Preliminary Concept for Multiple Operations at non-tower, non-radar Airports in Instrument Meteorological Conditions

Victor Carreño victor.a.carreno@nasa.gov

Hanne Gottliebsen hago@nianet.org

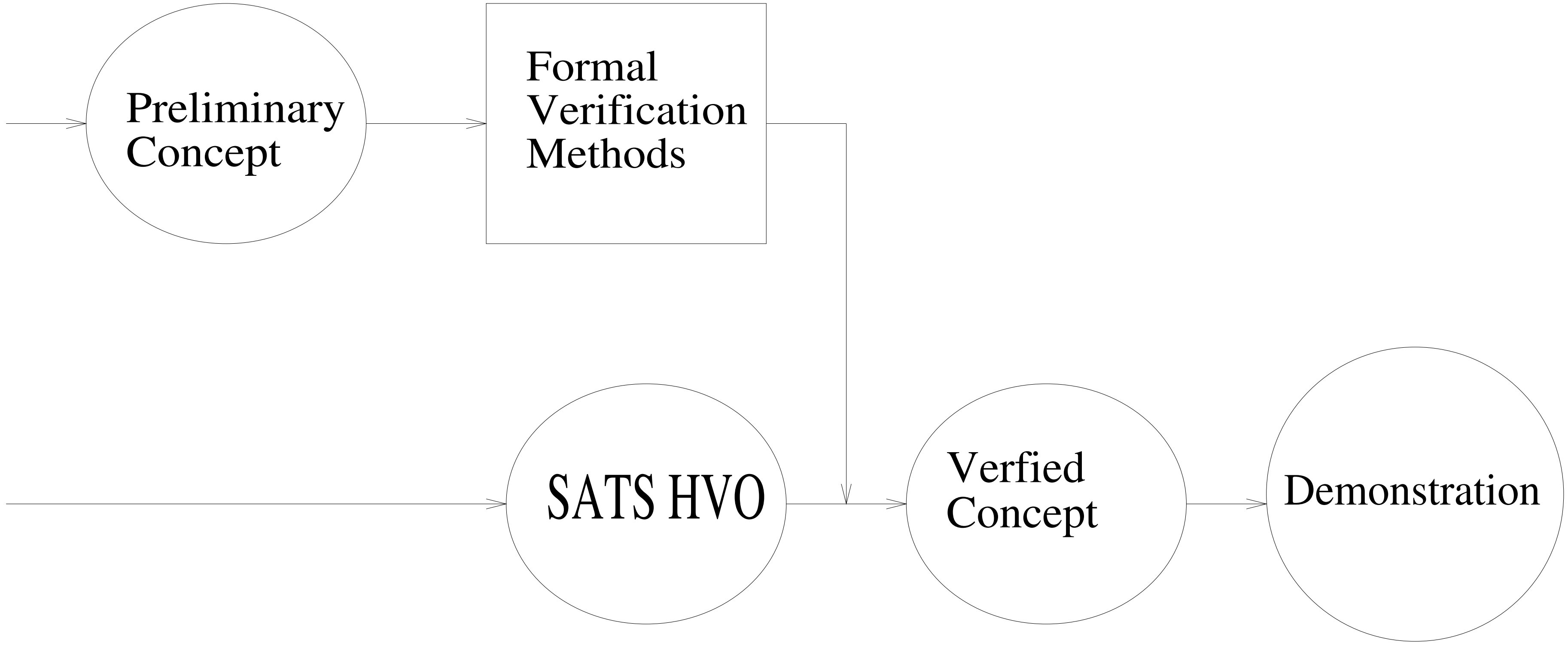
Ricky Butler r.w.butler@larc.nasa.gov

Sara Kalvala sk@dcs.warwick.ac.uk

NASA Langley Research Center/NIA

October 2003

Two Concepts of Operation



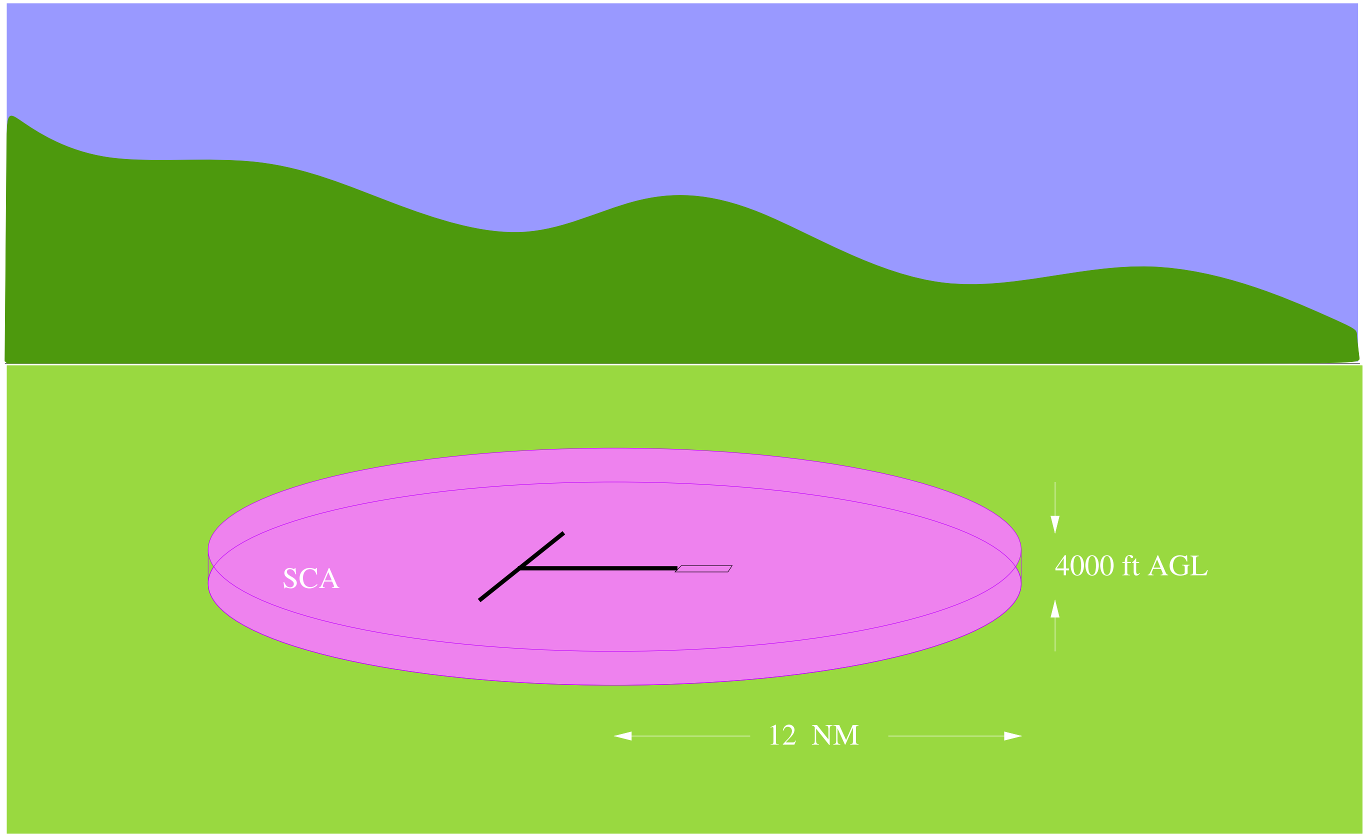
Preliminary Concept of Operations

