GPS RAIM Prediction Service

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FAA's Operational Tool GPS Navigation Predictions in the Flight Planning Process

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GNSS Service Availability Prediction

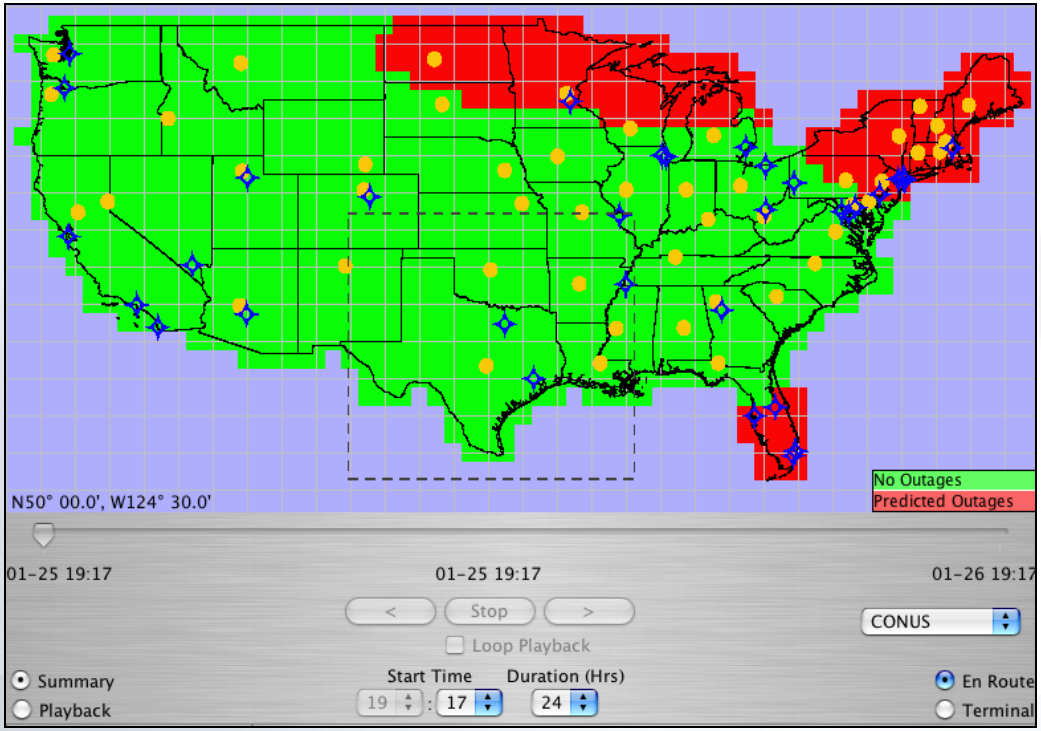
Operational Mission Planning Tools

