A Preliminary Design Process for Airspace Systems

Initial Assessment - Chicago Case Study (VNTSC-DTS20-PDP-001)

NEXTOR

November 14, 2000

Bob Schwab, Technical Fellow

Boeing Air Traffic Management Services

NAS Architecture Evolution

Strategic Goals

ATM 2000+
FAA
ICAO
NASA Goals

Options for the NAS

¥NAS Growth & Constraints
¥ Emerging Techndogies
¥ Alternative Futures
¥ Globalization

Modernizing the NAS

¥NAS Performance
¥ NAS Safety Enhancement
¥ NAS Affordability

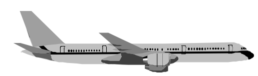
Sustaining the NAS

¥ NAS Sustaining
¥ Funding Profiles
¥ Limited User Benefits
¥ Risk Management

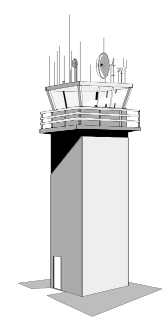
Phase 3
¥ Far Term (2008-2020)
¥ Concept Architecture
¥ Technology Exploration

Phase 2
¥ Mid Term (2003-2007)
¥ Modernization Architecture
¥ New Functionality

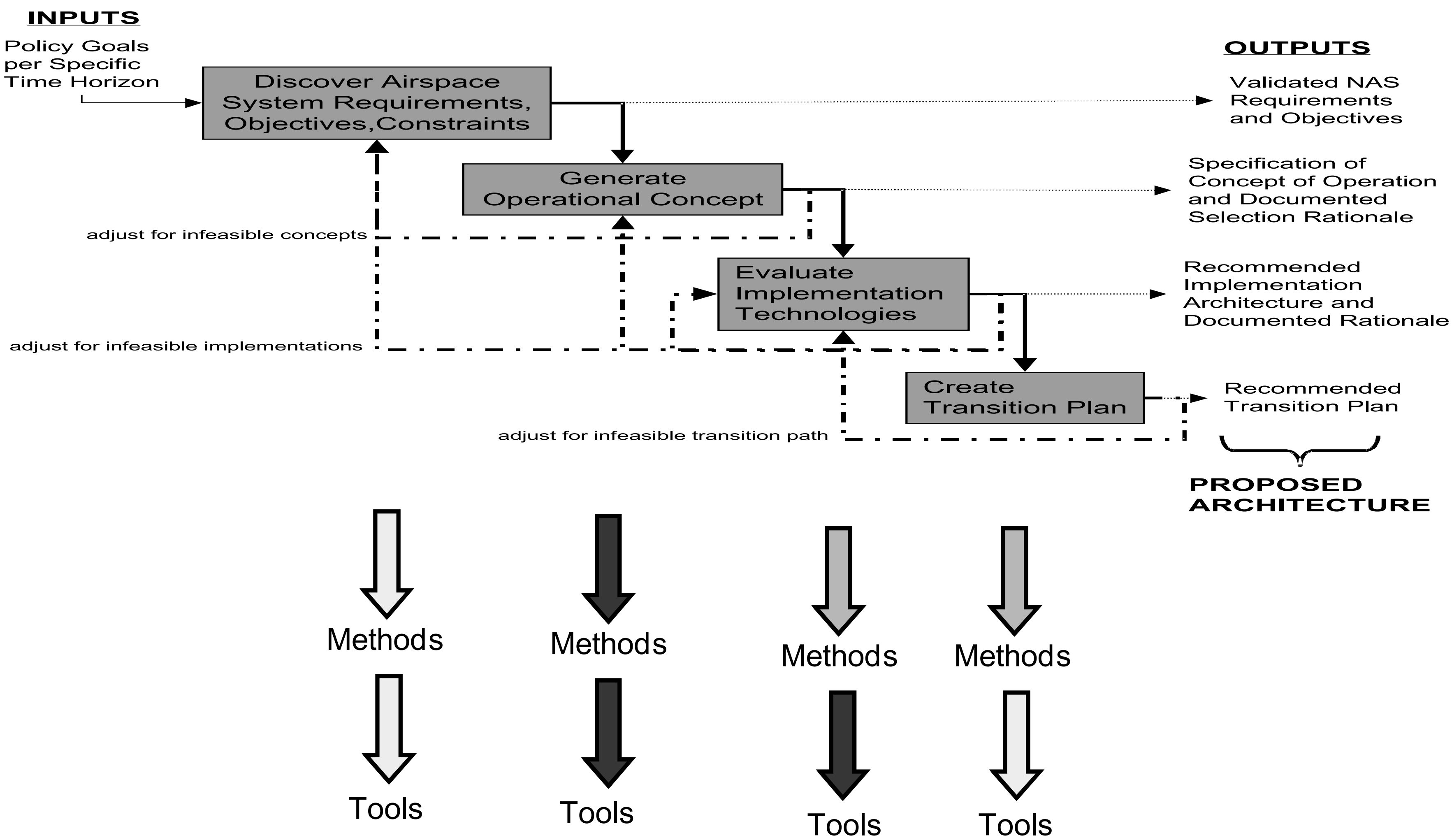
Phase 1
¥ Near Term (2000-2002)
¥ Sustaining Architecture
¥ Committed Deployment