- Generic concept to use as case study for analysis and verification methods.

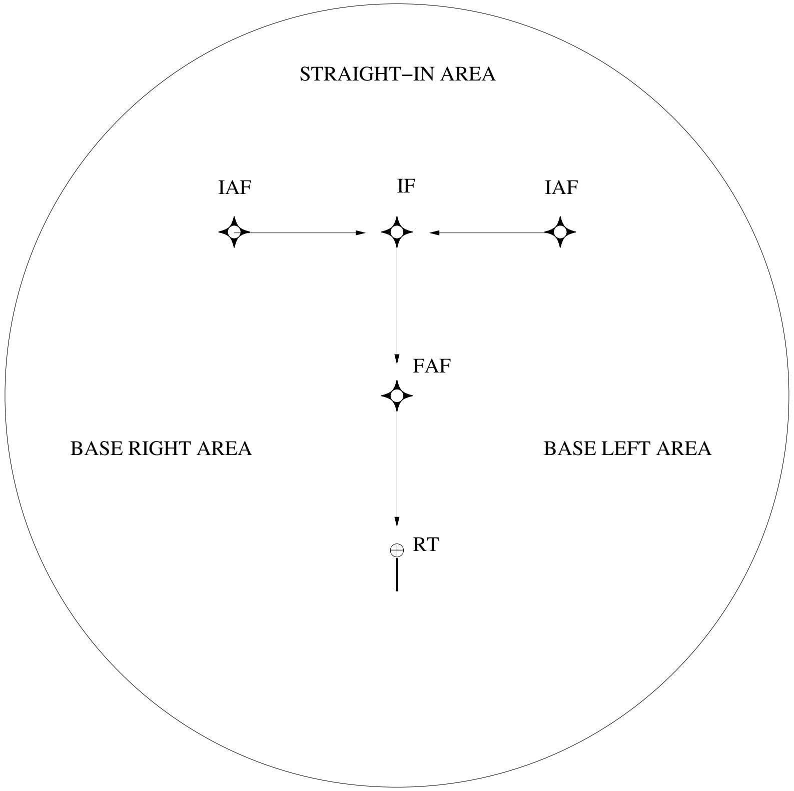
- Four main elements
  - Self Controlled Area (SCA).
  - Airport Management Module (AMM).
  - Data communication link between aircraft and AMM.
  - State information broadcast and associated on-board navigation and traffic displays.

The Self Controlled Airspace

- Cylinder surrounding the airport airspace.
- Approach based on GPS "T" approach.
- Pilots accept responsibility for separation.



