Benefits Assessment Methodology for an Air Traffic Control Tower Advanced Automation System

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Outline

- Overview of system
- Need for benefits assessment
- Methodology
- Application/Data analysis
- Results: Informing system development priorities
- Summary

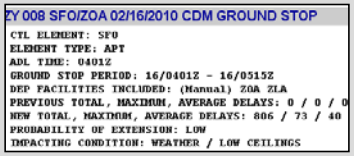
Tower Flight Data Manager (TFDM)

- **Integrated tower system being considered for development by FAA**

External Sources

Terminal and Surface Surveillance

Flight Plan Data

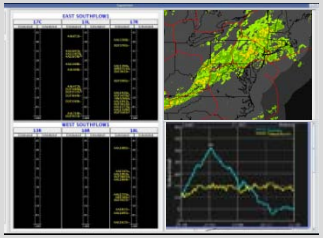


Traffic Flow Constraints

Flight Operations Data

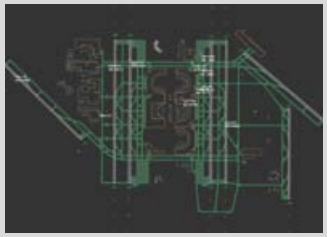
Weather / Hazards

Tower Flight Data Manager

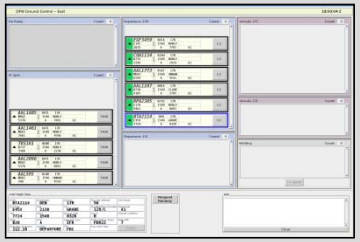


Decision Support Tools (DSTs)

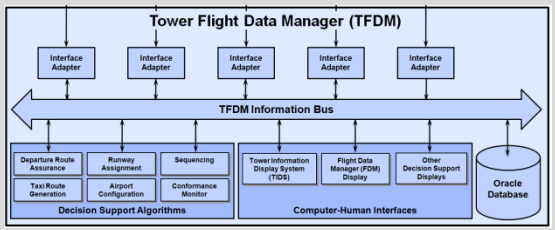
Remote / Enhanced Visual Awareness



Surveillance Display



Flight Data Manager



Net-centric Infrastructure

Enablers

Consolidated tower systems

Enhanced cross-domain information exchange

Decision support tools

Benefits

Robust operations

Reduced delay, fuel, environmental impact

Enhanced safety

Ability to support remote operations: Staffed NextGen Tower (SNT)

Operational Users

Tower controllers
Flight data, Clearance, Ground, Local, Supervisor

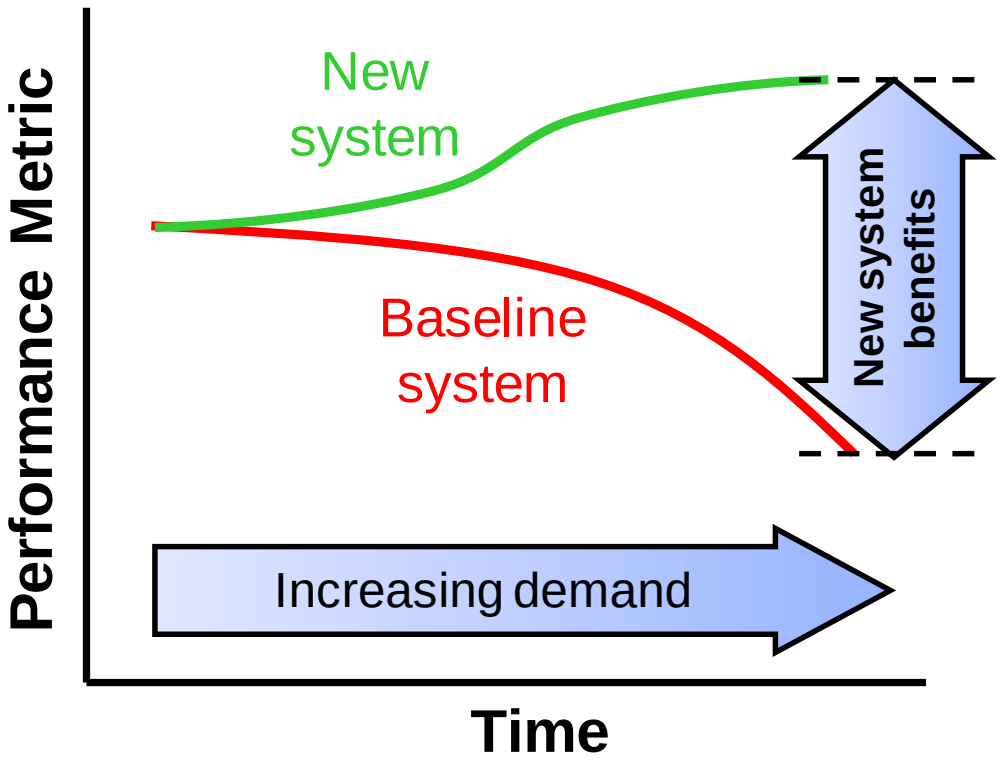
TRACONs, ARTCCs

Flight Operations Centers

Ramp Tower

Airport Authority

Need for Benefits Assessment



- Quantifies how well the new system performs relative to baseline
- Needed for Investment Analysis to make business case for continued development and/or deployment
- Leads to understanding of system inefficiencies and causality to help guide capability development