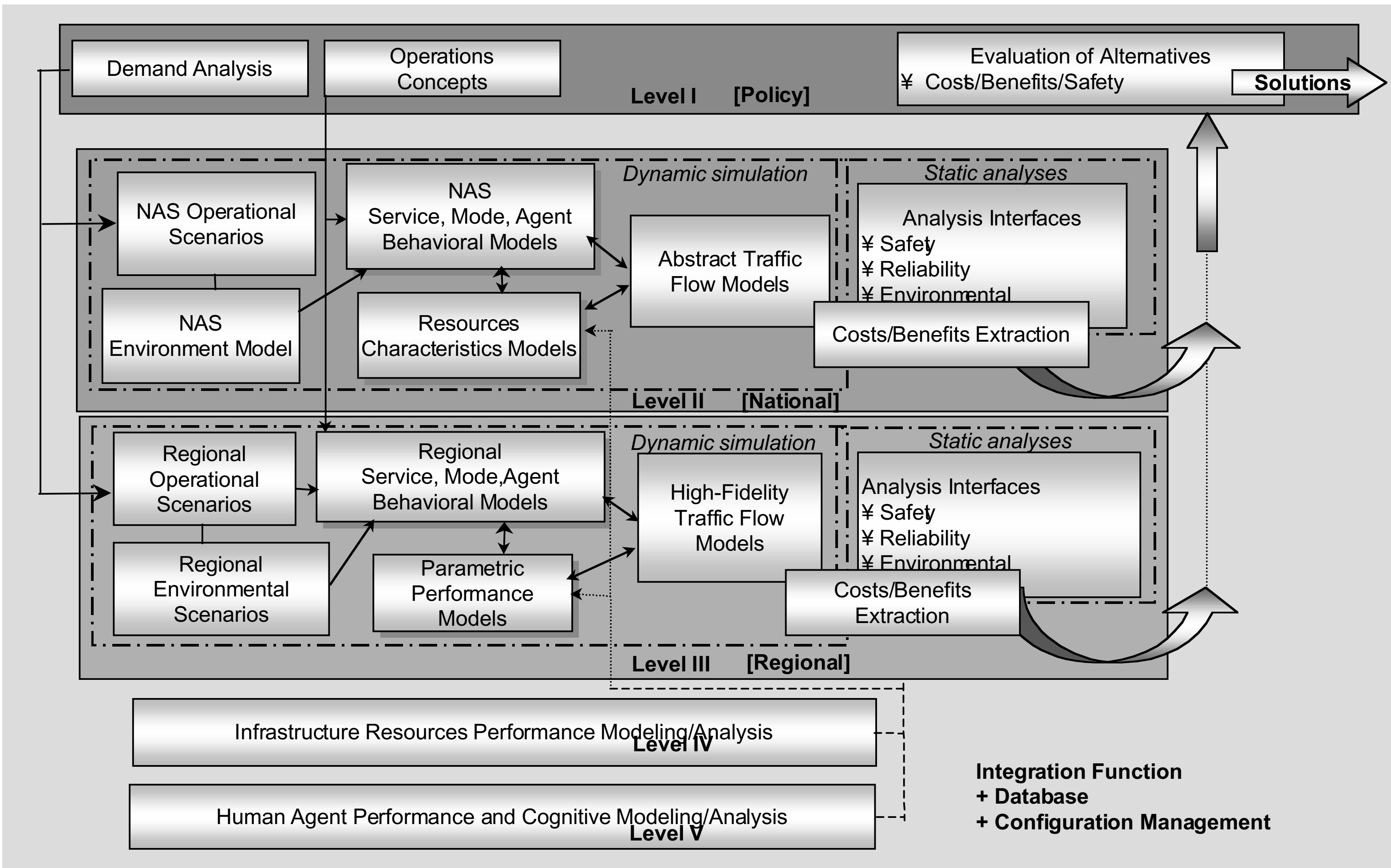
Today s Installed Base



System Methods and Analysis Tools are Required



An Architecture is Required for an Integrated Modeling, Simulation and Analysis Capability



Case Study Approach

¥ A Preliminary Design Process has been drafted

— process needs to be validated

— baselining and solution development must be grounded in real NAS performance needs

— Case Study approach using several NAS operating regions to provide operational insight and real-world validation data

¥ Chicago is the initial Case Study airport/airspace region

— some operational issues are specific, others are common to high-density complex terminal areas

¥ Additional Case Study regions to address overall NAS performance

— comprehensive concept and technology exploration

— sufficient scope to develop toolset requirements for NAS-wide trades

Preliminary Design Process, Phase 1

Project sponsored by the NASA AATT program, Shahab Hasan

Project team:

- Boeing Commercial Airplane Group (Aslaug Haraldsdottir, Bob Schwab)
- Volpe Transportation Center (Dick Wright, Suzanne Chen, Bob Wisemann)
- Logistics Management Institute (Pete Kostiuk)
- Flight Transportation Associates (Bob Simpson)
- NEXTOR (John Hansman)
- FAA Coordinator Air Traffic Airspace Management (Bruce Ware)

Airline Schedule Models under Capacity Constraints

- Accommodate growth by increasing fares and rationing demand in the face of scarce capacity
- Establish new hub airports to mitigate congestion at existing hubs
- Increase direct service to avoid congested hubs and gateways
- Move flights to off-peak times
- Increase nighttime operations
- Employ larger aircraft equipment, as opposed to growth in frequency
- Combination of five active strategies