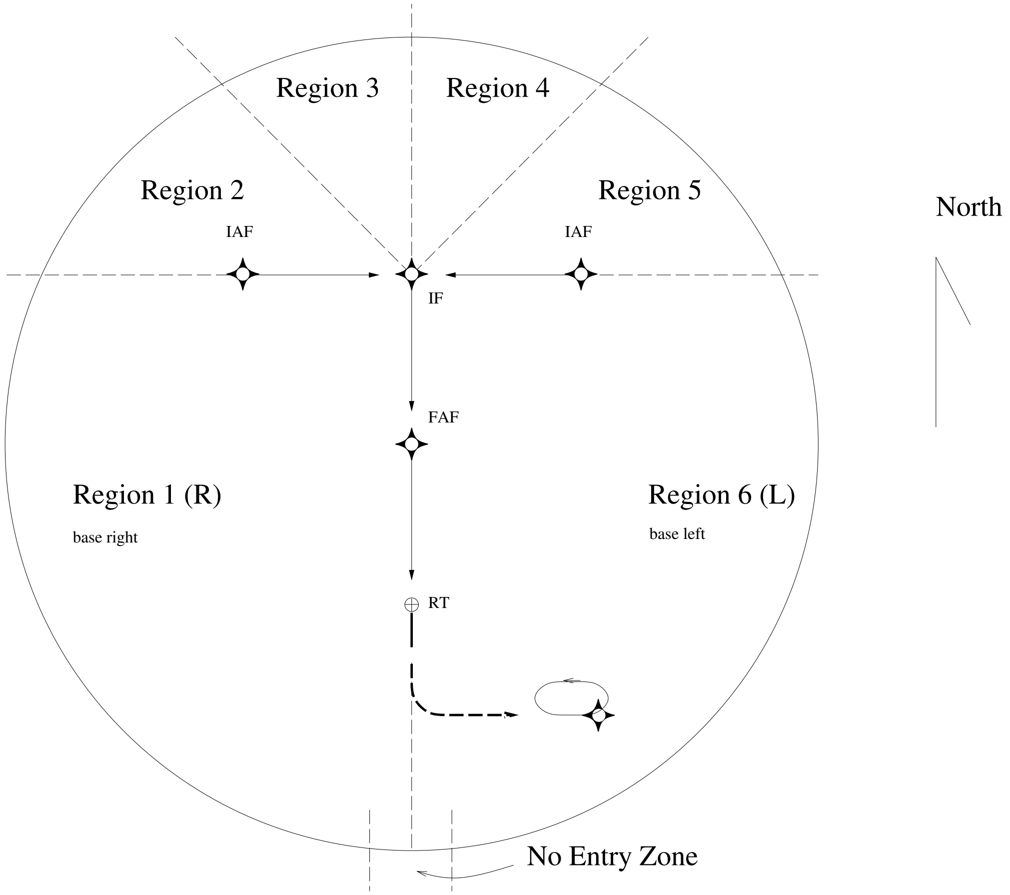
The Self Controlled Airspace, Cont.



The Airport Management Module

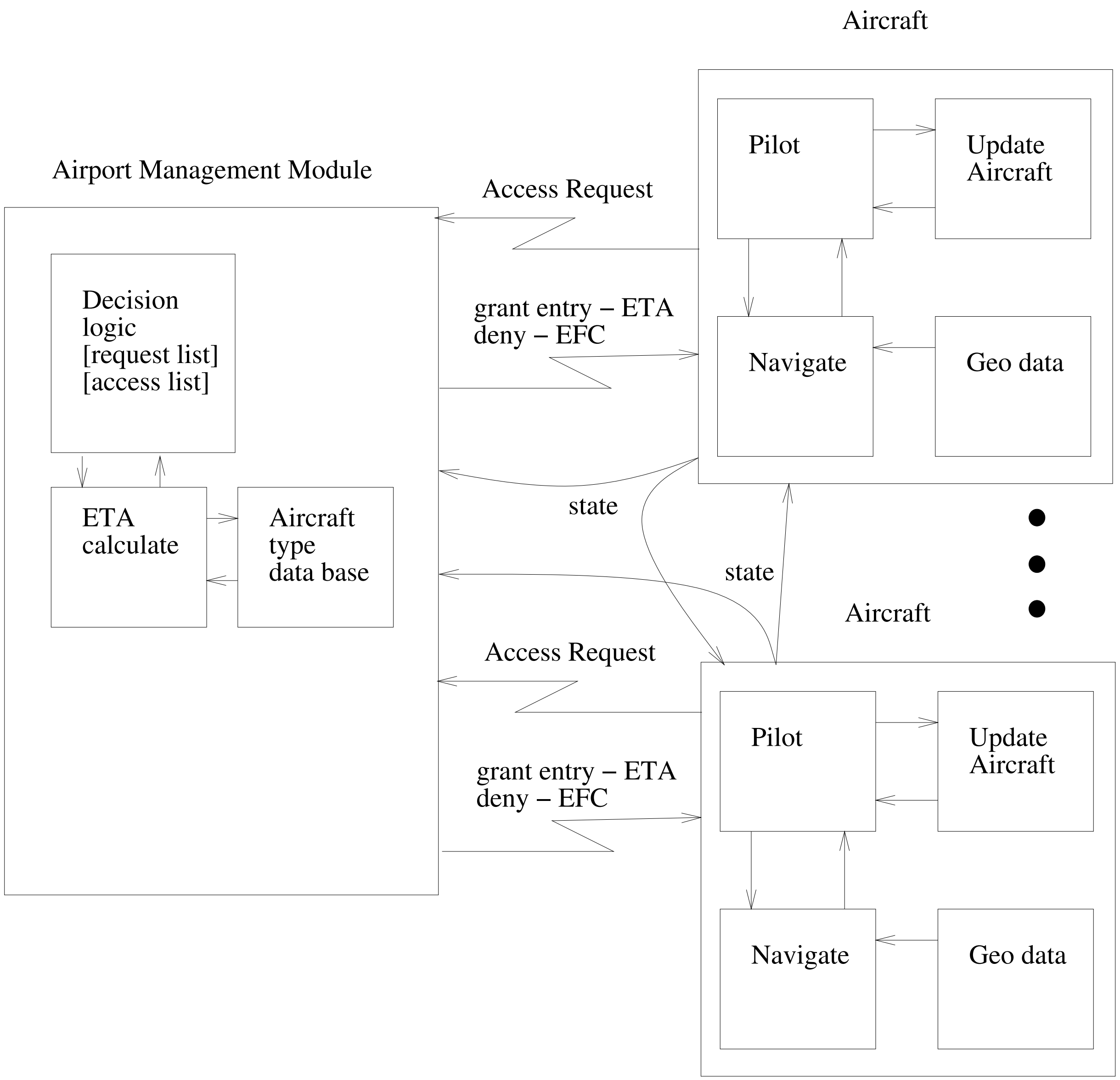
- The AMM is an arbiter and sequencer.
- It receives, from aircraft, requests to enter the SCA.
- It grants or denies requests based on time separation criteria.
- When entry is granted, it generate Estimated Time of Arrivals at fixes.
- When entry is denied, it generates Expect Further Clearance time.