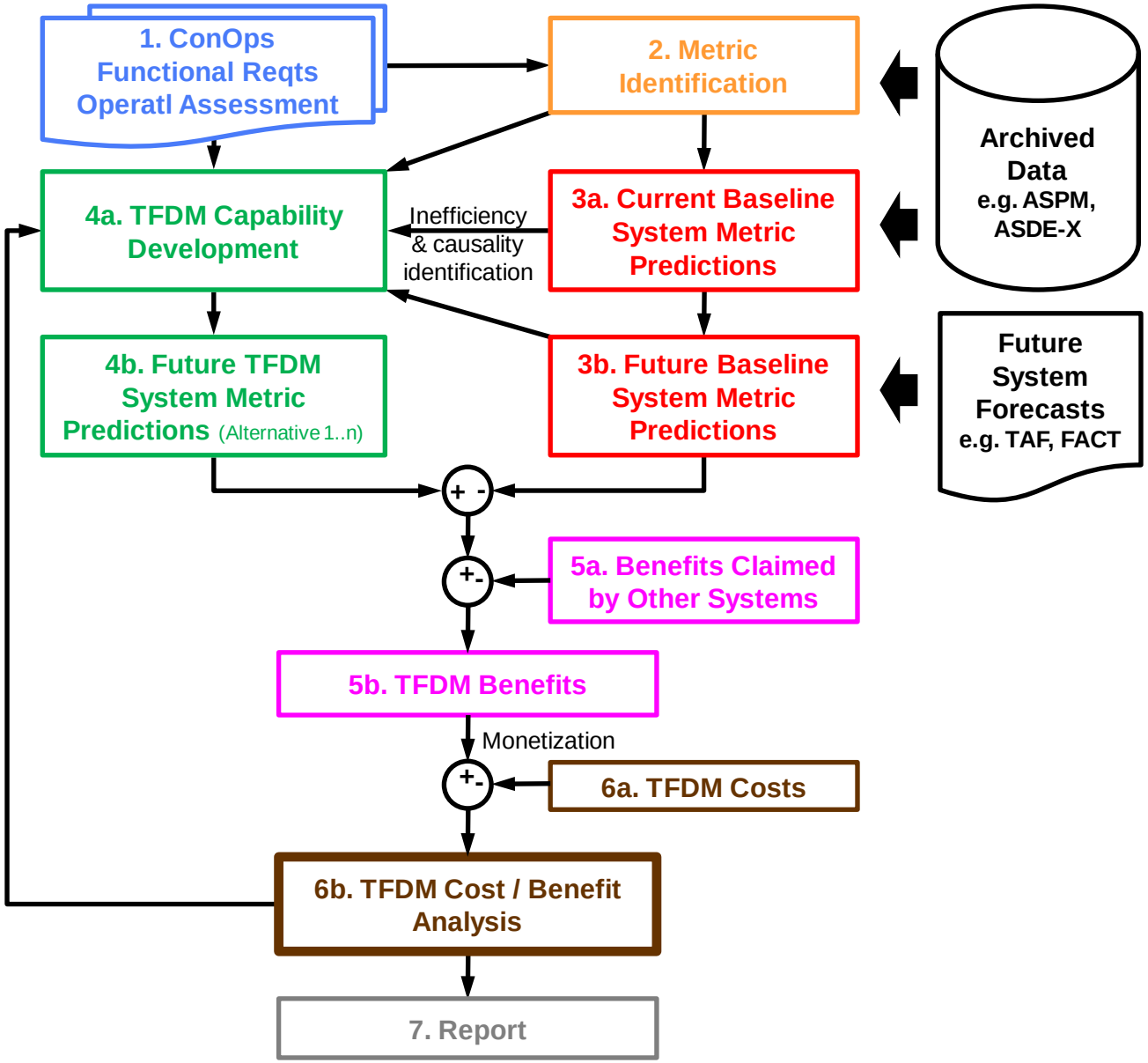
FAA Standard Benefits Assessment Methodology

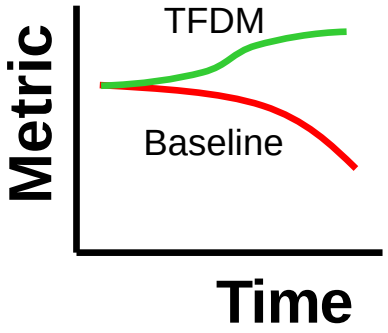
- FAA defines 11-step benefits analysis methodology

- Distilled version:

  1. Understand the program
  2. Identify relevant performance metrics
  3. Identify current & future “baseline” system performance
  4. Identify current & future “new” system performance
  5. Define the benefits impact
  6. Convert to economic values and compare to costs
  7. Report