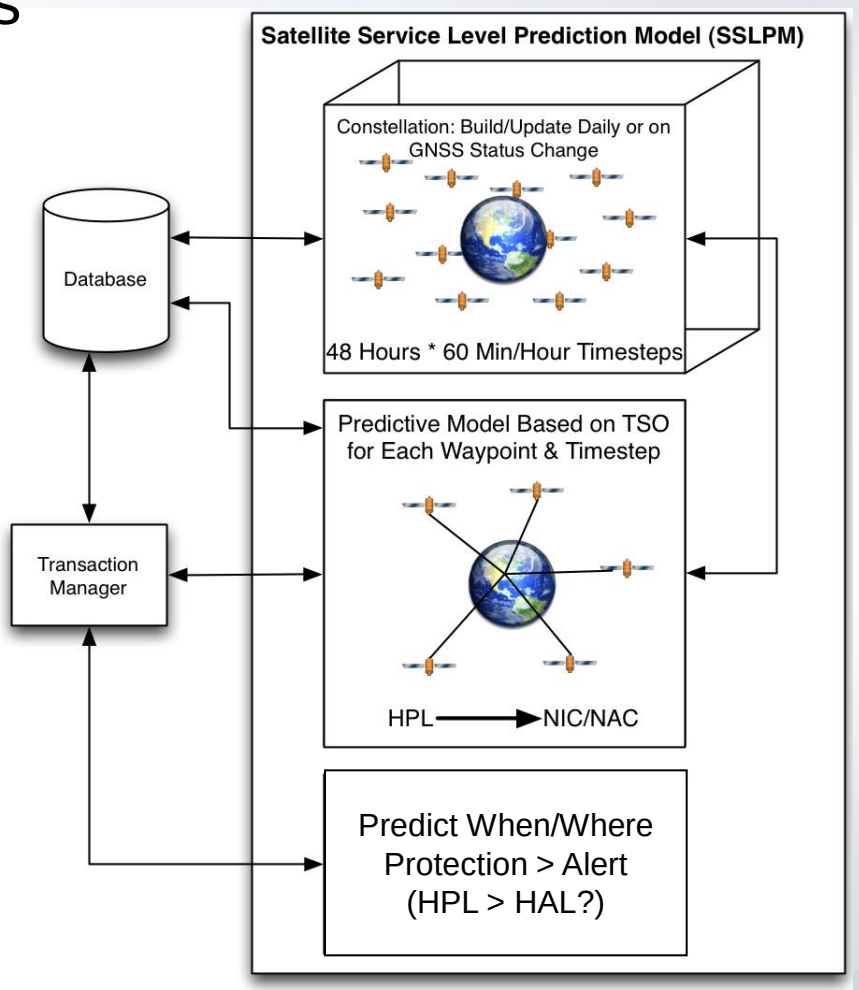
--Anticipate Service Outages

--Mitigate Continuity Breaks

--Enable Graceful Degradation

--Improve User Acceptance





US FAA GPS RAIM Prediction Service Overview

- **Early Motivation:**

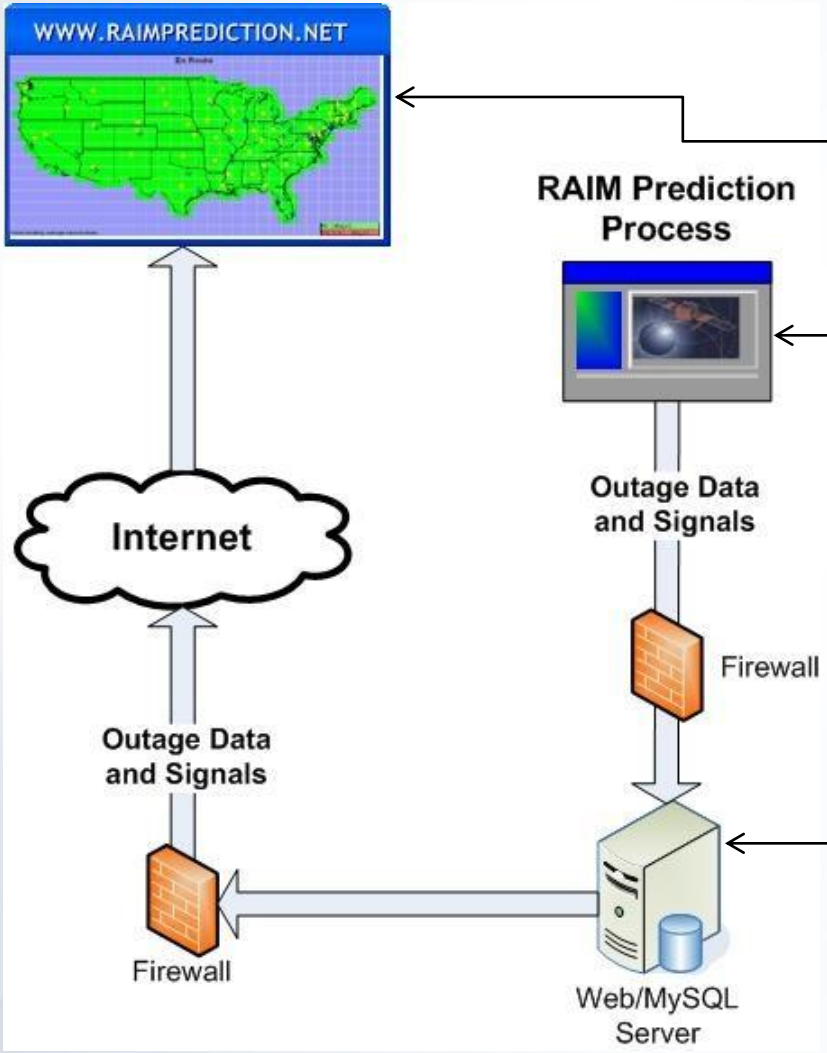
  AC90-100A establishes rule for pre-flight check of GPS navigation

