencies represents a rapid and high-yield investment; eliminating 75% of a quantified $230,000 annual loss with a modest investment yields a potential first-year ROI of over 592%.

2.1.2 Resource Conflict Management Failures and Lack of Visibility

A fundamental limitation of the current manual system is the severe **lack of enterprise-wide resource visibility**. Managers cannot easily access a centralized, real-time inventory of available physical assets (rooms, specialized equipment, lab time) or intellectual resources (personnel with specific skills).

The dependence on outdated tools and basic spreadsheets for planning results in pervasive issues of incompetent resource allocation and scheduling conflicts. This systematic mismatch between the supply of available resources and the demand from projects directly impacts organizational goals:

- **Project Disruption and Profitability:** The inability to accurately assign resources based on up-to-date skill information and workload balance leads directly to delays, missed project deadlines, and subsequent reduction in project profitability.
- **Employee Morale and Attrition:** Unbalanced workloads across projects and frequent, erratic scheduling adjustments contribute significantly to employee stress, burnout, and dissatisfaction, which increases high employee attrition rates and multiplies training expenses (replacement costs range from 50% to 200% of an employee's annual salary).

2.2 Motivation for an Intelligent Event Scheduler App (IBM NJ Context)

The complexity of a global organization like IBM necessitates a scheduling solution that transcends simple booking functionality and embraces algorithmic intelligence.

2.2.1 Requirement for Intelligence and Optimization

The challenge of scheduling in a large enterprise is fundamentally a multi-objective optimization problem. A sophisticated application must be capable of simultaneously balancing competing and often contradictory business priorities. These priorities include minimizing operational labor costs, maximizing the utilization of specialized assets, ensuring exceptional service quality, and maintaining high employee satisfaction.

- **Constraint Programming Imperative:** Achieving optimized

  outcomes requires a system capable of leveraging advanced Constraint Programming (CP) techniques. The system must manage

numerous, complex, and highly specific business rules unique to corporate operations. Examples include defining specific

skill requirements for tasks, mandating time-off periods, enforcing limitations such as "no two night shifts in a row," or addressing personnel incompatibility restrictions (e.g., "Employee A doesn't want to work with Employee B").

- **Predictive Capabilities:** A manual or basic automated system is inherently reactive. The intelligent system must integrate real-time data and leverage predictive analytics to forecast potential bottlenecks, resource shortages, or delays well in advance. This proactive identification capability is essential for allowing management to address issues before they impact service delivery or project timelines.

2.2.2 Mitigating Enterprise Legal and Compliance Risk (Mandatory Constraint)

One of the most critical motivations for building a centralized, intelligent scheduler is the imperative to mitigate escalating legal and financial risks associated with labor law

non-compliance.

- **Predictive Scheduling Law Exposure:** Modern labor legislation, often referred to as "Fair Workweek" or predictive scheduling laws, mandates employers to provide employees with sufficient advance notice of schedules and, in many cases, requires additional compensation for last-minute changes or inadequate rest periods (e.g., "clopening" shifts).
- **Geopolitical Risk Factor:** Given the proximity of IBM NJ to major metropolitan jurisdictions (e.g., New York City, which has strict predictive scheduling laws), the system must be designed to enforce configurable geopolitical labor constraints. Even if a facility is outside the immediate boundary, operations frequently cross jurisdictional lines, or remote employees may be subject to specific municipal regulations. Legal violations result in steep fines, back wages (the U.S. Department of Labor collected over $213 million in back wages for wage and hour violations in FY2024 alone), and severe reputational damage.
- **Architectural Mandate:** The necessity to hard-enforce these legal parameters elevates compliance risk mitigation from a functional requirement to a **Non-Functional Requirement (NFR)** that must be engineered directly into the core architectural characteristics of the scheduling engine. The system must prevent the booking of non-compliant schedules, thereby protecting the corporation from costly litigation and penalties.