TFDM Benefits Assessment Methodology



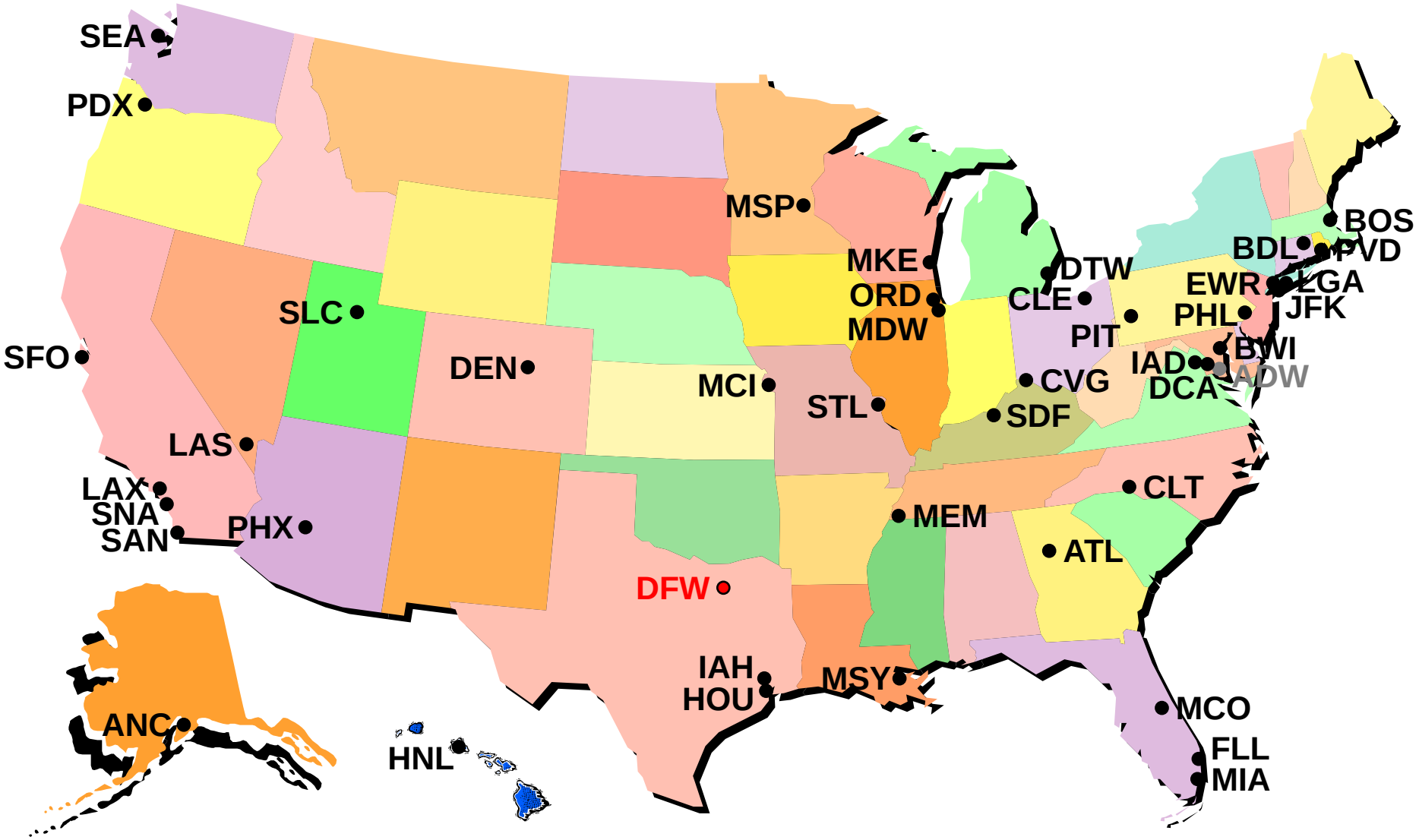


1. Understand the new system
2. Identify relevant metrics
3. Establish baseline metric values
4. Establish new system metric values
5. Define the benefits impact
6. Convert to economic values and compare to costs
7. Report

TFDM Benefits Assessment Methodology Application

- **Step 1: Primary objective of TFDM is to improve efficiency of surface operations**
- **Step 2: Taxi-out delay time & fuel burn performance metrics**
- **Step 3a: Current baseline system performance**
  - **ASPM analysis**
  - **ASDE-X analysis**
- **Step 3b: Future baseline system performance**
  - **Queuing model**
- **Step 4a: Informing TFDM capability development**
- **Step 4b: Future TFDM system performance**
- **Step 5/6/7: TFDM cost/benefit analysis and report**

