



Air Transportation System Architecture Analysis

Project Phase I

Advanced System Architecture

Spring 2006

March 23rd, 2006

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Motivation

- The air transportation system is facing and will continue to face significant challenges in terms of meeting demand for mobility
- Current multi-agency effort to establish a roadmap for the “Next Generation of Air Transportation System”
- Navigation in current system under most conditions requires use of fixed-location of current infrastructure to facilitate mobility
- Future (evolved) architecture of the system require understanding of the structure of the current system
- Lack of integrated quantitative analysis of structure of the current system

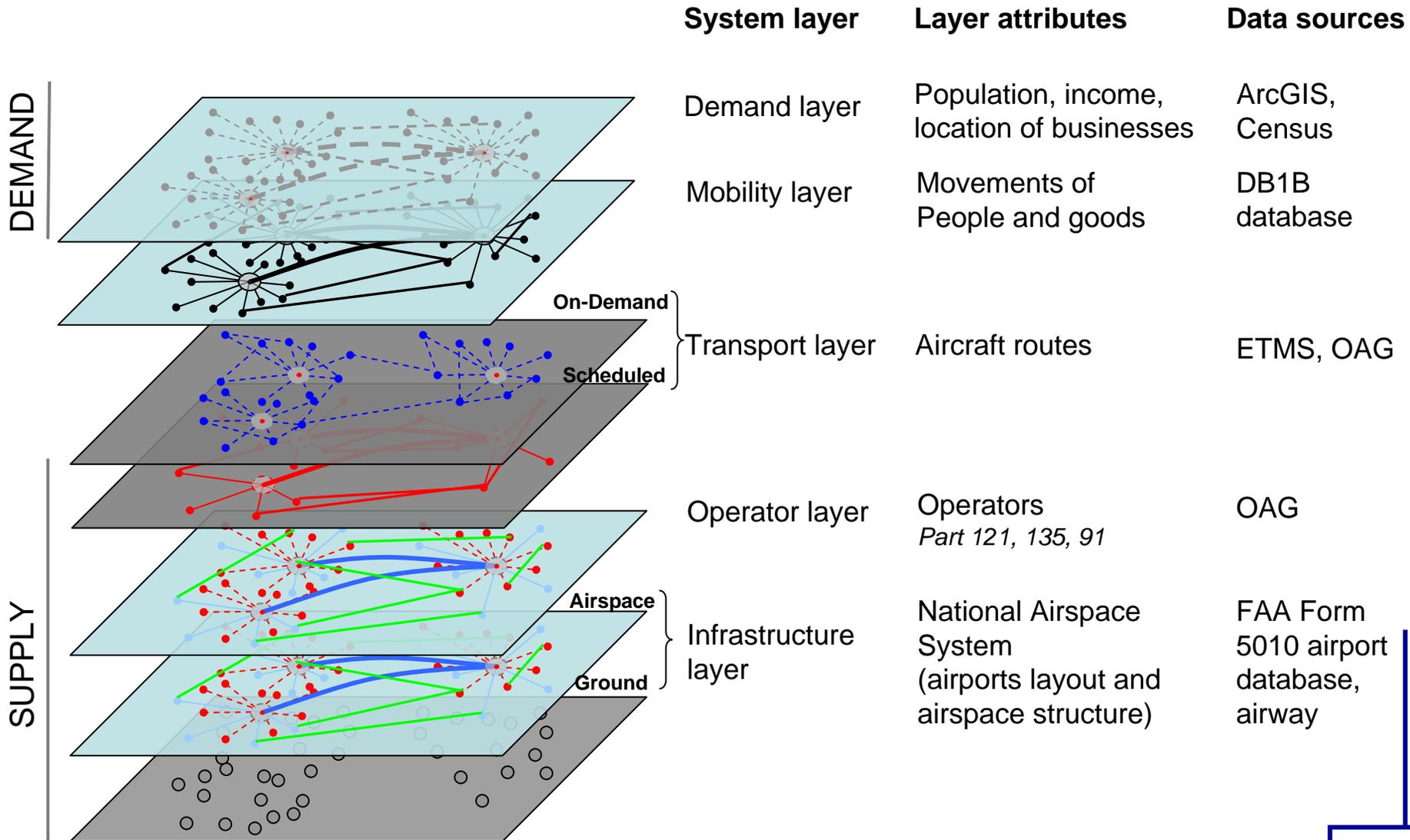


Objective of the project

- Better understand the architecture of the current system through network analyzes
- Understand
 - the network characteristics of **individual system layers**
 - Influence of constraints, desired properties (i.e. safety, capacity, etc.) in **explanation of network characteristics**
 - comparison of network **characteristics across different layers**, through coupling of infrastructure or comparison of different network characteristics across layers