2.3 Defined Problem Scope (Phase 1 Inclusions and Exclusions)

2.3.1 Inclusions (Phase 1)

Phase 1 efforts will focus exclusively on establishing the core operational and compliance capabilities:

- Event creation, modification, and cancellation management.
- Attendee and critical resource matching functionalities.
- Real-time conflict detection using the Intelligent Scheduling Core (ISC).
- Basic automated notifications (email, internal alerts).
- Implementation of Role-Based Access Control (RBAC).
- Foundational integration capabilities for importing/synchronizing existing corporate calendars and resource asset lists.

2.3.2 Exclusions (Phase 1)

To maintain focus and ensure a rapid delivery cycle, complex features

requiring extensive external system integration or advanced machine learning model training will be deferred to subsequent phases:

- Full integration with corporate financial and billing systems for cost reporting.
- Complex vendor coordination and management outside of IBM's internal premises.
- Advanced predictive machine learning models designed for high-level cost and demand forecasting (this advanced analytics dashboard will be scoped for Phase 2).
- Complex workflow automation beyond simple reminders and basic task-board integration.

3.0 Users and Stakeholders

3.1 Primary User Classes and Characteristics

The system must serve distinct user groups, each having specific goals and operational pain points that the application must resolve.

User Class	Description	Goals	Key Pain Points
Employee (End User)	IBM staff member who consumes scheduled time, attends meetings, or utilizes shared resources.	Easily view and manage personal schedule; achieve fair, balanced workload distribution; decline conflicting invitations without fear of retaliation.	Unbalanced workload and resource conflicts ; erratic scheduling practices leading to stress and burnout ; difficulty confirming resource availability in advance.
Event/Department Manager	Personnel responsible for team scheduling, labor oversight, resource allocation, and department budget management.	Minimize expensive unplanned overtime ; maximize team utilization against project demands; ensure schedule compliance with all labor laws; resolve scheduling conflicts quickly and efficiently.	High administrative burden (spending ~12 hrs/week resolving conflicts) ; critical lack of enterprise-wide resource visibility ; inability to track schedule/budget adjustments effectively.

Event Administrator (Admin)	Centralized staff responsible for master data management, system configuration, user access, and compliance monitoring.	Maintain high data integrity and accuracy; rapidly configure new resource pools (rooms, labs); audit compliance records systematically;	Frequent data reconciliation errors due to manual input ; absence of up-to-date skill information for staff ; cumbersome
		enforce user permissions (ACLs).	processes for physical venue booking management.

3.2 Secondary User Classes and Characteristics

Secondary users are not daily operators of the scheduling interface but rely on the system's output or governance capabilities.

- **Facility Operations Team:** This team requires read-only access to physical asset schedules (rooms, auditoriums, labs). Their operational goal is to optimize the turnover time between events, ensuring rooms are properly cleaned, maintained, and set up for the next occupant. Their pain point is operational disruption caused by last-minute event cancellations or changes, which the new system must minimize via early notifications.
- **IT Support & Architecture Review Board (ARB):** This group demands a system that is secure, scalable, and highly available, aligning with core IBM infrastructure standards. Their goal is to ensure system availability (mandating NFRs like 99.999% uptime) and

verify compliance with corporate security and data retention policies. A major concern is the difficulty and potential risk associated with integrating the new application with legacy IBM IT systems, such as existing SSO and departmental calendars.

- **External Clients/Guests:** These non-IBM personnel are invited to events. Their goal is seamless, clear, and timely receipt of invitations and event details. Their pain point is complexity associated with external access, requiring robust support for industry standards (e.g., iCal synchronization) and secure, temporary viewing links.

3.3 Stakeholder Expectations and Engagement Strategy

A successful project demands a tailored communication and engagement strategy that recognizes the differential impact various groups have on the project's success, based on their level of influence and vested interest. Executives must be satisfied with high-level outcomes, while core users must be consulted on functional design.
The following matrix details the engagement required for key stakeholders, using the standard Influence vs. Interest model.
Stakeholder Influence vs. Interest Matrix

Stakeholder Group	Influence Level	Interest Level	Engagement Strategy	Primary Concern
IBM NJ Executive Sponsors	High	Low	**Keep Satisfied**: Provide monthly, metrics-focused reports detailing ROI achievements, risk reduction status, and adherence to budget and scope.	Financial Justification, Mitigation of Financial/Legal Risk