AMM Protocol



- Self Control Airspace (SCA) is divided into 6 regions.
- Entry is based on time separation.

Simulation



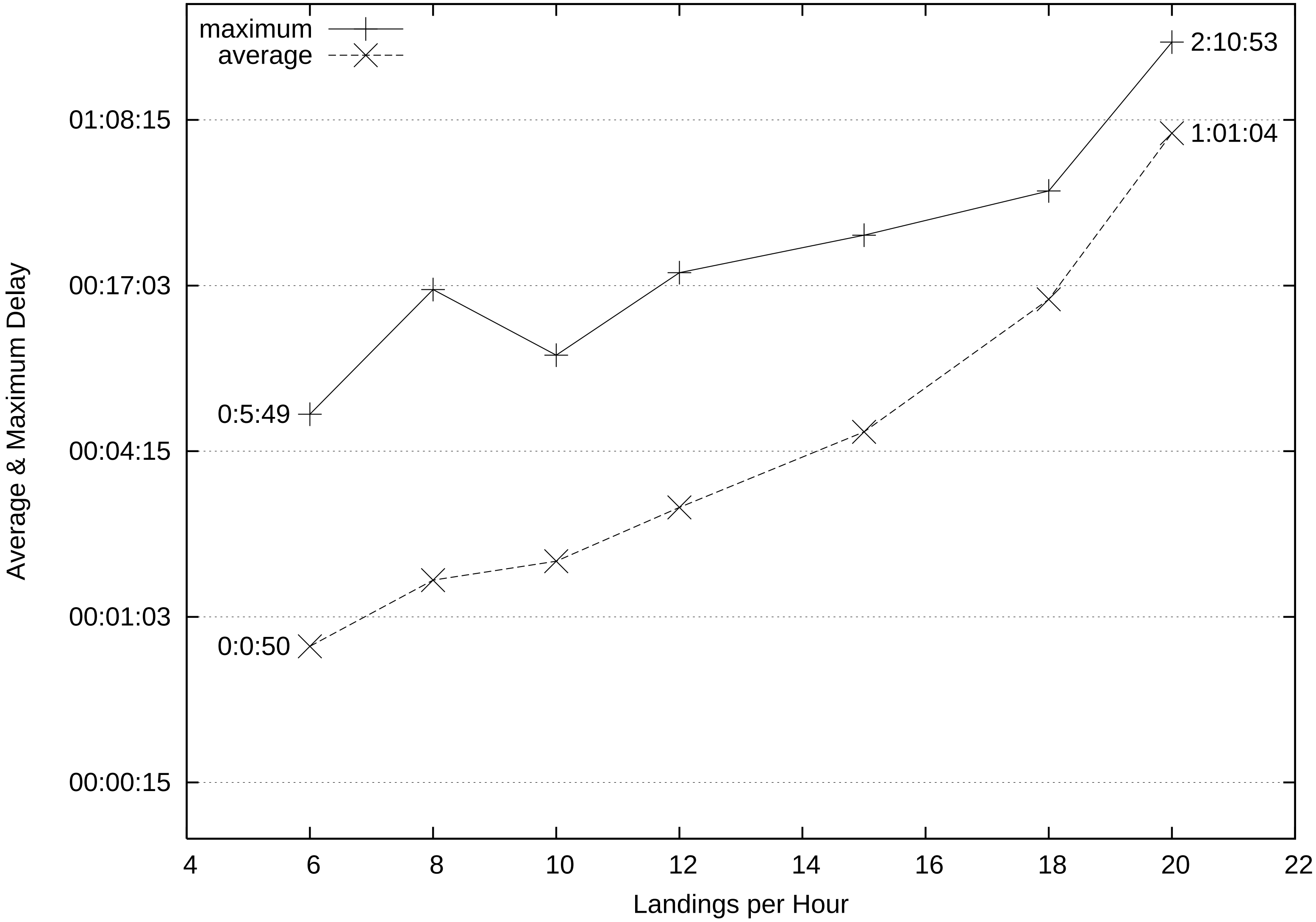
Aircraft
Airport Management Module
Access Request
Pilot
Update
Aircraft
Decision
logic
[request list]
[access list]
grant entry – ETA
deny – EFC
Navigate
Geo data
ETA
calculate
Aircraft
type
data base
state
state
Aircraft
Access Request
Pilot
Update
Aircraft
grant entry – ETA
deny – EFC
Navigate
Geo data