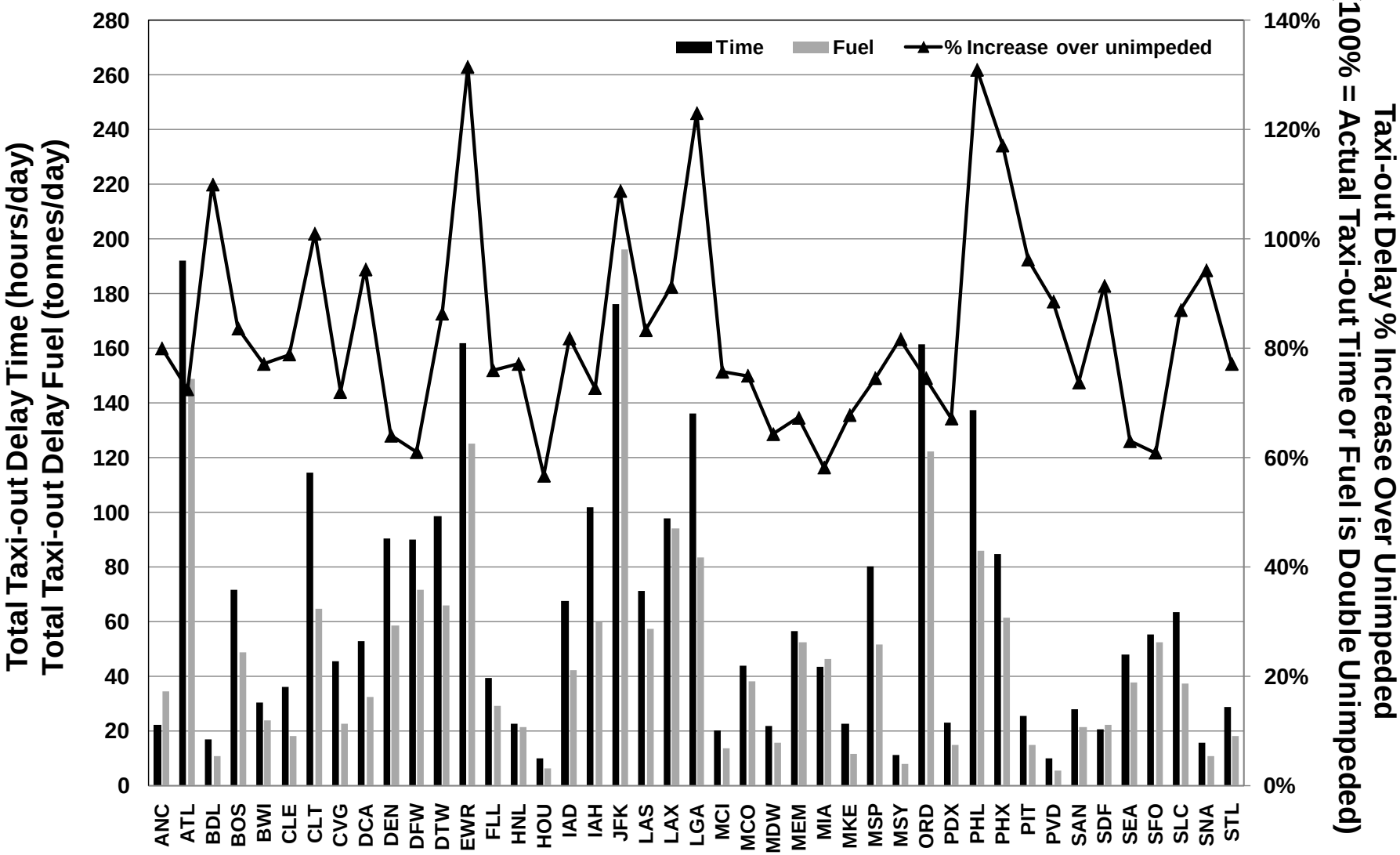
TFDM Investment Analysis Airports



Current Baseline System Performance ASPM Analysis

- **FAA Aviation System Performance Metrics (ASPM) data extracted for analysis airports**
- **Taxi-out delay time: average versus unimpeded push-back-to-wheels-off time**
- **Taxi-out delay fuel: Delay time x Fleet-mix-weighted fuel flow**
  - **Fuel flow for individual aircraft from ICAO ground idle rate**
  - **Assumes all delay absorbed with engines on (upper bound)**

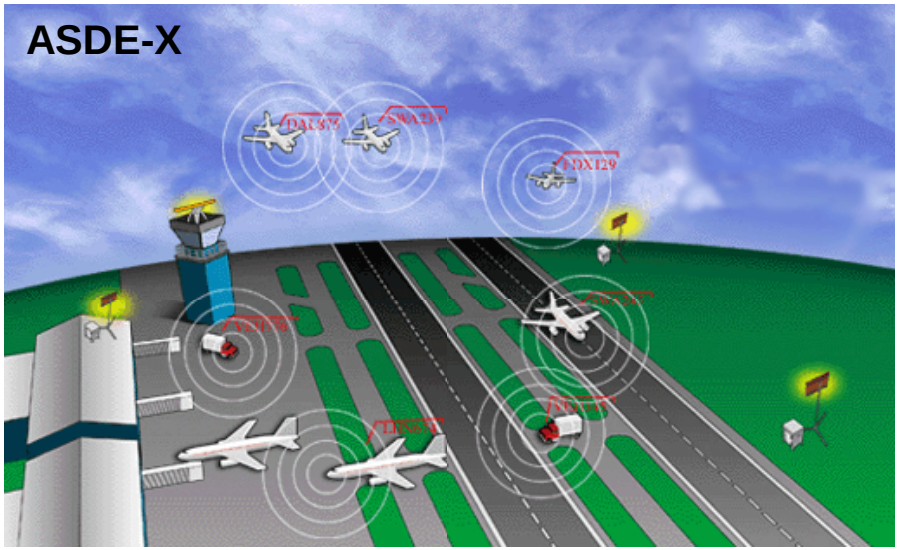
Current Baseline System Performance
ASPM Analysis (2008)