Event/Depart ment Managers	High	High	**Manage Closely:** Maintain active participation in requirements definition, sprint reviews, and User Acceptance Testing (UAT) to validate administrativ e relief and system usability.	Core Functionality, Resource Utilization, Reduction of Administrative Time
IT Architectur e Review Board (ARB)	High	Medium	**Keep Satisfied:** Regular technical consultation on proposed security architecture, data standards, and critical integratio n	Security (SSO, Encryption) , Scalability (NFRs), System Stability

Stakeholder Group	Influence Level	Interest Level	Engagement Strategy	Primary Concern
			pathways, ensuring NFR adherence.	
Employee Base (End Users)	Low	High	**Keep Informed:** Proactive communicatio n regarding deployment, training sessions, and continuous solicitation of feedback focused on interface usability (UX/UI) and fair scheduling outcomes.	Usability, Availability (NFRs), Fairness in Workload Balance

Legal/Compliance Team	Medium	High	**Manage Closely:** Detailed consultation on defining all mandatory operational constraints (e.g., predictive scheduling rules, audit log requirements, data retention policies).	Legal Risk Avoidance, Data Integrity, Regulatory Enforcement

The Legal/Compliance Team requires heightened management. Although

their organizational influence might be classified as medium, their function defines non-negotiable architectural constraints (NFRs) that directly protect the company from multi-million dollar penalties.
Therefore, their requirements supersede standard functional preferences, making close management essential for project success.

4.0 User Stories

User stories serve as the smallest unit of work, linking functional requirements and quality constraints directly to user value. These stories are written from the end-user's perspective, providing context for the development team.

4.1 Functional User Stories (Core System Behavior)

A. Core Scheduling and Conflict Resolution

1. **As a Manager,** I want to view the real-time availability of resources (rooms, specialized

equipment, and key personnel skill sets) simultaneously on a single interface, **so that** I can select the optimal combination without manual cross-referencing and immediately prevent multi-faceted scheduling conflicts.

2. **As an Employee,** I want to define my maximum desired meeting allocation per week and preferred work boundaries, **so that** the scheduler algorithm uses these parameters as soft constraints, prioritizing my defined work-life balance and reducing the risk of fatigue or presenteeism.

3. **As a Manager,** I want the system to automatically calculate and suggest 3–5 viable alternative event times when an initial hard conflict is detected, factoring in attendee seniority and historical resource utilization rates, **so that** I can efficiently resolve scheduling deadlocks without having to restart the booking process manually.

4. **As an Event Organizer,** I want the capability to mark specific resource allocations as "tentative" or "mandatory," **so that** the Intelligent Scheduling Core (ISC) can appropriately weigh the rigidity of these constraints and prioritize non-bypassable requirements during optimization calculations.

5. **As an Employee,** I want to accept, decline, or propose a new time for an event invitation directly through external channels, such as a confirmation email or my existing corporate calendar client (e.g., Outlook), **so that** the central scheduling application's data is instantly synchronized, minimizing the possibility of data divergence and confusion.

B. Administration and Resource Management

1. **As an Administrator,** I want to easily tag physical resources (e.g., "Auditorium A," "R&D Lab 4") with multiple searchable features (e.g., "Video Conferencing Ready," "50+ Capacity," "High-Security Access"), **so that** end-users can filter complex resource needs and locate appropriate venues quickly.

2. **As an Administrator,** I want to define and enforce tiered Access Control Lists (ACLs) for specific resource pools (e.g., ensuring specialized manufacturing equipment is only bookable by certified engineers), **so that** only authorized personnel can schedule high-security or expensive specialized assets.

3. **As an Admin,** I want to generate utilization reports for specific

resource categories (e.g., all high-capacity meeting rooms) over a specified period (e.g., the last quarter), **so that** management can objectively assess the real-world resource demand, identify

patterns of ineffective utilization, and make informed capital expenditure decisions.

c. Compliance and External Interaction

1. **As a Manager,** I want the system to proactively run a constraint check against jurisdictional labor laws and flag any proposed schedules that violate mandatory rules (e.g., insufficient advance notice, inadequate rest period between shifts), **so that** I can correct the schedule prior to submission and avoid costly non-compliance investigations and penalties.

