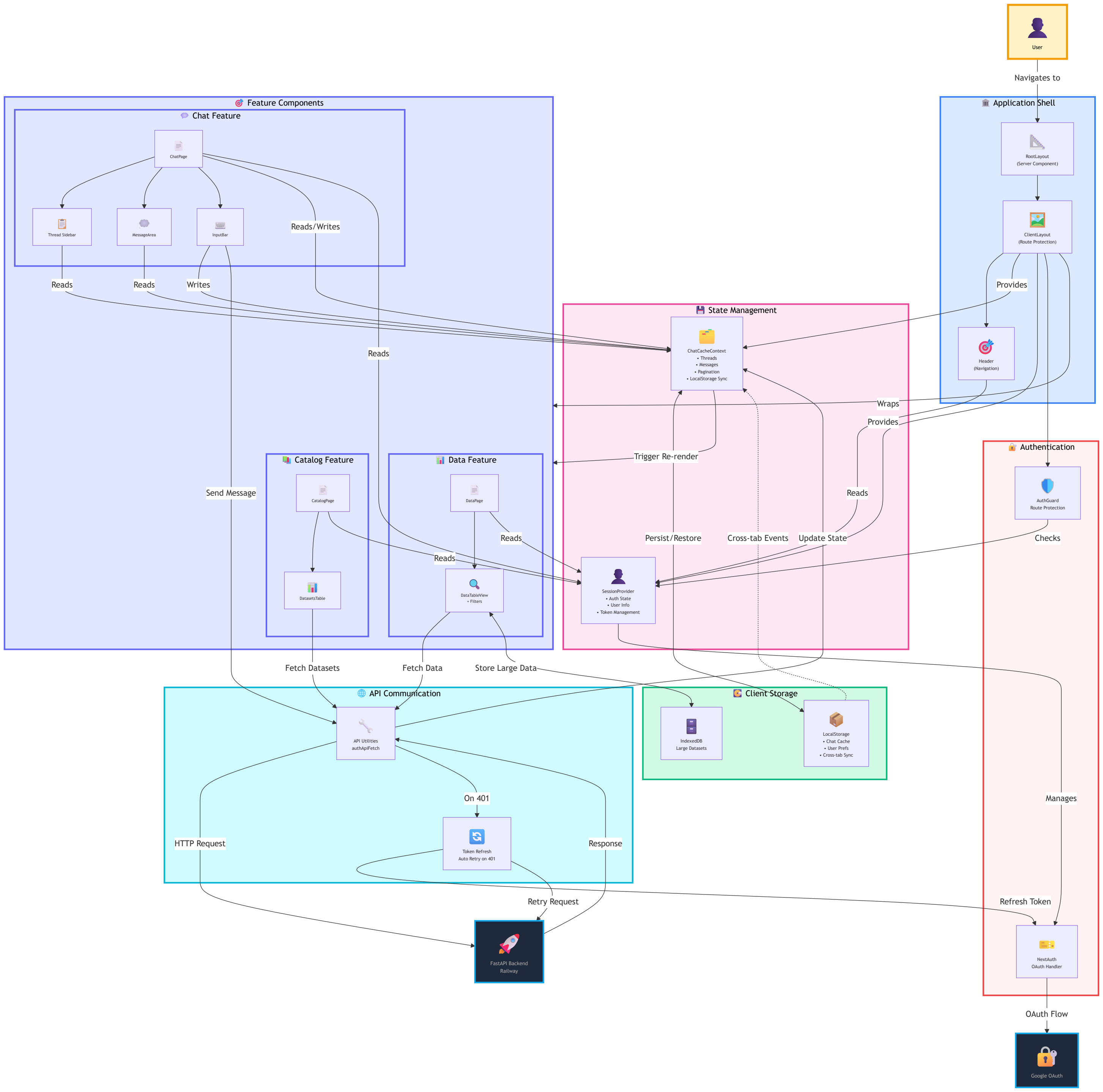
Frontend Architecture Diagram - Version 3 (Component-Interaction Focused)



Architecture Overview

🎯 Core Architectural Components

1. **Application Shell** (Entry Point)

- **RootLayout**: Server-side rendered HTML structure
- **ClientLayout**: Client-side route protection and state providers
- **Header**: Global navigation component

2. **State Management** (Single Source of Truth)

- **ChatCacheContext**:
  - Manages all chat-related data (threads, messages, pagination)
  - Persists to LocalStorage with cross-tab synchronization
  - Provides optimistic updates for instant UI feedback
- **SessionProvider**:
  - Manages authentication state
  - Provides user information to all components
  - Handles token lifecycle

3. **Feature Components** (Business Logic)

- **Chat Feature**:
  - Sidebar displays thread list from ChatCache
  - MessageArea renders messages from ChatCache
  - InputBar sends messages via API and updates ChatCache
- **Catalog Feature**:
  - Displays browsable dataset catalog
  - Fetches data via API utilities
- **Data Feature**:
  - Table view with filtering capabilities
  - Uses IndexedDB for large dataset storage

4. **API Communication** (Backend Integration)

- **API Utilities**: Centralized HTTP request handling
- **Token Refresh**: Automatic retry mechanism on authentication failures
- Handles all backend communication with error recovery

5. **Authentication System** (Security)

- **NextAuth**: OAuth 2.0 flow handler
- **AuthGuard**: Protects routes from unauthorized access
- Integrated with SessionProvider for state management

6. **Client Storage** (Performance)

- **LocalStorage**: Fast access for cache and preferences
- **IndexedDB**: Large dataset storage without memory pressure
- Cross-tab synchronization for consistent state

🔄 Key Interaction Patterns

Message Send Flow:

```
User types message
    ↓
InputBar captures input
    ↓
InputBar calls APIUtils.authApiFetch('/analyze')
    ↓
APIUtils sends to Backend with auth token
    ↓ (if 401)
TokenRefresh gets new token → Retry request
    ↓
Backend returns response
    ↓
ChatCache updates with new message
    ↓
MessageArea re-renders with new data
```

Authentication Flow:

```
User navigates to protected route
    ↓
AuthGuard checks SessionProvider
    ↓ (if not authenticated)
Redirect to NextAuth login
    ↓
NextAuth redirects to Google OAuth
    ↓
Google returns with tokens
    ↓
NextAuth creates session
    ↓
SessionProvider updates state
    ↓
User redirected to protected route
```

Cache Persistence Flow:

```
ChatCache state changes
    ↓
useEffect triggers save to LocalStorage
    ↓
Other browser tabs receive storage event
    ↓
Other tabs' ChatCache syncs with new data
    ↓
All tabs show consistent state
```

🏗️ Architectural Principles

1. **Unidirectional Data Flow**: State flows down, events flow up
2. **Single Source of Truth**: ChatCacheContext is authoritative for chat data
3. **Separation of Concerns**: Components, state, API, and auth are independent
4. **Error Recovery**: Automatic token refresh and retry on failures
5. **Performance**: LocalStorage + IndexedDB for fast access and large data
6. **Consistency**: Cross-tab synchronization ensures consistent state

📊 Component Communication Matrix

Component	Reads From	Writes To	Communicates With
InputBar	SessionProvider	ChatCache, API	Backend
MessageArea	ChatCache	-	-
Sidebar	ChatCache	ChatCache	-
ChatCache	LocalStorage	LocalStorage	-
APIUtils	SessionProvider	-	Backend, TokenRefresh
AuthGuard	SessionProvider	-	NextAuth

Version 3 Focus: Component-based architecture showing actual components, their relationships, data flow patterns, and interaction mechanisms. Emphasizes HOW components work together rather than WHAT layers exist.