- **Modeling and Prediction Function**
  - **Provide location-based information on expected availability of GPS navigation services**
  - **Account for active state of GPS constellation**
  - **Evaluate availability of require navigation performance (RNP) service against certification models (initially, FAA TSO-C129)**
- **Web based Service: http://www.raimprediction.net**
  - **Two primary interfaces:**

    -- Interactive, graphical display via web browser

    -- Procedural, XML protocol on tcp/ip stack
  - **"Live" monitoring of the SVN constellation via GPS Almanac, SV NOTAM, and US DoD NANU**

GPS RAIM Prediction Service Network

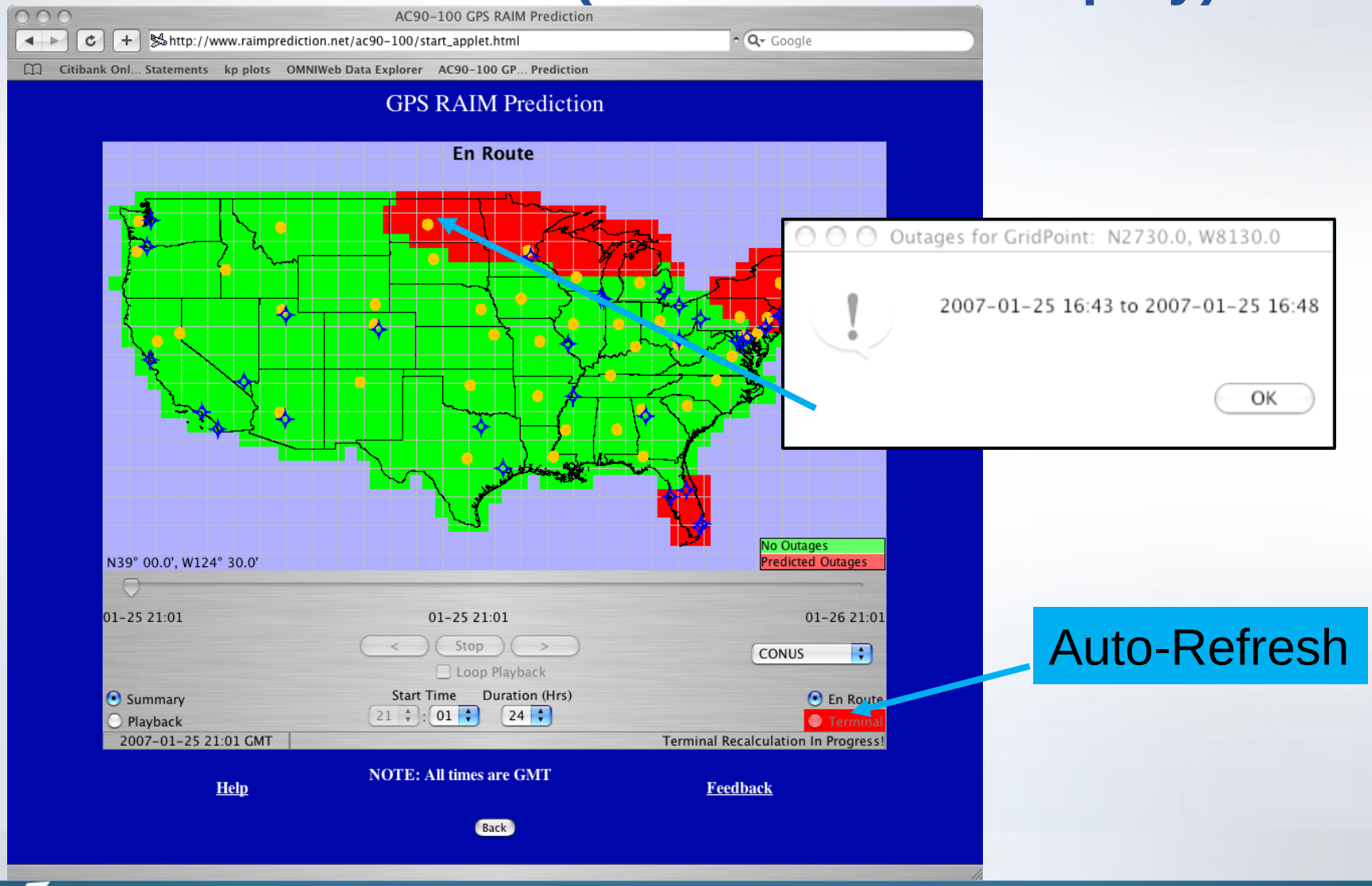


- Presentation & Display
- Service Volume Model (Calculates HPL)