Primary Operational Issues Identified

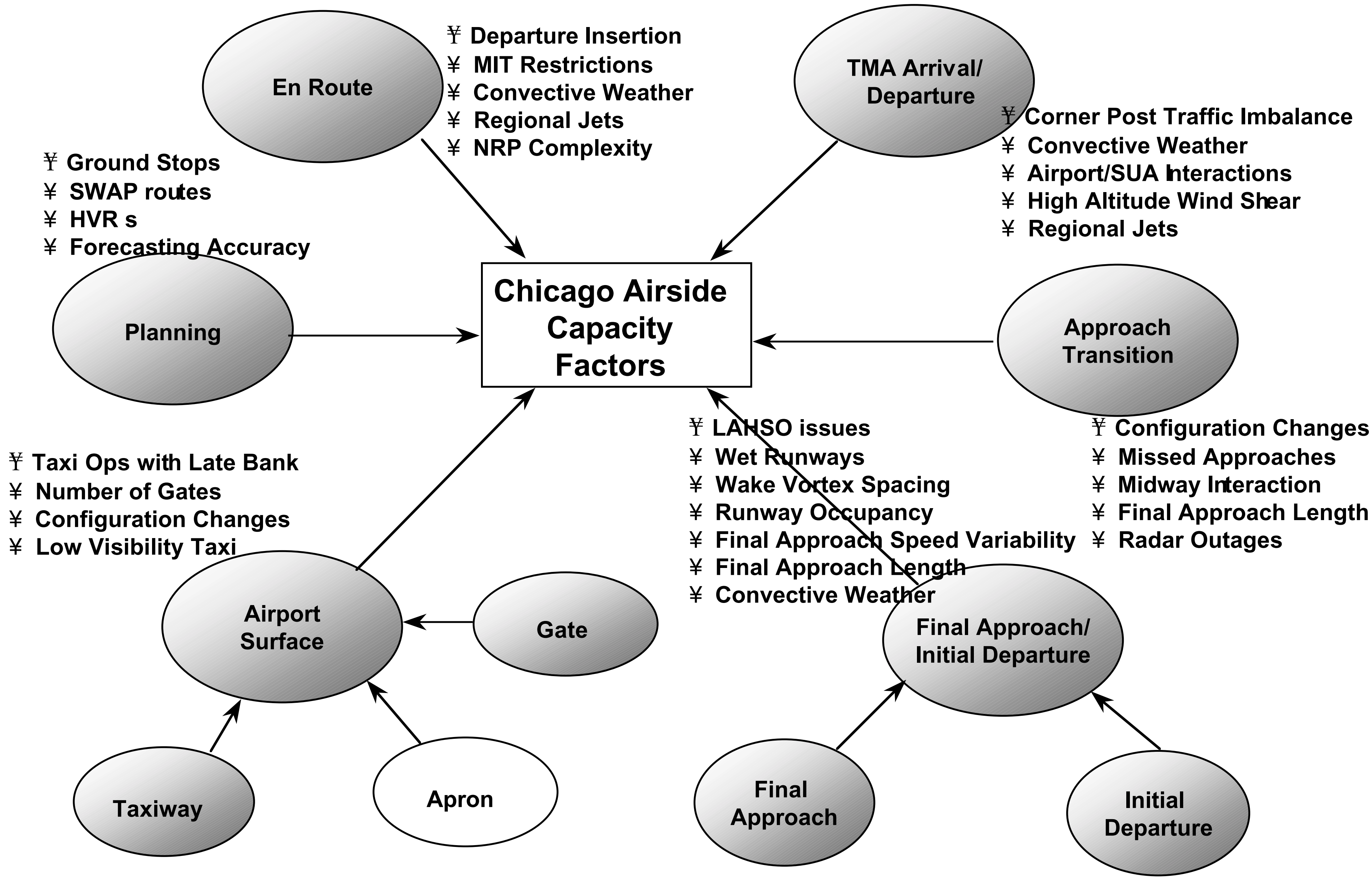
1. Slot control and insufficient gate capacity
   - when slot control is lifted, gates will immediately limit growth
2. O Hare airfield complexity and configuration management
   - wind changes
   - traffic demand
   - runway condition and intersecting runways
   - noise mitigation
3. Land And Hold Short Operations (LAHSO)
   - maximum throughput is reduced 10% by new rules
   - further impact of turbojet growth

Primary Operational Issues, continued

4. Regional flow management
   - Historically Validated Restrictions (miles-in-trail)
   - Swap Routes
   - Ground Stops, by phone TMU to TMU
   - coordination with Central Flow
5. En route capacity
   - growth in turbojets
   - National Routes Program
   - MIT restrictions in overhead streams to East coast
6. Congestion at arrival fixes
   - unbalanced arrival demand, runway utilization issue
   - high-altitude tailwinds, MIT up to 12 nm