2. **As a Guest (External Client),** I want to receive an invitation that includes a secure, temporary, one-time-use link to view the complete event details, materials, and venue location, **so that** my access is seamless and immediate while strict corporate security protocols are maintained.

3. **As a Manager,** I want the system to automatically track the allocated budget for an event against the costs of utilized internal resources (e.g., labor costs for assigned staff, hourly

room rental rates), **so that** I can monitor expenditures in real-time and control against potential budget overruns.

4.2 Non-Functional User Stories (System Constraints/Quality Attributes)

Non-functional requirements (NFRs) define the essential quality attributes (such as performance, security, and availability) that dictate the long-term success of the enterprise system.

1. **[Performance/Latency] As a high-volume scheduler,** I want the Intelligent Scheduling Core (ISC) to calculate and display optimized scheduling options (involving up to 50 attendees and 5 resource constraints) within **2.5 seconds** of input submission, **so that** I maintain flow and do not experience frustrating delays during peak enterprise booking periods.

2. ** As an IBM Employee,** I want the application to transparently authenticate me using the corporate Single Sign-On (SSO) service, **so that** I am not required to manage yet another unique password and all system access is universally governed by existing, centralized security policies.

3. ** As the IBM CTO,** I want the mission-critical event scheduling service to be reliably available **99.999 percent** of the time, **so that** key strategic initiatives, high-level project meetings, and client engagements are functionally immune to system disruption.

4. ** As an IT Operations Analyst,** I want the underlying system architecture to be demonstrably capable of supporting up to **1,000 concurrent users** performing lookups and booking attempts simultaneously without any measurable degradation in response time, **so that** the application can be confidently scaled across the entire New Jersey campus and potentially to other branches.

5. **[Usability/Accessibility] As an Employee utilizing assistive technology,** I want the interface to be fully compliant with WCAG standards (e.g., navigable via keyboard commands) and compatible with standard corporate screen reading software, **so that** I can manage and participate in scheduling processes without accessibility barriers.

5.0 MVP Features

The Minimum Viable Product (MVP) for Phase 1 is strictly defined to maximize the capture of immediate business value by addressing the core problems identified: conflict chaos, administrative waste, and

compliance risk. The MVP must validate the viability of the Intelligent Scheduling Core (ISC) approach.

5.1 Core MVP Feature Set (Phase 1 Essential Deliverables)

The following features are mandatory for the Phase 1 Go/No-Go decision and represent the minimal set required to replace the existing, fragmented manual methods.

5.1.1 Intelligent Scheduling Automation Engine (ISC)

The ISC is the core technological differentiator of this project. It must move beyond sequential booking checks to perform **multi-objective optimization**, ensuring that schedules meet the

triple demands of cost efficiency, compliance, and utilization simultaneously.

- **Real-Time Data Integration:** The engine must pull and synthesize data feeds from mandatory sources, including employee availability, resource constraints (e.g., room capacity), and high-level project deadlines.
- **Constraint Handling:** Crucially, the ISC must manage and

  enforce hard business rules and complex labor constraints. The system architecture must ensure that mandatory compliance checks (like predictive scheduling notice periods) are non- bypassable constraints in the optimization model, not mere warnings.

5.1.2 Real-Time Conflict Detection and Resolution

This feature eliminates the high administrative burden identified in the problem statement (12 hours/week managerial time).

- **Instantaneous Validation:** Provides immediate validation of resources and attendees upon input, eliminating manual error.
- **Automated Suggestions:** Based on the ISC output, the system must provide rapid, automated suggestions for alternative scheduling configurations (e.g., new time slots or alternative resources with matching skill tags).

5.1.3 Integrated Communication and Notification System

While not a dedicated email service, the application must manage internal scheduling communications effectively.