Average total delay: 2533 hrs/day (925 khrs/yr), 1874 tonnes/day (684 ktonnes/yr)

Current Baseline System Performance ASDE-X Analysis

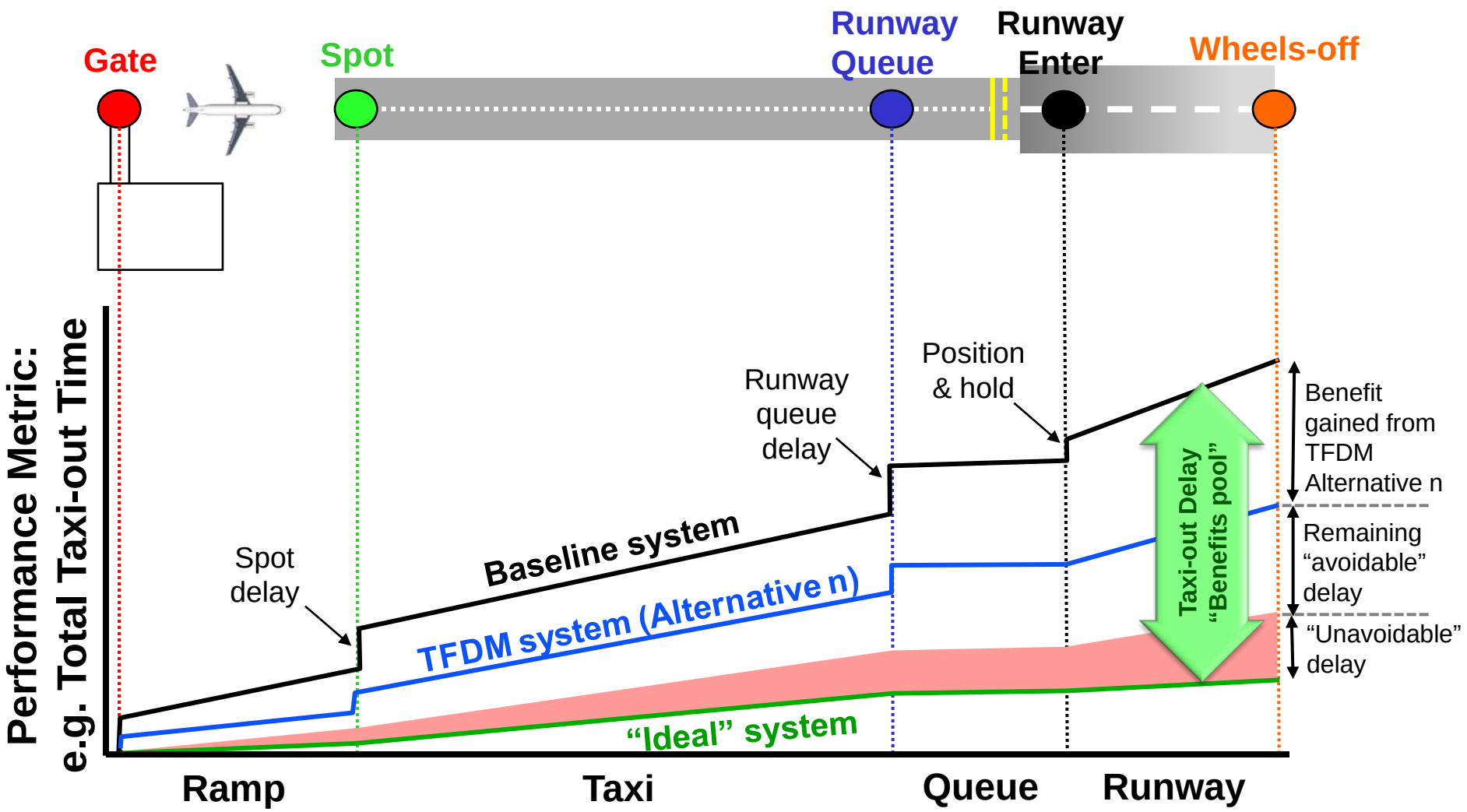
- **Airport Surface Detection Equipment-Version X (ASDE-X) surveillance allows identification of location of delay on surface**
  - **Gate**
  - **Spot**
  - **Queue**
  - **Runway**