Simulation Results

- 3 minutes time separation at fixes.
- 12 nautical miles SCA radius.
- Aircraft request entry at 25 nautical miles from airport.
- Two aircraft modeled to represent slow and fast aircraft.
  - Cessna 172
  - LearJet 45

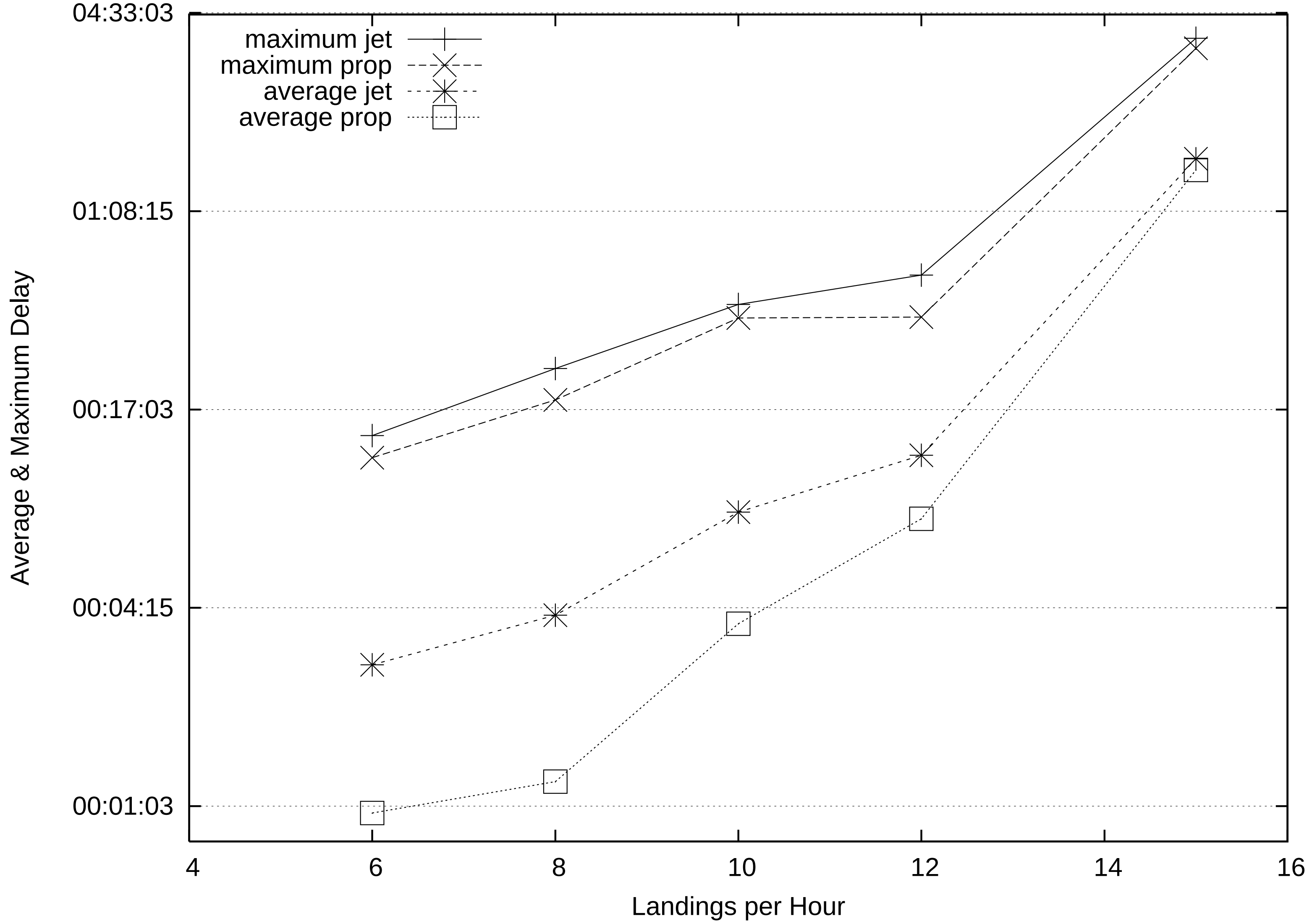
100% Propeller; Delay vs. Arrival Rate

20 knots out of 180 (S)