Primary Operational Issues, continued

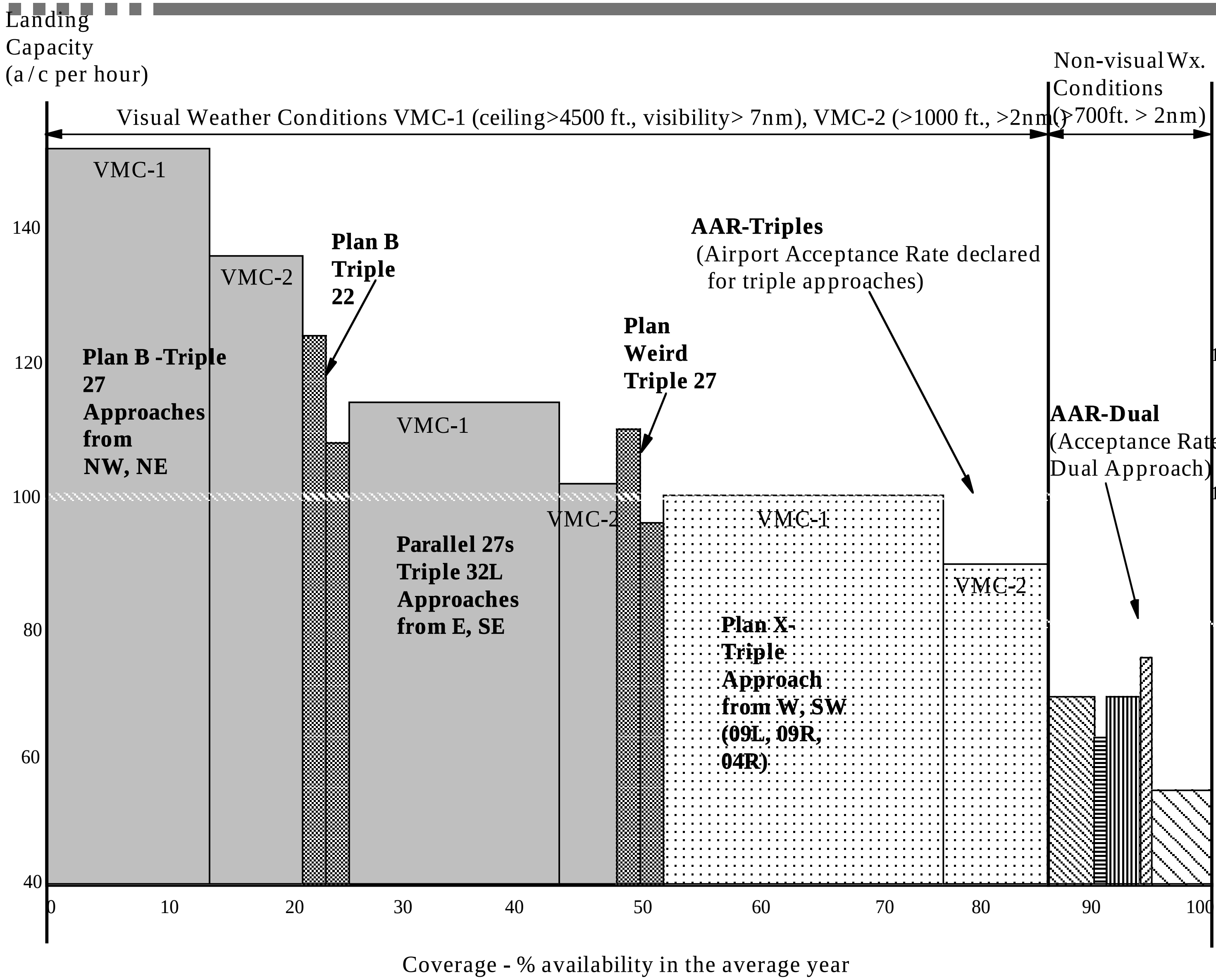
7. Sever weather impact
   - —weather forecasting accuracy
   - —pilot/airline unpredictable reluctance to fly through storm cells
8. Growth at nearby airports
   - —Midway, airport construction, rapid growth
   - —cargo operations during night
9. Final approach spacing
   - —VFR, runway occupancy
   - —IFR, wake vortex rules
10. Capacity of surrounding facilities
    - —Cleveland Center, complexity and controller workload
    - —MIT restrictions daily to East coast cities