Overview of the System





Current Progress (examples in next slides)

- Infrastructure Layer:
 - Airspace Structure (Nav aids) Analysis
 - Low Altitude routes (Victor Airways)
 - High Altitude routes (Jet routes)
- Transport Layer:
 - Traffic Data (ETMS) Analysis



Preliminary Analysis of the High Altitude (Jet) Route Network

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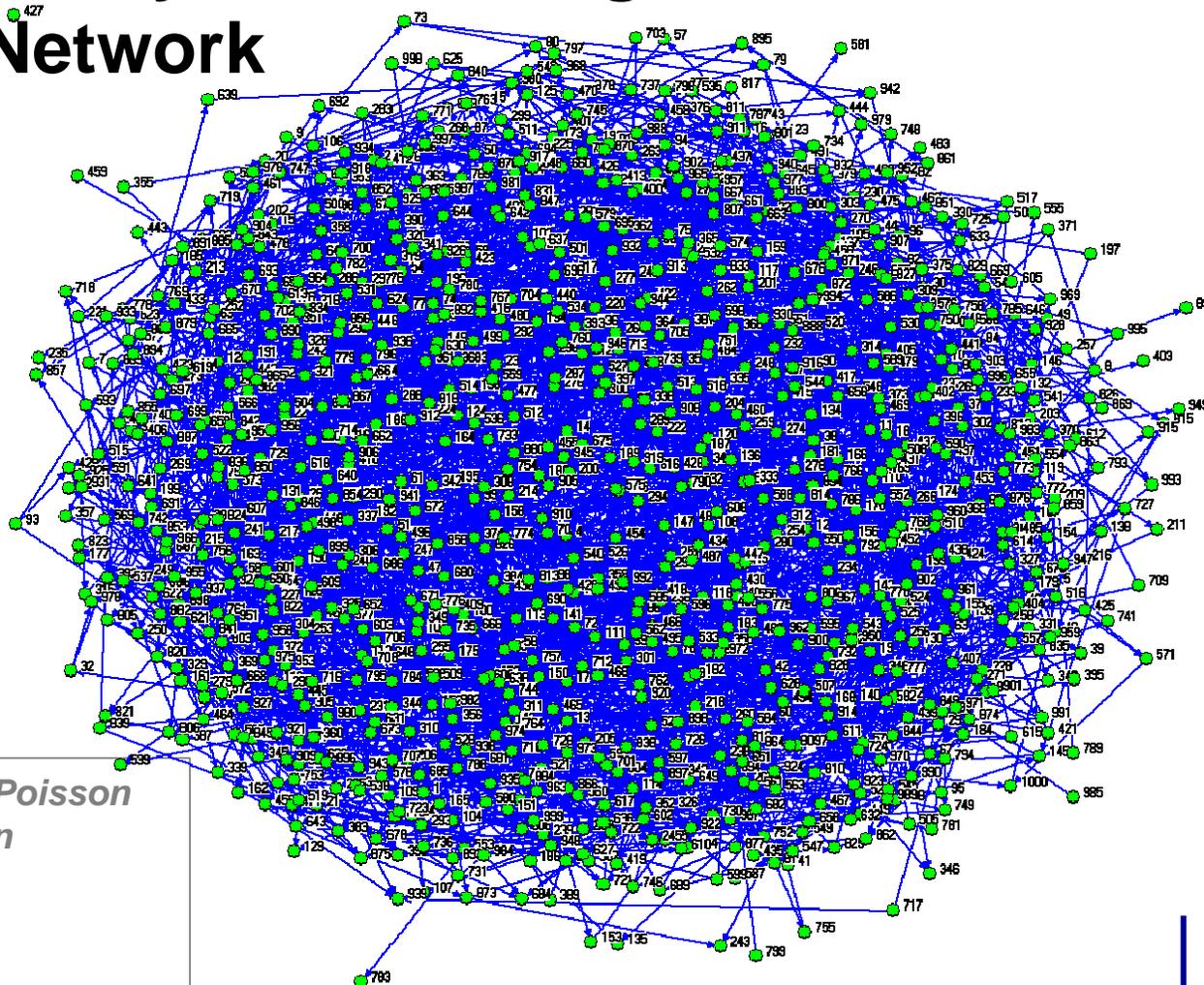
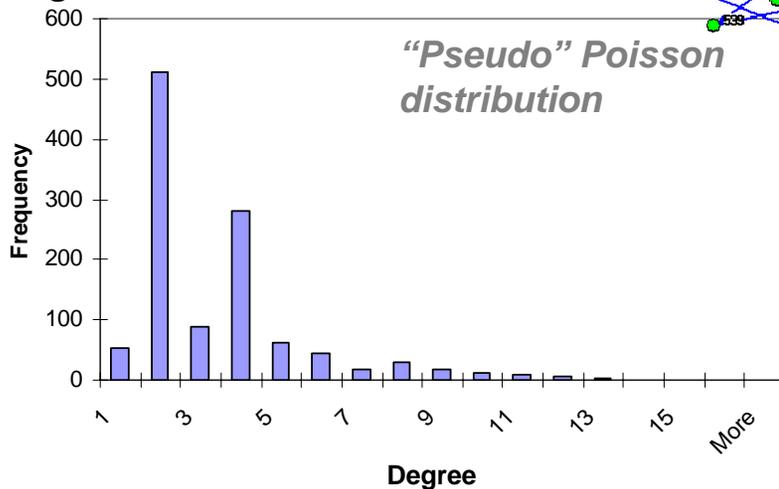