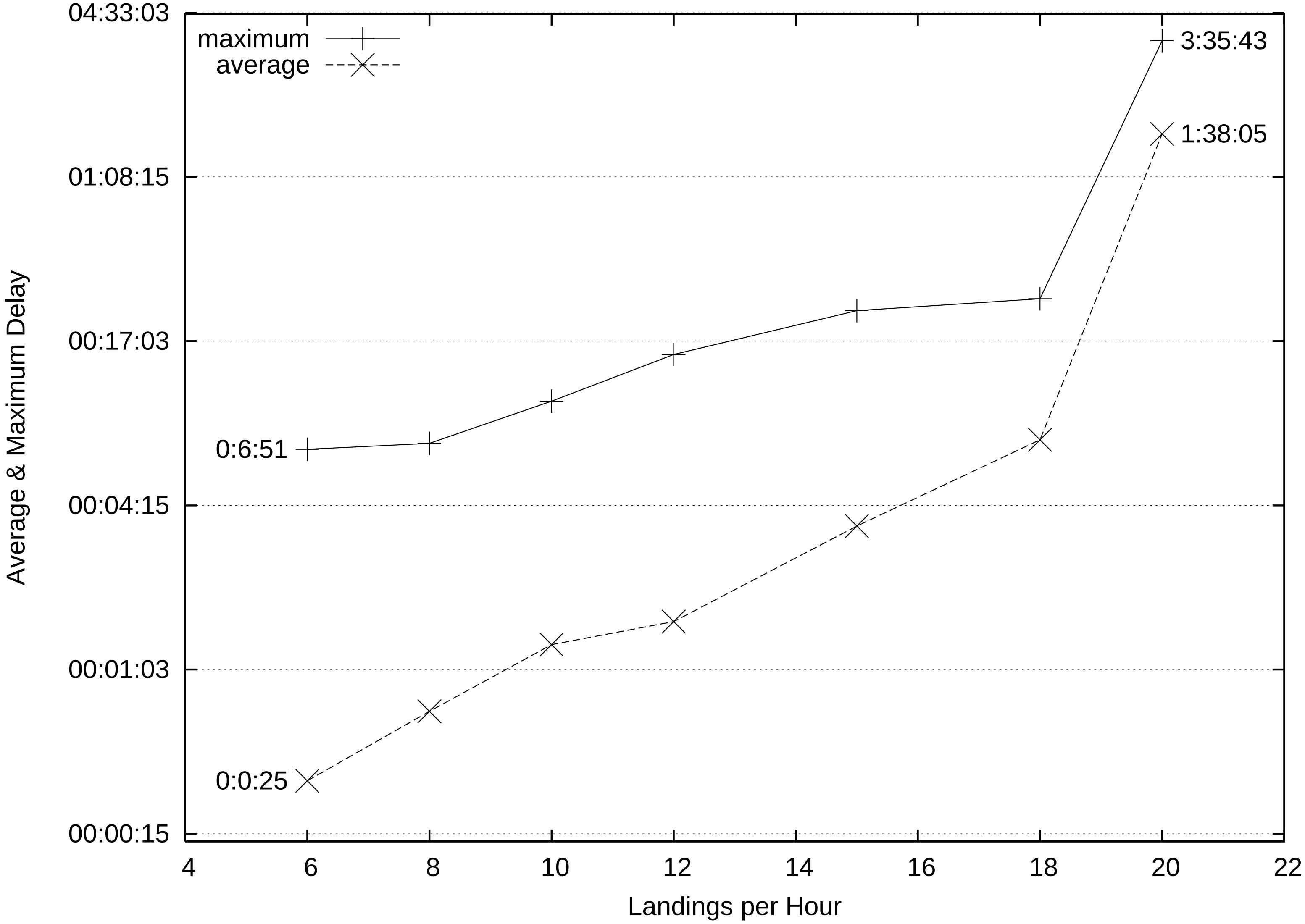
50% Prop., 50% Jet; Delay vs. Arrival Rate

20 knots out of 180 (S)