- Relational Database
- Network Protocols

Interactive GPS RAIM Service Interface

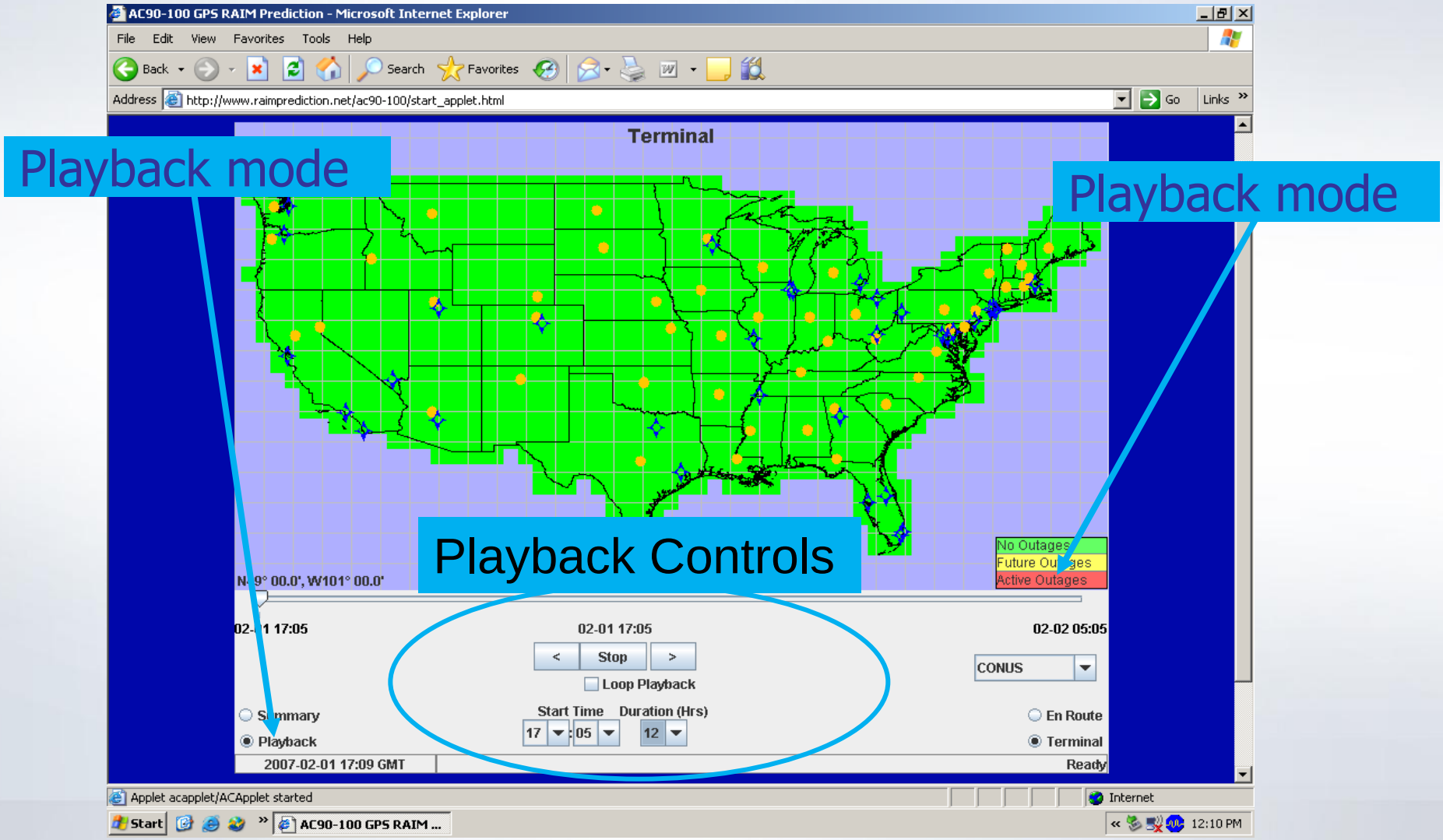
- **Nominally 24/7 Web Access via Browser**
- **Reads Out Three Levels of RNP Service (all horizontal)**
  - **En Route (HAL < 2 nmi)**
  - **Terminal Area (HAL < 1 nmi)**
  - **Non-precision Approach (HAL < 556m)**
- **Graphical Display**
  - **Interactive URL http://www.raimprediction.net**
  - **Service volume (US NAS)—1x1 degree (0.5 x 0.5 for NPA) grid**
  - **Time resolution is 1 min sampling of the GPS constellation with 6 min outage threshold**
- **System Auto-Refreshes on Any Constellation Change**
  - **New almanac issued**
  - **SV NOTAM issued or cancelled**
  - **NANU issued or cancelled**