- **Confirmation Workflow:** Automated notifications (email and in-app alerts) for creation, confirmation, modification, and cancellation of events.
- **Workflow Automation:** Basic automation to manage time- sensitive events, such as automated reminders 24 hours prior to a meeting and prompts for organizers to release reserved resources upon event conclusion.

5.1.4 Enterprise Calendar Synchronization

Synchronization is essential for data integrity and user adoption.

- **Two-Way Sync:** Guaranteed, reliable, two-way, real-time synchronization with the IBM standard calendar platform (e.g., Microsoft Exchange/Outlook), treating the Scheduler App as the

source of truth for resource booking.
- **Standard Compatibility:** Support for open standards (e.g.,

iCal) to facilitate smooth integration for external guests and non-standard internal users.

5.1.5 Role-Based Access Control (RBAC) and ACL Management

Security and data governance require strict access partitioning.

- **Role Definition:** Secure definition and enforcement for distinct access roles (Employee, Manager, Event Admin, Guest).
- **ACL Enforcement:** Fine-grained management of Access Control Lists (ACLs) applied at the resource level, ensuring that certain calendars or specific, high-value resources are only accessible to designated user groups.

5.2 Optional Features (Phase 1.5 Candidates, Post-MVP)

These features provide significant incremental value and should be scoped for inclusion immediately following the successful technical validation of the Phase 1 MVP.

- **Customizable Reporting Engine:** Provides managers with self-service capabilities to generate ad-hoc reports beyond the standardized dashboard metrics, focusing on resource utilization rates and efficiency gains.
- **Working Location Management:** Allows employees to dynamically update their planned working location (e.g., home office, satellite location, specific NJ campus building), enhancing the ISC's ability to schedule location-aware events accurately.
- **Advanced Cost Tracking Module Hooks:** Implementation of the necessary API integration points and data structures required to track real-time labor costs and overhead associated with each scheduled event or resource allocation. This prepares the system for full integration with corporate financial systems in Phase 2.

5.3 Future Enhancements (Phase 2 and Beyond)

These features leverage the accumulated data and architectural foundation established in Phase 1 to deliver high-level strategic value.

- **Predictive Analytics Dashboard:** Utilizing accumulated historical scheduling data and optimization outcomes to forecast crucial operational elements, such as potential resource shortages, peak period bottlenecks, or emerging skill gaps within the workforce. This allows executive management to make proactive strategic decisions, such as advanced planning for talent acquisition or targeted training initiatives.
- **Foundation Model Integration:** Integration with advanced IBM Foundation Models and Generative AI to interpret complex, natural language requests (e.g., "How do I create the best employee schedule that balances workload and reduces labor costs?"). The system would then use optimization algorithms (e.g., IBM Decision Optimization/ILOG CPLEX) to propose prescriptive schedules, accompanied by natural language explanations of the optimization trade-offs. This feature aligns directly with IBM's strategic vision for AI as an advisory partner.
- **Automated Skill Matching and Resource Leveling:**

Implementing advanced logic to match specific project tasks against a defined skill matrix of employees, ensuring the optimal talent is consistently allocated based on expertise and current

workload capacity, leading to productivity improvements of 10–20%.

6.0 Wireframes / API Endpoint List

6.1 Text-Based Wireframe Specifications (UX/UI Foundation)

The user interface (UI) design emphasizes a user-centered experience, guiding the user through the complex processes of constraint definition and conflict resolution.

6.1.1 Authentication Screens (Login, SSO Integration)

- **Purpose:** Secure, streamlined entry into the application.

- **Layout:** Minimalist, adhering to IBM corporate branding guidelines. The screen prominently displays the IBM logo and a single field for IBM ID or corporate email.
- **Core Interaction:** The primary action button initiates redirection to the existing corporate Identity and Access Management (IAM) service (SSO) for token exchange. There must be no standard username/password fields, reinforcing NFR 13 (Security/Authentication). A secondary link provides access to corporate password recovery services.

6.1.2 User Dashboard (Personal Schedule, Key Metrics)

- **Goal:** Provide an immediate, actionable summary, prioritizing user tasks and potential compliance issues.
- **Layout:** Standard enterprise dashboard structure.