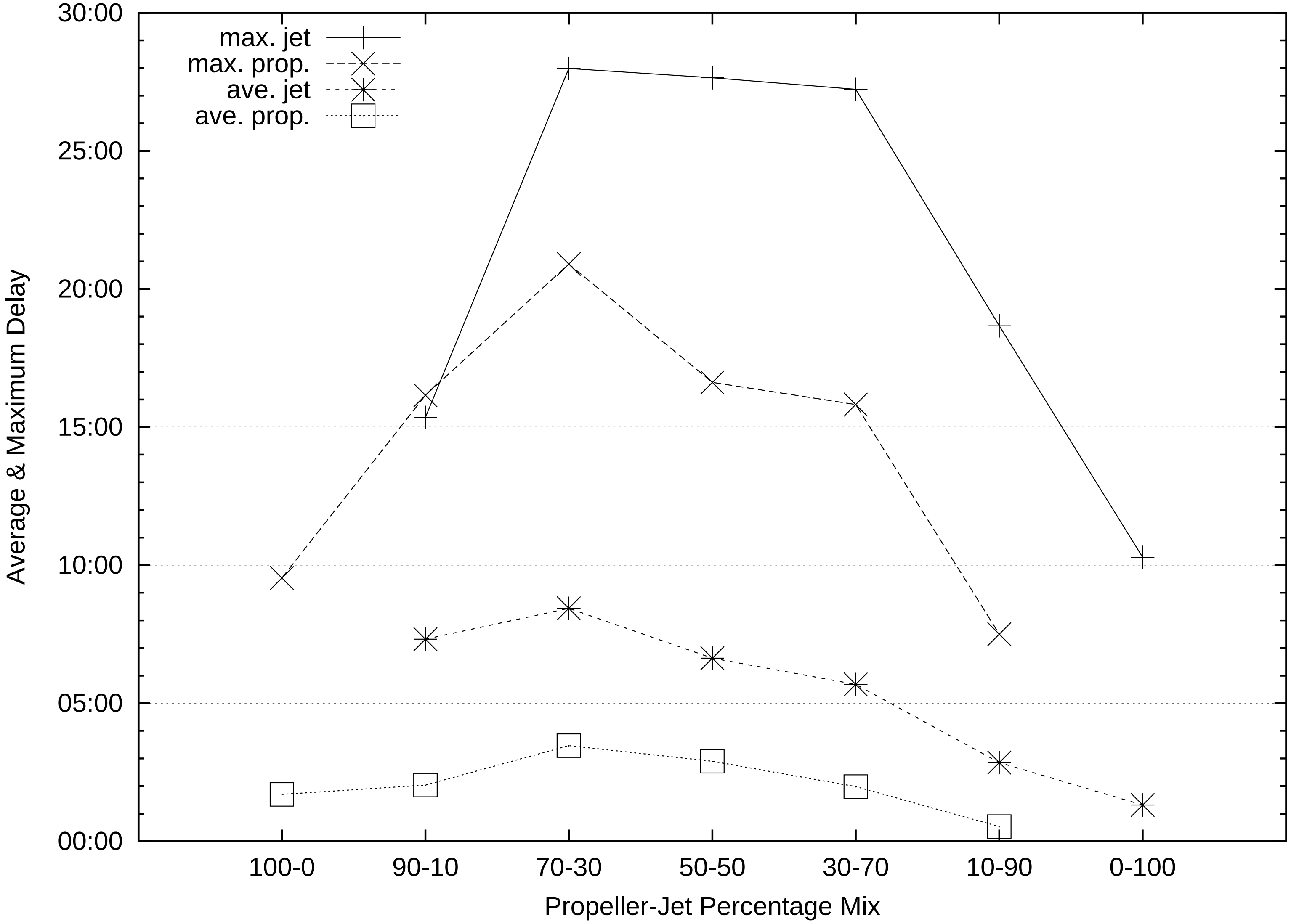
100% Business Jet; Delay vs. Arrival Rate

20 knots out of 180 (S)