Interactive Interface (Web Browser Display)

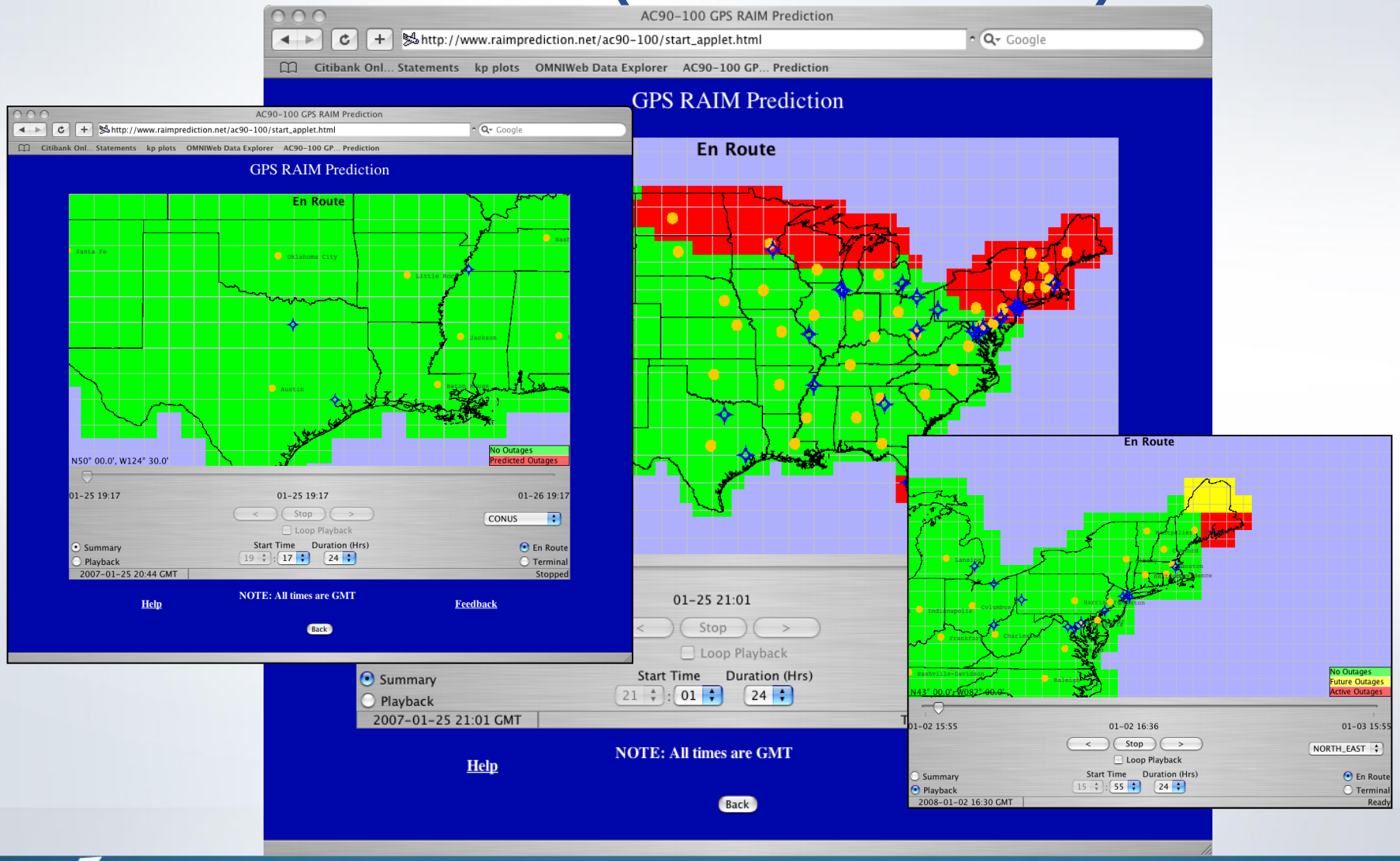


Auto-Refresh

Interactive Interface (Playback Modes)