Chart of Jet Routes

Degree Distribution





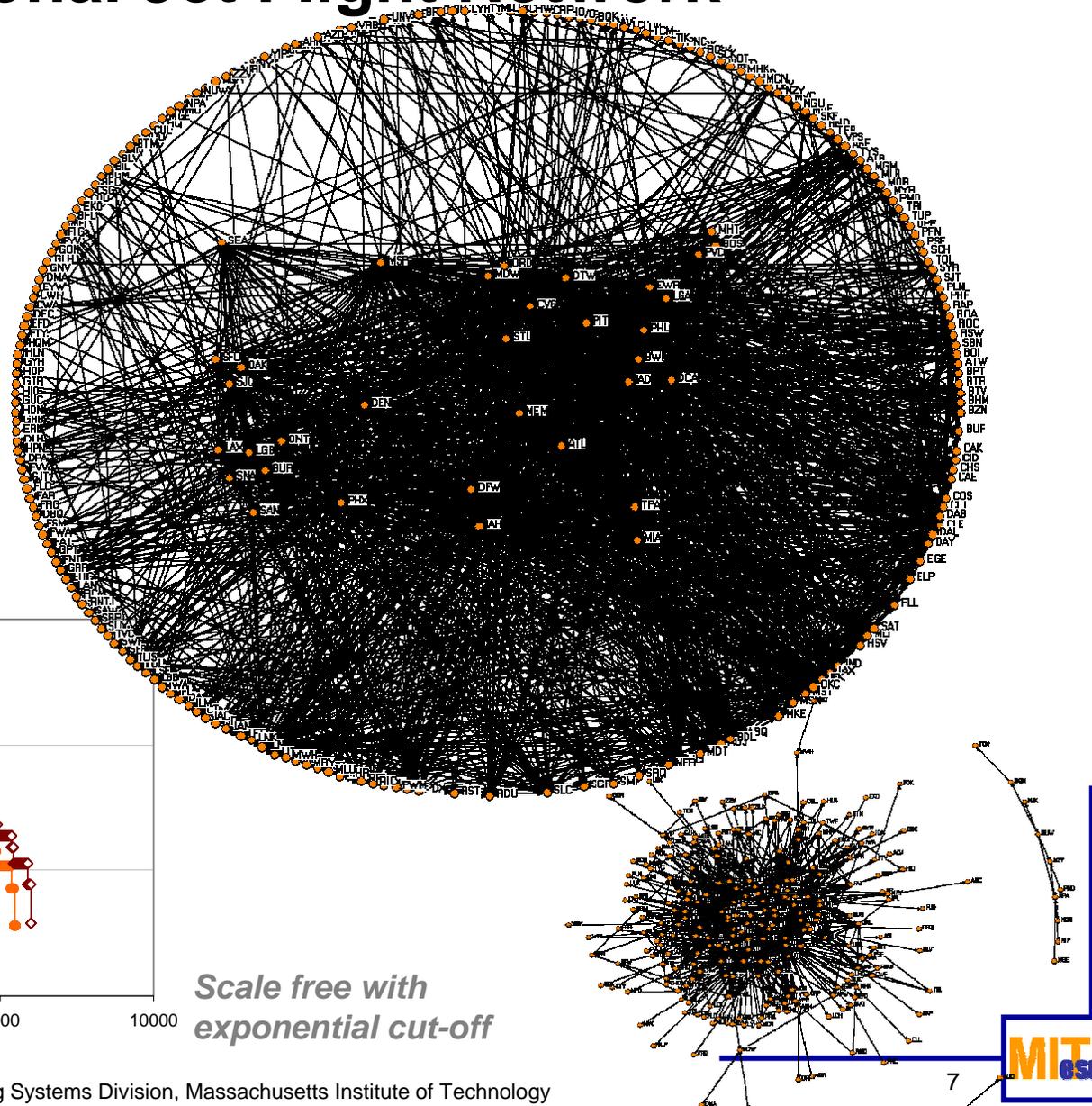
Preliminary Analysis of the Wide-Body/Narrow Body & Regional Jet Flight Network