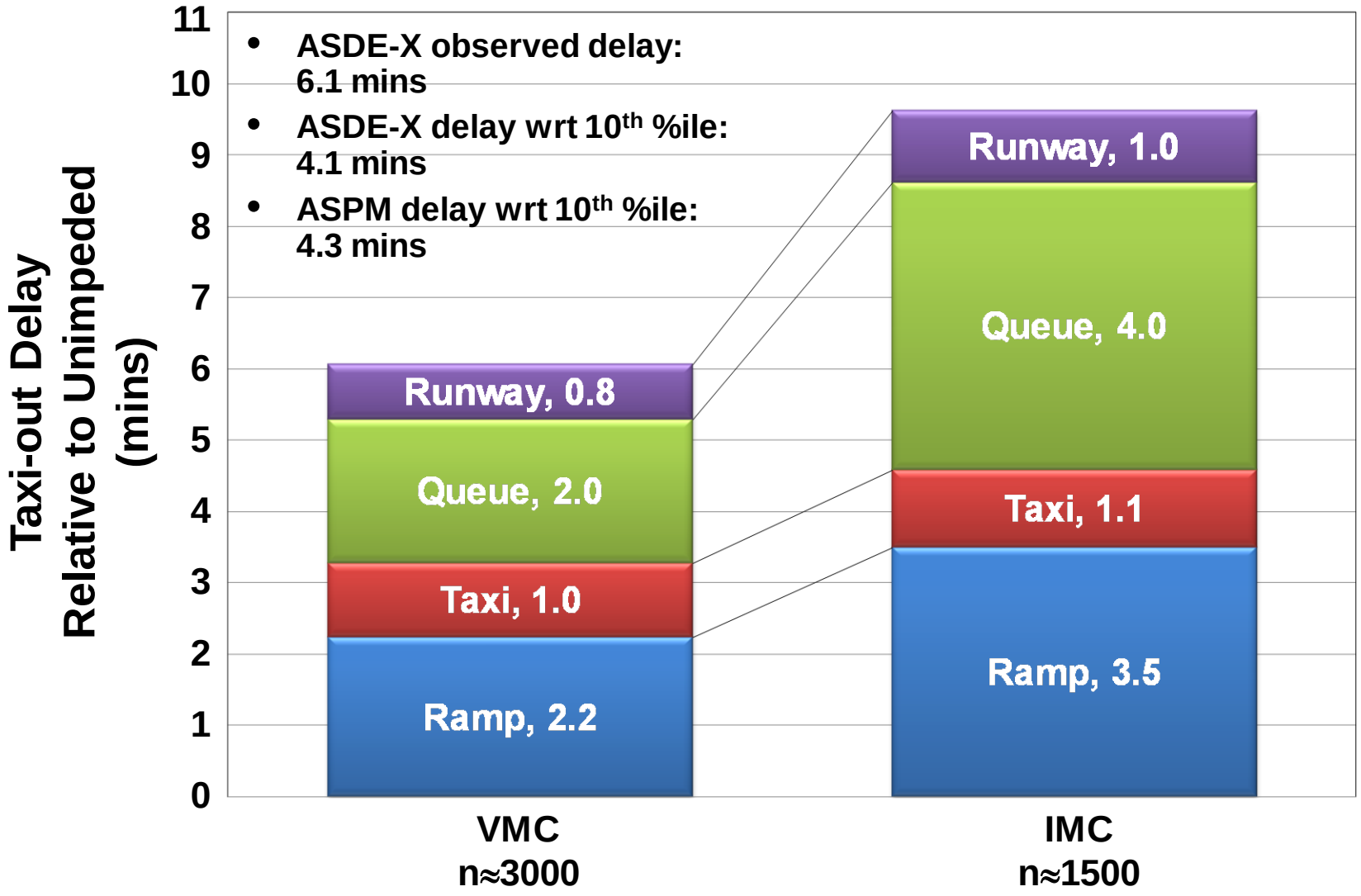
- **At these locations, inefficiencies can be observed & control mechanisms applied**

- **ASDE-X data from Dallas-Fort Worth (DFW) airport analysed**
  - **TFDM prototype site**

