**Details of this prototype**  
  
The provided prototype is an advanced Dash-based interactive dashboard tailored for East African airspace management, incorporating synthetic data along with AI-inspired features. Here are the full details of the prototype components, functionality, and design:  
  
**Prototype Overview**  
The dashboard visualizes real-time-style flight traffic and airspace zones over East Africa, aiming to provide operational insights to optimize airspace management for delay reduction, efficiency, and safety. It includes:  
  
- Synthetic airline flight positions with realistic operational status (on-time, delayed, rerouted).  
- East African Flight Information Regions (FIRs) and upper traffic zones rendered as translucent polygons.  
- Major airports highlighted as distinct markers.  
- Dynamic flight routes connecting origin and destination airports.  
- Congestion heatmap coloring for flights indicating traffic hot spots.  
- Routes for rerouted flights with alternate paths visually distinguished.  
- Interactions such as filtering flights by status, airline, and recent time window.  
- Clickable flight markers reveal detailed flight information panels.  
- Summary statistics for filtered flights including counts, average delays, emissions saved, and congestion levels.  
  
  
  
**Key Components**  
**1. Synthetic Data Generation**- Synthetic flight data mimics real-world East African regional airspace bounds.  
- Parameters assigned include flight ID, latitude, longitude, status (on-time, delayed, rerouted), congestion level, airline, timestamps, origin and destination airports, estimated delay, and emissions saved.  
- Flight routes are generated as line segments between origin and destination coordinates.  
- Rerouted flights have synthetic detours simulated by inserting midpoints offset to simulate alternate trajectories.  
  
**2. FIR and Upper Traffic Zone Polygons**- FIRs such as Kenya FIR, Uganda FIR, Tanzania FIR, and an additional hypothetical upper traffic zone are drawn on the map.  
- Each polygon is semi-transparent with distinct colors to visually differentiate controlled airspace sectors.  
- FIR boundaries assist with spatial analysis and situational awareness in airspace management.  
  
**3. Flight and Airport Visualizations**- Airports shown as orange icons, representing major hubs.  
- Flights shown as circular markers colored on a congestion scale (OrRd colorscale).  
- Flight routes displayed as lines; rerouted flights have thicker blue lines for clarity.  
  
**4. Interactivity and Filters**  
- Dropdown filters control flights shown by status and airline.  
- Range slider limits flights displayed to those within selected recent time windows.  
- Clicking markers opens detailed flight info: status, airline, origin, destination, estimated delay, emissions saved, congestion, rerouting info, timestamp.  
  
**5. Summary Dashboard**  
- A flexible summary bar shows live stats from filtered data: number of flights, average delay (minutes), total emissions saved (metric tons), and average congestion.  
- Helps operators quickly gauge airspace performance and issues.  
  
**Technical Details**- Built with Dash (Plotly) in Python for interactive frontend.  
- Map uses Open Street Map tiles rendered via Plotly's mapbox integration.  
- Synthetic data generated and refreshed in-memory on page interaction, simulating live data feeds.  
- Callbacks update map and summary stats responsively.  
- Designed for running locally or as a web deployable lightweight dashboard app with minimal dependencies (`dash`, `plotly`, `pandas`, `numpy`).  
  
**Potential Extensions**- Connect to real ADS-B or live flight tracking APIs for actual flight positions.  
- Integrate AI models for congestion prediction and automated reroute recommendations.  
- Add weather overlays impacting airspace conditions.  
- Inclusion of sector controllers’ workload and communication logs.  
- Real-world FIR polygon data for precise boundaries.  
- Deployment on cloud platforms enabling multi-user access and data streaming.  
  
**Summary**This prototype forms a comprehensive foundation for demonstrating and testing AI-enabled airspace management solutions in the East African aviation context. It visually correlates flight traffic, airspace controls, operational delays, emissions, and dynamic routing in a simulated but realistic environment, supporting better decision-making and safer, efficient airspace utilization.