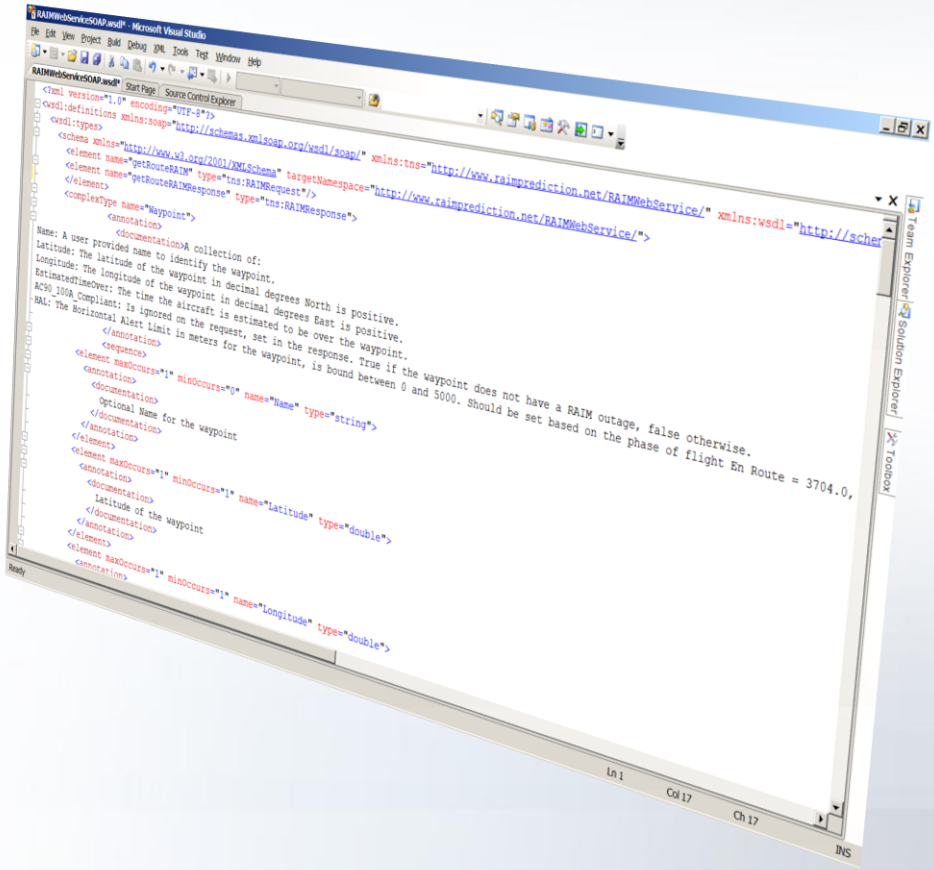
Interactive Interface (Zoom/Pan/Select)



Procedural GPS RAIM Service Interface

RAIMWebServiceSOAP Interface Control Document (ICD)