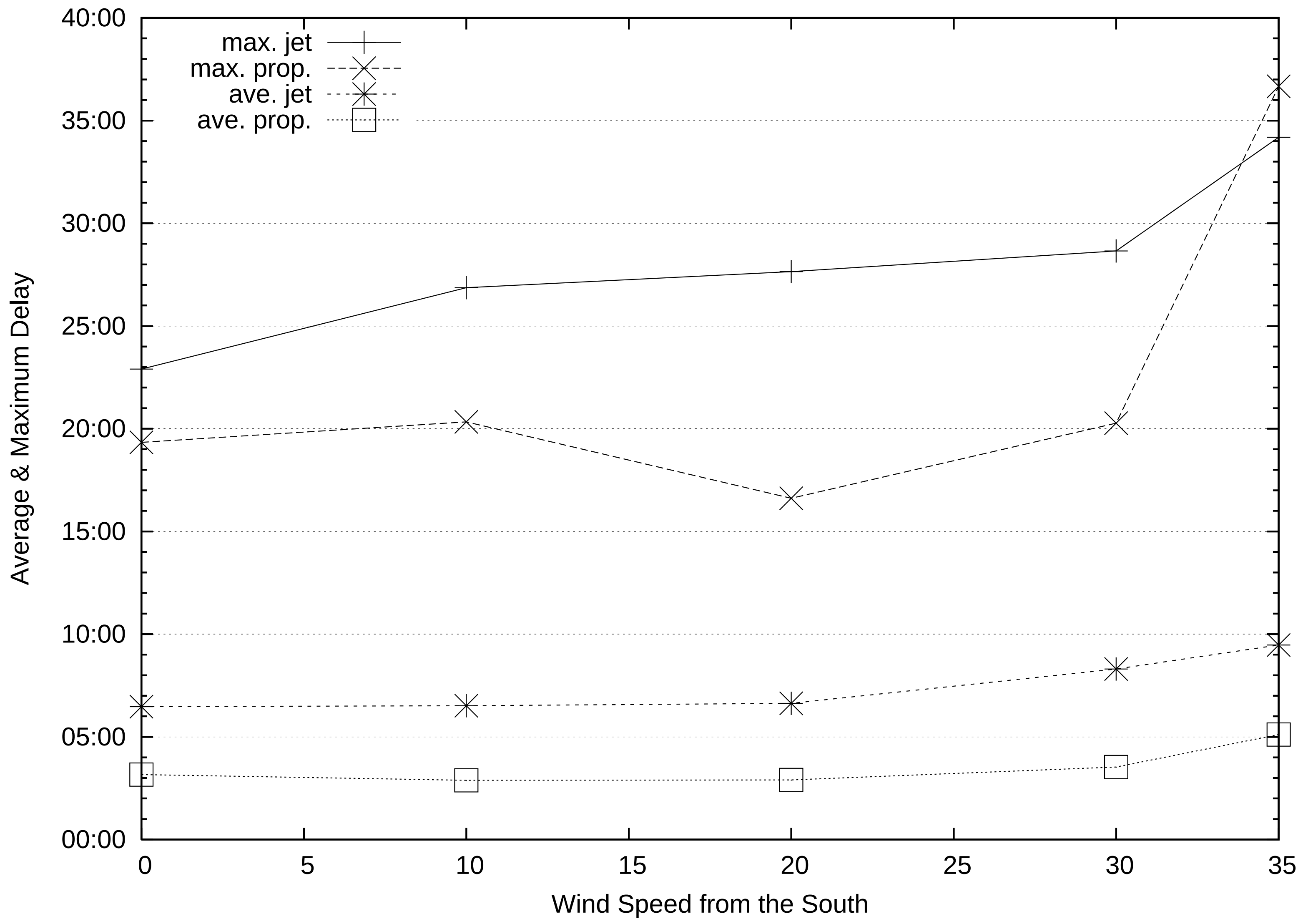
Delay vs. Aircraft Mix

10 arrivals per hour, 20 knots out of 180 (S)



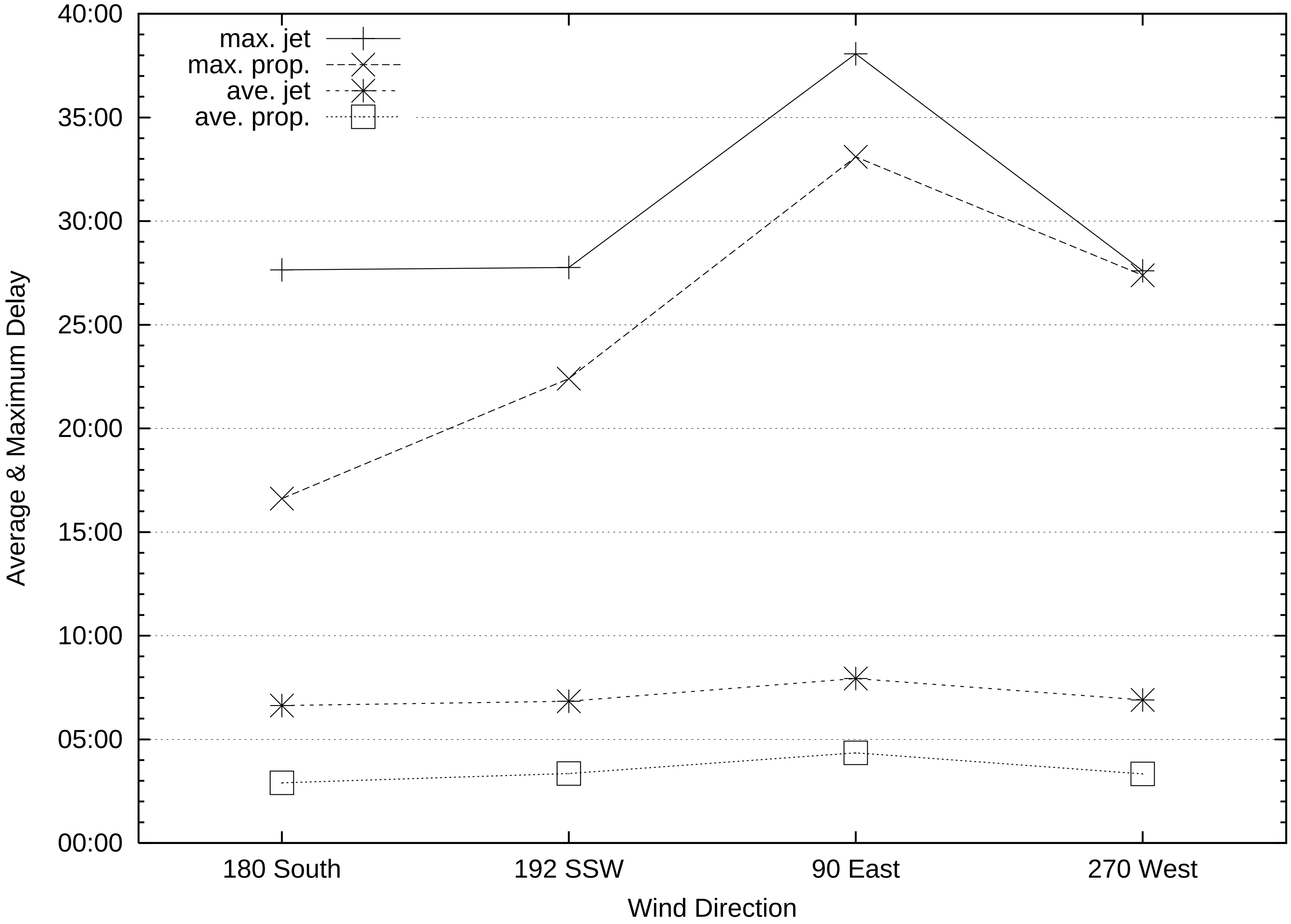
Delay vs. Wind Speed

10 arrivals per hour, 50% Propeller, 50% Business Jet



Delay vs. Wind Direction

10 arrivals per hour, 50% Propeller, 50% Jet, 20 knot wind



Verification of Preliminary Concept

- A mathematical model has been created that represents:
  - the SCA and geographical configuration
  - the AMM access rules
  - the trajectories of the airplanes
- Proofs have been developed, for representative cases, to show that if aircraft follow AMM rules and approach procedures then separation will be maintained in the SCA airspace.