  - **Header:** Displays user name, current time/location, and a prominent 'Create New Event' button.
  - **Left Navigation Panel:** Primary links (Calendar View, Resource Search, Reports, Admin Panel - conditional).
  - **Central Panel (Focus):** Day/Week view of the personal schedule. Above the calendar, a dedicated section lists **Pending Invitations** requiring RSVP and high-priority **Alerts/Notifications** (e.g., schedule change alerts, compliance warnings).
  - **Right Rail:** Displays key user-centric metrics, such as a derived personal Resource Utilization Score (comparing allocated meeting time versus available focused work time) and a count of **Open Conflicts** requiring user attention (optimally zero).

6.1.3 Event/Meeting Creation Workflow (Constraint Definition Focus)

- **Goal:** A multi-step, form-driven process ensuring all necessary resource and compliance constraints are defined before submission.
- **Step 1: Event Metadata:** Input fields for Title, Detailed Description, Event Type (e.g., Client Meeting, Internal Workshop), and Start/End Date/Time/Time Zone.
- **Step 2: Personnel & Skills:** Searchable field integrated with the IBM Directory for adding attendees. Mandatory secondary input for defining required **Skill Tags** (e.g., "L4 Security Clearance," "COBOL

Expertise") necessary for the event.

- **Step 3: Resource & Venue Allocation:** Filterable search interface for physical and virtual resources. Filters include Location (IBM NJ

building/floor), Capacity, and Equipment Tags (e.g., Whiteboard, Video Conferencing, Lab Access). Real-time checker displays available resources for the specified time slot.

- **Step 4: Constraint Review & Optimization (ISC Interaction):** Before final submission, the system displays a "Compliance Check Status" (Pass/Fail) against labor rules (NFR 9) and a summary of any pending conflicts. The system then offers optimized time/resource alternatives calculated by the ISC.
- **Final Action:** Two buttons: "Schedule Optimized Event" (default) and "Force Schedule (Acknowledge and Override Conflicts/Warnings)" (requires elevated Manager permissions and audit logging).

6.1.4 Centralized Calendar and Visualization View

- **Goal:** Provide operational visibility across departments, subject to strict ACLs.

- **Key Features:** Switchable views (Day, Week, Month, Agenda, Resource Heatmap). Highly performant search functionality with filters for Department, Project Code, and specific Resource Type. Events are color-coded based on status (Confirmed, Tentative, Conflict). Supports drag-and-drop functionality for rapid schedule adjustments, which must trigger immediate conflict re-checks.

6.1.5 Administration Panel (User/Resource Management)

- **Access Restriction:** Available only to users with the 'Event Administrator' role, enforced via RBAC/ACL (NFR 8).
- **Content:** Organized into distinct management tabs:
  - **User Management:** Tools for managing user roles (RBAC) and setting specific, granular access control rules (ACLs) for resource groups.
  - **Resource Master Data Management (MDM):** Interface for adding, editing, and retiring physical resources (rooms, equipment) and managing associated metadata (tags, location, capacity).
  - **Compliance Configuration:** Management interface for defining and updating region-specific labor laws and rest periods, which feed into the ISC constraints engine (NFR 9).
  - **System Health Dashboard:** Monitoring panel for tracking NFR metrics (availability, latency, security audit logs).

6.2 RESTful API Endpoint List for Phase 1 Development

The API design follows RESTful principles, using standard HTTP methods (GET, POST, PUT, DELETE) and clearly defining the resource representations. This structure facilitates clear separation of concerns, scalability, and ease of integration with other IBM systems.
API Endpoint Specification — Phase 1 MVP

Endpoint	HTTP Method	Resource Type	Description
/api/auth/login	POST	Authentication	Initiates SSO token exchange, validates corporate credentials, and returns a secure session token.