Current Baseline System Performance
ASDE-X Analysis



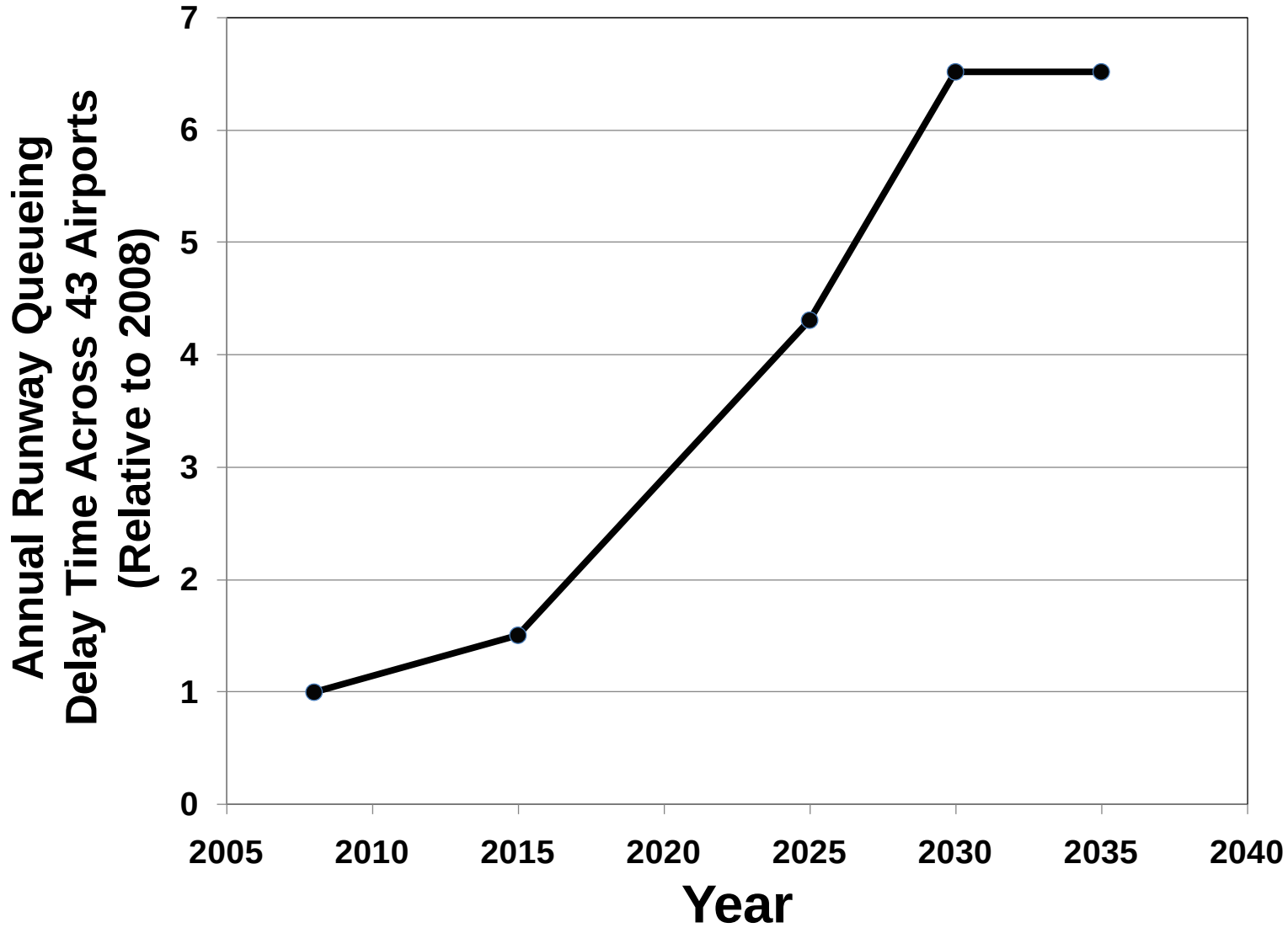
Current Baseline System Performance
ASDE-X Analysis



Future Baseline System Performance Queuing Model

- **Investment analysis period: 2015-2035**
- **Queuing model developed to project taxi-out delay time & fuel at analysis airports into future**
- **Assumptions:**
  - **Runway is dominant airport constraint**
  - **Poisson demand rates**
  - **Exponentially-distributed service times**
- **Model inputs:**
  - **Demand: FAA Terminal Area Forecast**
  - **Capacity: FAA FACT2 Airport Capacities (2007-2025, no increase 2025-2030)**
  - **Average delay capped at 15 mins in VMC and 45 mins in IMC (consistent with system evolving when delays increase)**