- Schema Advertised via Web Service Definition Language (WSDL)
- Inputs:
  - Trajectory of 4D points
  - Desired RNP level
  - Avionics configuration
- Outputs:
  - Echo of input data
  - Diagnostic information
  - Point-by-point indication of any predicted outages (HPL > HAL)



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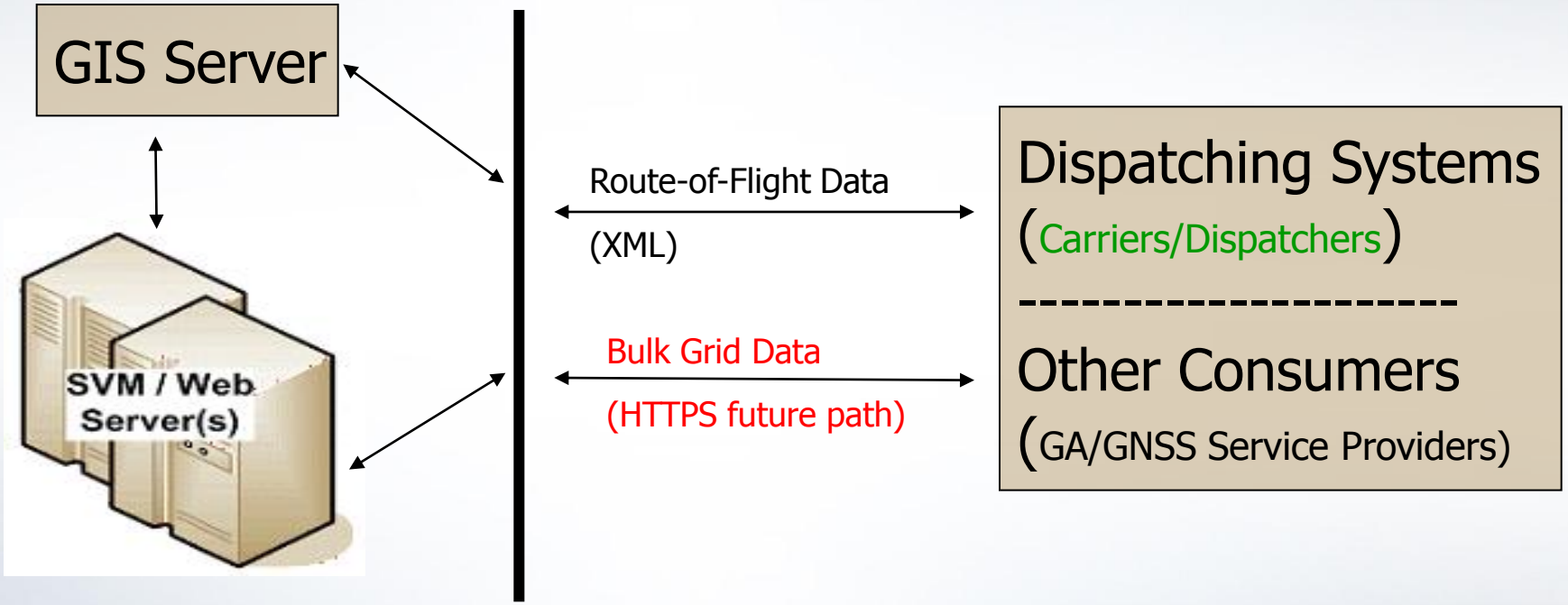

GPS RAIM Prediction Service

Operational Statistics Since Deployment (1 Jul 2009)

- 8 million+ Transactions Served
- Response Time Performance (< 5 Second Transactions)
- User Adoption
  - **Carriers/Operators: Horizon, NetJets, Continental, JetBlue, Delta**
  - **Vendors/Dispatchers: DUATS, WSI, Sabre**
- Primary Demand Is Trajectory Based Operations (Procedural Interface)

Conclusions

- **Service Availability Predictions Important Factor in Adoption of GNSS Services**
  - **Gives users confidence and additional convenience**
  - **Assists service providers with automated forward looks at service volume performance**
  - **Improves conditions for safety of operations via planning**
- **Customized Prediction Services**
  - **Presentation and interface options**
  - **Selection of models (nominally TSO specifications)**
  - **Access control, secure connection, transaction history, etc.**
- **Sponsor Acknowledgement on AC90-100A Effort:**

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