/api/events	GET	Event List	Fetches a paginated list of all events visible to the authenticated user within the specified time range. **Query:** timeMin, timeMax.
/api/events	POST	Event Creation	Creates a new event record, validates mandatory inputs, and triggers the ISC conflict check before saving. **Body:** {title, start, end, organizerId, attendees,

Endpoint	HTTP Method	Resource Type	Description
			resourceIds, constraints}.
/api/events/{event Id}	PUT	Event Update	Modifies core details of an existing event (e.g., time, location). Triggers mandatory re-check for conflicts.
/api/events/{event Id}	DELETE	Event Deletion	Removes an event. Requires high-level ACL check on the user's role relative to the organizer.
/api/events/{event Id}/re spond	POST	RSVP Management	Allows an attendee to submit a formal response (Accept, Decline, Tentative, Propose New Time). **Body:** {status, comment?}.

/api/resources	GET	Resource List	Fetches a list of physical or logical resources (rooms, equipment, skill pools). Supports filtering by availability and tags. **Query:** location, capacity, available_at_time.

/api/conflicts	POST	Conflict Check	Dedicated ISC endpoint. Runs the multi-objective optimization engine on a proposed schedule to identify hard and soft conflicts before commitment. **Body:** {proposed_schedule}.

/api/conflicts/sugg estio ns	GET	Optimization	Fetches alternative time/resource configurations calculated by the ISC based on the latest conflict detection.
/api/admin/acls	POST/PUT	Access Control	Allows administrators to manage and update access control rules for

Endpoint	HTTP Method	Resource Type	Description
			resources or specific calendar views.
/api/admin/resources/{r esourceId}/metad ata	PUT	Resource MDM	Updates the tag, capacity, or location metadata for a specific physical resource.
/api/users/{userI d }/free busy	GET	Availability	Fetches the derived free/busy status for a specified user or group based on synchronized calendar data, respecting privacy settings.

The API structure reflects the system's requirement for enterprise intelligence. By separating the core scheduling logic (CRUD operations on /api/events) from the computational logic (/api/conflicts), the design enforces the use of the Intelligent Scheduling Core (ISC) as a mandatory service layer, rather than allowing simple, unvalidated bookings. This ensures that optimization and security checks are central to the system's function.

7.0 Acceptance Criteria

Acceptance Criteria (AC) serve as the quantifiable definition of system completion, ensuring that all functional, business, and non-functional requirements are testable and measurable. The criteria are defined to be clear, concise, and focused on the observable outcome, utilizing measurable targets, particularly for quality attributes (NFRs).

7.1 Functional and Non-Functional Acceptance Criteria

The following criteria table incorporates specific measurable parameters, often derived from the Gherkin methodology (Given-When-Then), and addresses the crucial enterprise NFRs (Security, Performance, and Compliance). By setting these measurable targets, the project ensures that the development process prioritizes architectural resilience and operational stability.

Functional and Non-Functional Acceptance Criteria

Feature/User Story	Category	Acceptance Criteria (Measurable Target / Gherkin Format)
A. Event Creation & Notification	Functional	**Scenario:** Manager creates an event with 20 attendees. **When** the manager confirms the booking, **Then** the event is successfully written to the database, and all required confirmation notifications must be reliably dispatched (status 200) within **750 milliseconds**.
B. Real-Time Conflict	Functional/Bus. Rule	**Scenario:** Proposed booking

Feature/User Story	Category	Acceptance Criteria (Measurable Target / Gherkin Format)
Resolution		conflicts with a 100% capacity resource. **When** the user attempts to submit the event, **Then** the system must display an explicit conflict warning and present at least three optimized non-conflicting time slots (e.g., \pm 3 hours range) within **1.5 seconds** via the /api/conflicts/suggestio n s endpoint.
C. Compliance (Predictive Scheduling)	Compliance (NFR)	**Scenario:** Manager schedules a shift change violating the 10-hour mandatory rest period rule. **When** the system runs the compliance check, **Then** the transaction must be explicitly blocked with a status code 403 (Forbidden), and an unrecoverable

		audit log entry must be generated (NFR 9).