Future Baseline System Performance Queuing Model



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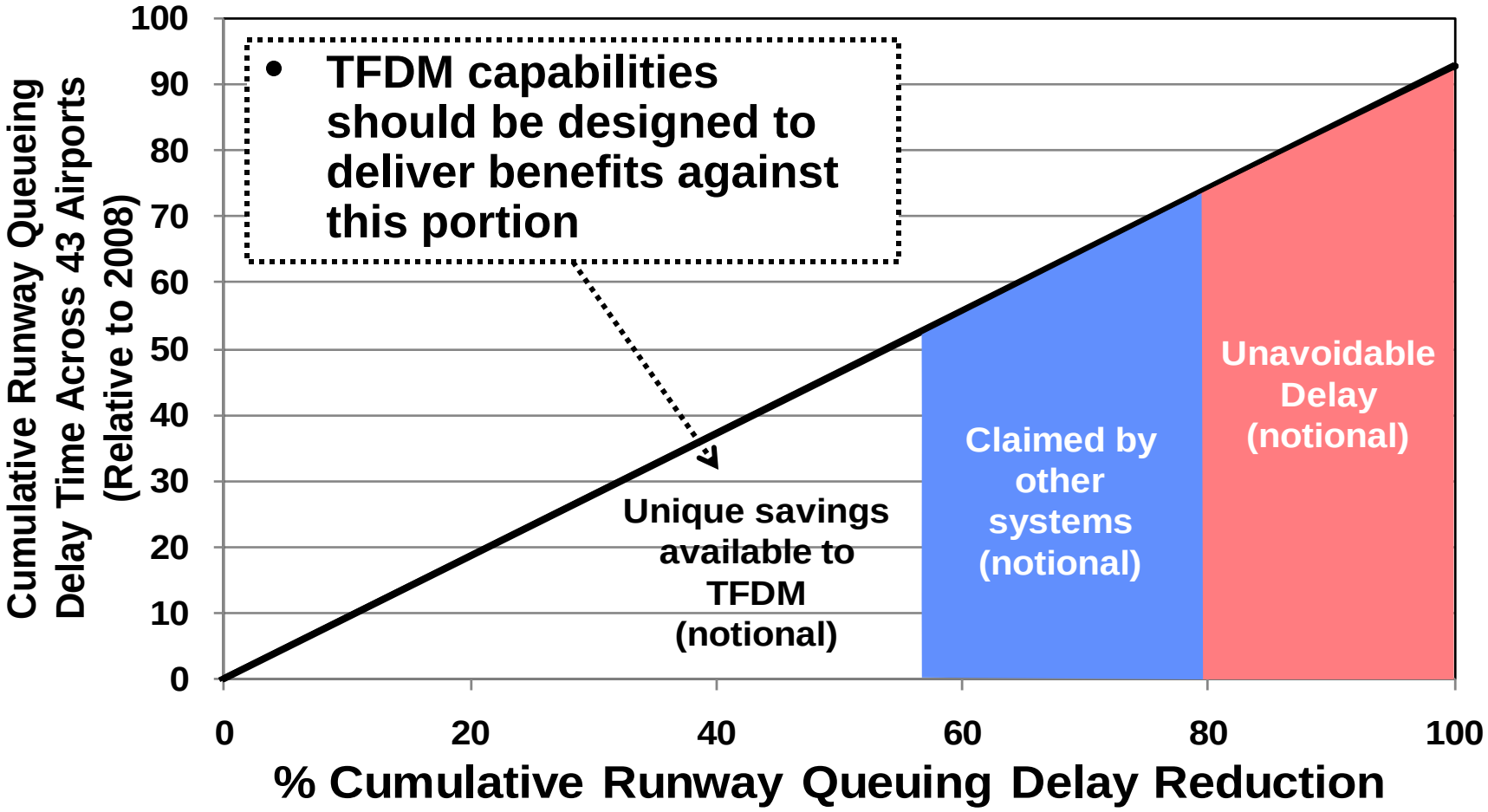

Informing TFDM Capability Development

- **Mapping delay location to possible causality**

Location of Delay	Identified Causes	TFDM Opportunities
Ramp	Aircraft not ready	Situational awareness
	Ground crew not ready	Situational awareness
	Ramp blocked	Situational awareness
	Forgotten at spot	Efficiency improvement
	Back propagation of delay	Indirect impact
Taxi	Runway crossings required	Situational awareness
	Long taxi route	Efficiency improvement
	Taxiway capacity limit	Efficiency improvement
Queue	Runway crossings by others	Situational awareness
	No airborne route available	Efficiency improvement
	Runway capacity limit	Efficiency improvement
	Inefficient departure sequence	Efficiency improvement
Runway	Aircraft not ready	Situational awareness
	Runway crossings by others	Situational awareness
	Aircraft performance	Situational awareness
	No airborne route available	Efficiency improvement

Informing TFDM Capability Development

- **Mapping causality to TFDM capability development opportunities**

Identified Causes	Benefits Mechanism	Candidate TFDM Capability	Key Enabling Capabilities	Observations & Analysis
Forgotten at spot	Prevent waiting aircraft from being overlooked	Notify controllers when aircraft is at spot for long time	Predict normal spot wait time	Frequency of occurrence; Assess proper threshold
Long taxi route	Avoid long taxi routes if shorter alternatives exist	Assign efficient taxi routes, accounting for upcoming runway configuration changes	Predict upcoming RW configuration changes; Taxi time modeling	Presence of alternative routes; Taxi time model accuracy
Taxiway/ runway capacity limit	Manage demand on taxiway/runway to match capacity	Recommend spot release times to meter surface traffic	Surface queuing models to predict congestion	Frequency of occurrence and correlated conditions; Ideal queue length
No airborne route available	Get aircraft to runway (only) when route is available	Predict route blockage and manage spot release time to achieve needed runway time	Departure route availability analysis; Taxi time modeling	Frequency of occurrence; Reliability of route availability forecasts
Inefficient departure sequence	Increase dep. seq. efficiency	Manage spot release times to improve sequence	Predict dep. sequence; Sequence optimization	Comparison to optimal sequence

Summary

- New integrated air traffic control automation system being developed
- Importance of benefits assessment in system development
  - Business case
  - Inform development priorities
- Methodology for benefits assessment presented, with sample applications and data analysis
- Illustrated insights for TFDM development