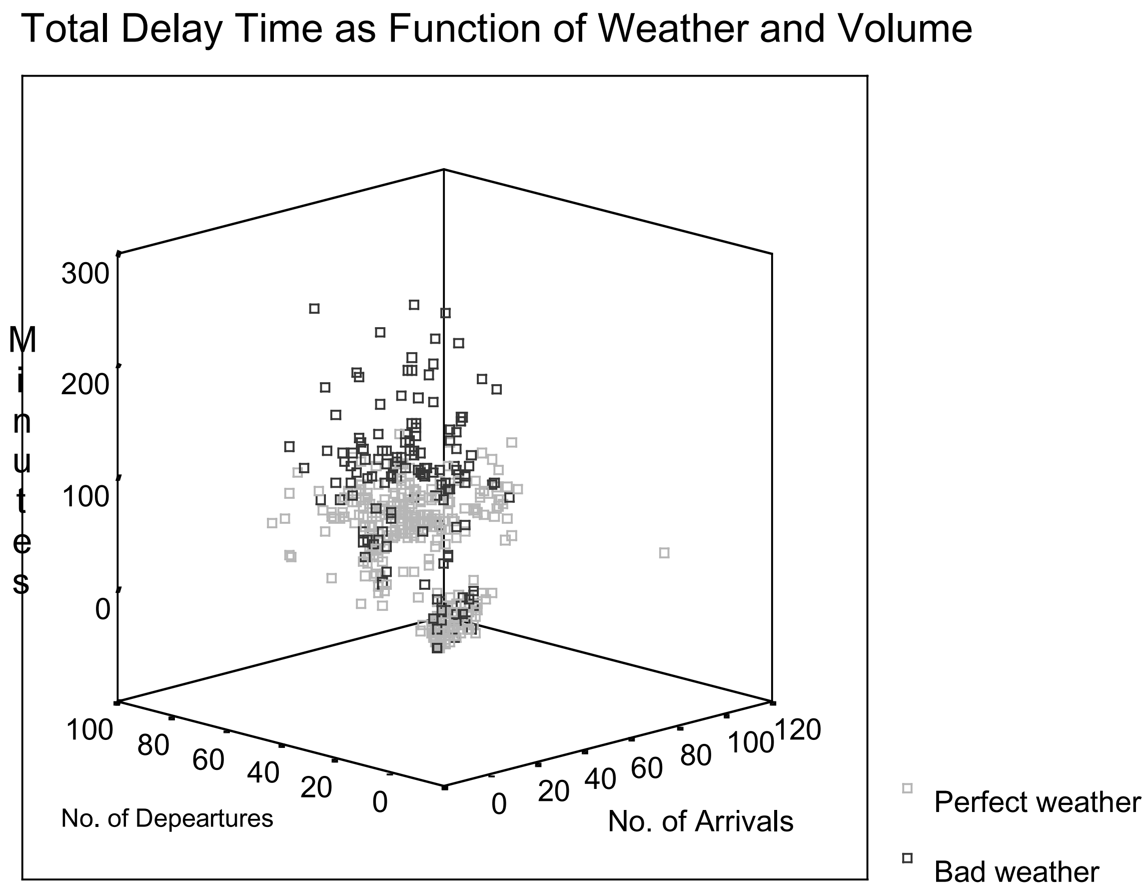
Complex, Inter-Acting Constraints Dynamically Change Airport and Airspace Capacities

Source: NASA Sponsored Airspace Preliminary Design Case Study

Runway Capacity Coverage Curve - Chicago O'Hare (based on LMI Report - NASA CR-19928-207