Wide Body Jets

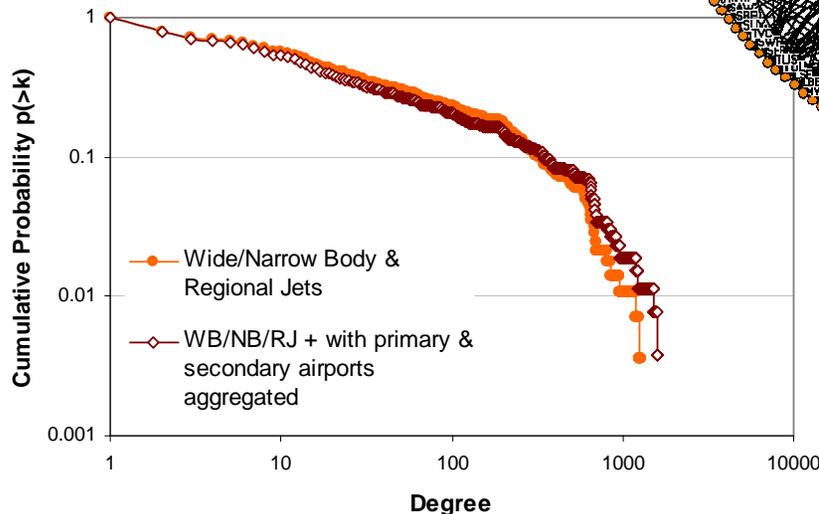
Narrow Body Jets

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Narrow Body Jets



Degree Distribution



Scale free with exponential cut-off

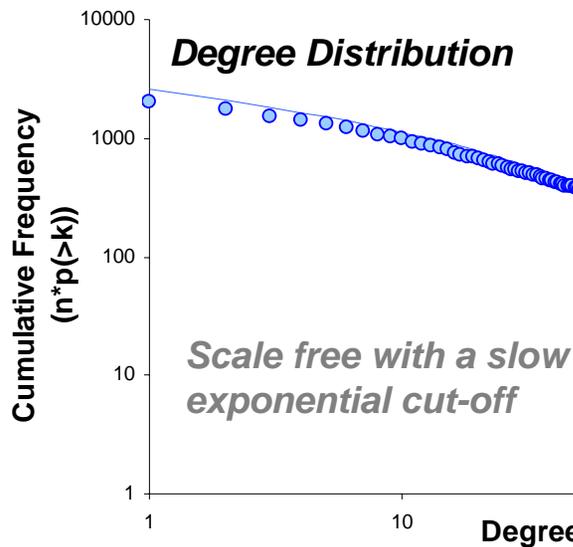
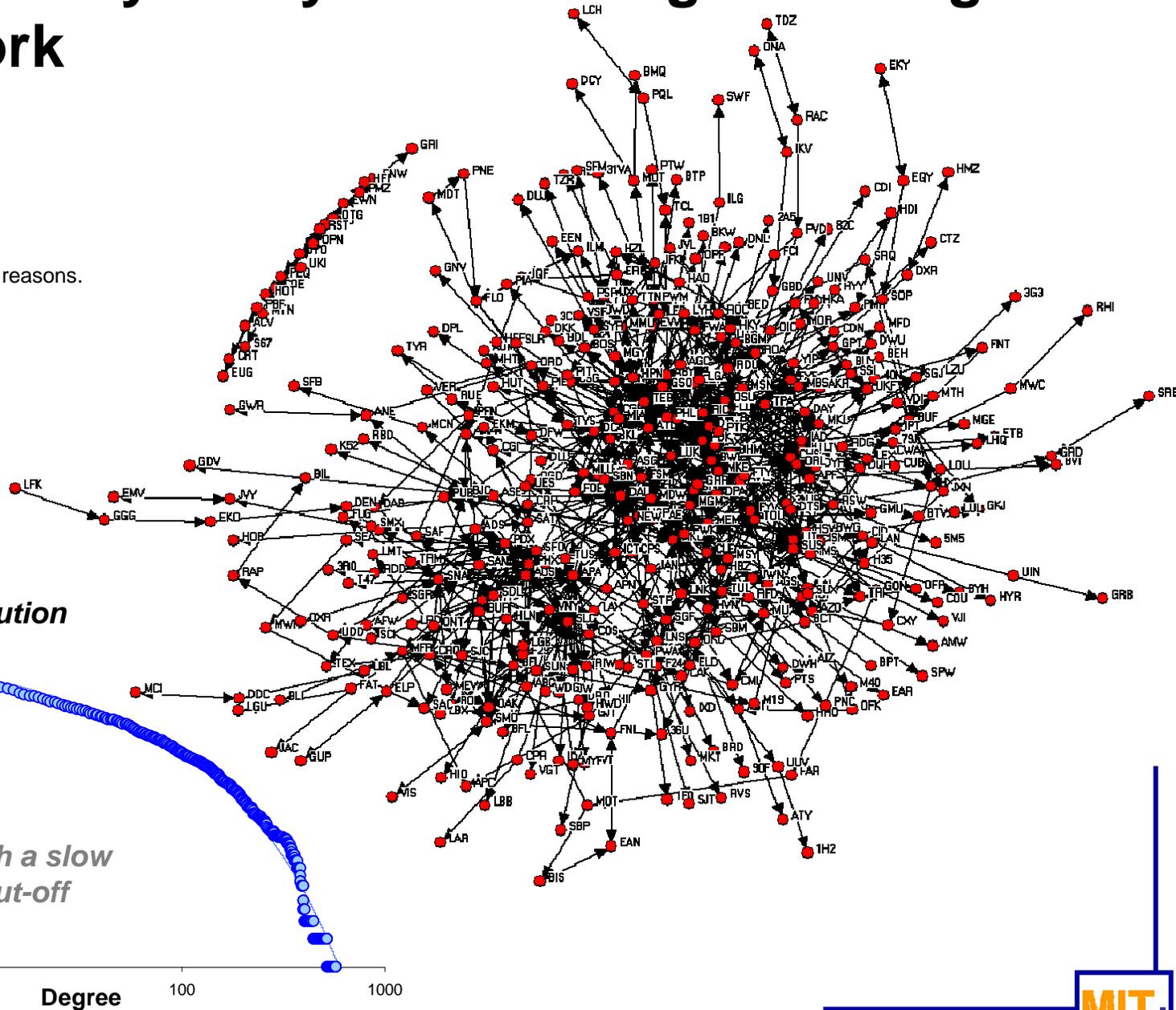




Preliminary Analysis of the Light Jet Flight Network

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Light Jets





Potential Additional Data Acquisition

- 10% Ticket Sample – DB1B Database
- Ground Delay Program Data
- Additional ETMS Days
- Air Traffic Control Sectors And Interfaces
- Additional Schedule Data (OAG)



Availability



Potential Future Areas of Investigation

- **Cross-Layer Comparisons**
 - Infrastructure, transport, and mobility layers
 - Domain expertise input on processes at work to create network structure
- **Intra-Layer Comparisons (Transport Layer)**
 - Network differences by aircraft type, or by air carrier
- **Influence of nodal constraints**
 - Airport and airspace capacity as nodal constraints on network growth
- **Maximum Route Efficiency Achievable**
 - Merging of airport and airway data
- **Motifs/Substructure**
 - Application of motif/ coarse-graining analysis to identify common patterns in network