D. Calendar Synchronization (Two-Way)	Data Integrity	**Scenario:** An external calendar client changes an RSVP status. **When** the Scheduler App polls or receives a webhook notification, **Then** the corresponding database record must reflect the change accurately within **90 seconds**. Data divergence integrity (sync errors) must be maintained at a rate of less than **0.001%** daily.
E. System Availability (Uptime)	Availability (NFR)	**Uptime Metric:** The production environment, including the ISC service, must maintain an annual uptime exceeding **99.995%** (equivalent to less than 26 minutes of unscheduled downtime per year).
F. System Performance (Latency)	Performance (NFR)	**Peak Concurrency Response:** During load testing simulating **1,000 concurrent users** performing data retrieval

Feature/User Story	Category	Acceptance Criteria (Measurable Target / Gherkin Format)
		(GET requests), the average API response time must remain below **2.0 seconds** at the 99th percentile.
G. Data Security & Encryption	Security (NFR)	**Data Protection Standard:** All sensitive data (PII, specialized resource metadata, and ACL records) must be secured at rest using **AES-256** encryption. All network communication, including API calls, must be secured via **TLS 1.3 or higher**.

H. Role-Based Access Control (RBAC)	Security/Bus. Rule	Unauthorized Access: Given a standard 'Employee' role user attempts to execute a PUT or POST request on an Admin-only endpoint (e.g., /api/admin/acls), Then the system must immediately reject the request with a status code 401/403 (Unauthorized/Forbidden) prior to processing any business logic.

I. Usability (Interface Load Time)	Usability (NFR)	Initial Load Time: The primary User Dashboard and the Event Creation wireframes (Sections 6.1.2 & 6.1.3) must fully render and be functionally responsive on corporate desktop browsers within 1.5 seconds under normal operating conditions.

8.0 Conclusion and Next Steps

8.1 Synthesis of Phase 1 Analysis and Deliverables

Phase 1 has established the critical business justification and technical requirements for the IBM-NJ-Event Scheduler App. The analysis demonstrated that the reliance on manual scheduling results in demonstrable, significant financial loss, potentially amounting to 23%

of annual revenue through hidden costs like labor waste and manager opportunity cost.

The proposed solution centers on the development of the Intelligent Scheduling Core (ISC), which transforms the process from reactive booking management to proactive, multi-objective optimization.

Crucially, the system is architecturally designed with mandatory non-functional requirements to mitigate high legal risk associated with contemporary labor laws, ensuring

automated compliance and protecting the organization from penalties. The MVP is narrowly defined to deliver immediate relief from conflict management burdens and administrative overhead while establishing the secure, high-performance foundation (99.995% availability, sub-2.0 second latency) required for an enterprise-grade application.

8.2 Proposed Activities for Phase 2 (Detailed Design and Integration)

Upon approval of this Phase 1 Problem Understanding and Requirements Specification, the project must immediately transition to Phase 2, focusing on detailed architectural design and integration planning. The key activities for Phase 2 are:

1. **System Architecture and Design Specification:** Develop the comprehensive technical architecture, including selection of the cloud hosting environment, definition of the microservices topology, and detailed logical and physical data model design. This includes the final selection of specific Constraint Programming (CP) libraries and algorithms to be implemented within the ISC.

2. **External System Integration Planning:** Create detailed interface specifications and data mapping documents for all mandatory external systems. This includes comprehensive mapping of authentication workflows for IBM IAM/SSO and deep integration planning with the existing corporate calendar platform to ensure robust two-way data synchronization and integrity (NFR D).

3. **High-Fidelity UX/UI Design:** Develop high-fidelity visual mockups based on the approved text-based wireframes (Section 6.1). This step will culminate in targeted User Acceptance Testing (UAT) sessions with primary user groups (Managers and Employees) to validate the Usability NFRs and fine-tune the human-computer interaction flow.

4. **Formal Test Strategy Development:** Formalize the quality assurance plan, including the development of security testing protocols (to validate NFR G and H), comprehensive load and stress testing procedures (to validate NFR E and F), and specific regression tests designed to confirm automated compliance enforcement (NFR C).

5. **Preparation for Foundation Model Data Layer:** Define the data acquisition, integrity, retention, and disposal policies necessary to collect and curate the high-quality scheduling data required to train and integrate the Foundation Models envisioned for Phase 3 (Future Enhancements).