Sample Statistical Analysis



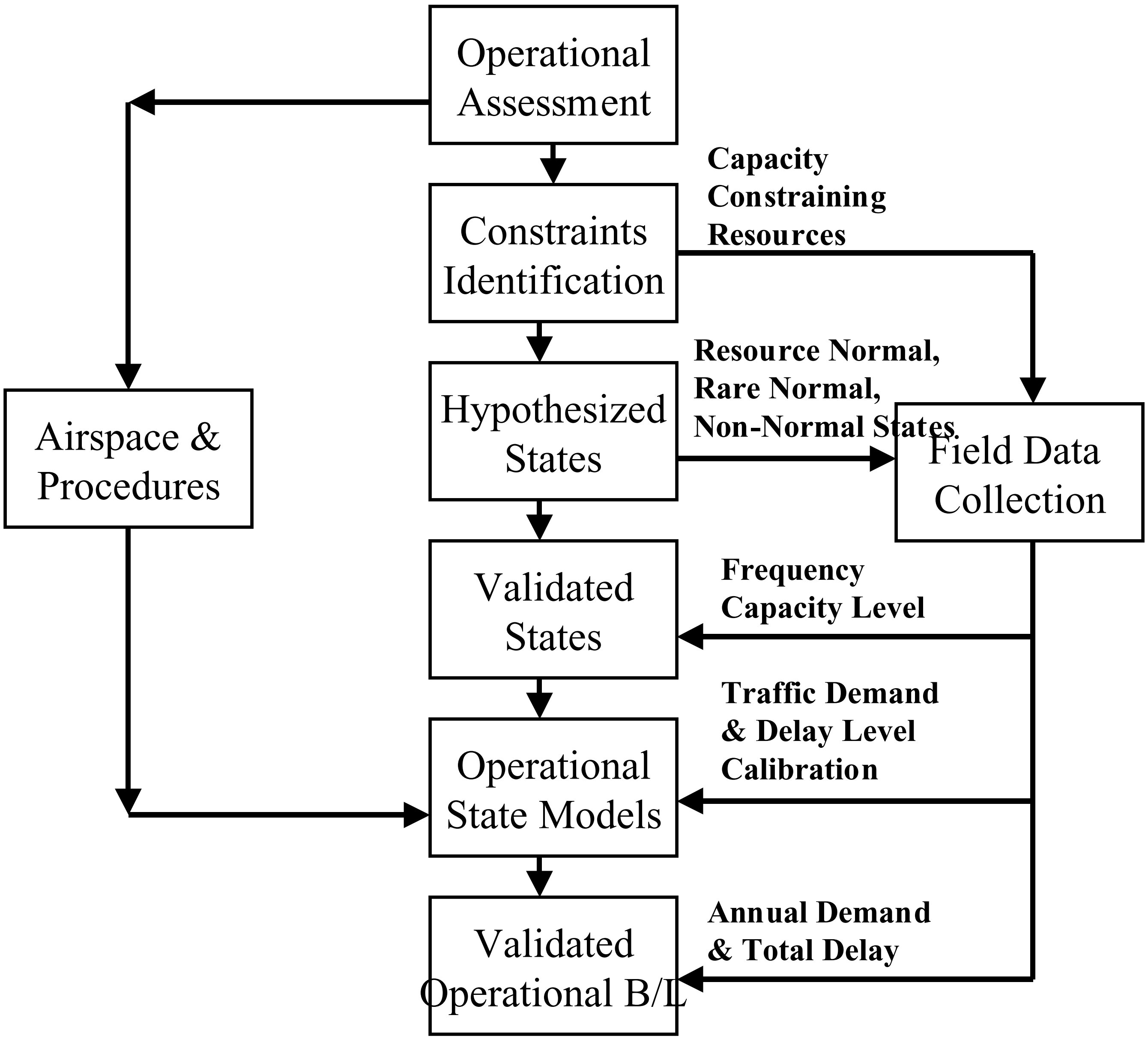
Source: Volpe Transportation Research Center

Initial ETMS Capacity Data Characterizations

- Cloud ceiling is a more important factor for arrival delay than for departure delay.
- The above set of six independent factors can explain approximately one third of the variations in **total** delay time per flight. These selected set of weather and volume related factors could only explain approximately 17% of **gate** delay and 22% of **arrival** delay.
- The stepwise regression model technique, when informed by a well-considered hypothesis, is an efficient way to understand the sensitivity of delay to other factors such as equipment outage, runway usage, and airspace congestion. Further analysis could be carried out.

Source: Volpe Transportation Research Center

Operational Baseline Development Approach



Case Study Conclusions

¥A Preliminary Design Process has been drafted

—process needs to be validated

—baselining and solution development must be grounded in real NAS performance needs

—Case Study approach using several NAS operating regions to provide operational insight and real-world validation data

¥Chicago is the initial Case Study airport/airspace region

—some operational issues are specific, others are common to high-density complex terminal areas

¥Additional Case Study regions to address overall NAS performance

—comprehensive concept and technology exploration

—sufficient scope to develop toolset requirements for NAS-wide trades