



*Aviation Short Course*



# ***Aviation Infrastructure Economics***

***October 14-15, 2004***

## ***The Aerospace Center Building***

*901 D St. SW, Suite 850*

*Washington, DC 20024*

*Lecture BWI/Andrews Conference Rooms*

Instructor:

Dr. Jasenka Rakas

University of California, Berkeley



*Aviation Short Course*



***NATIONAL AIRSPACE SYSTEM  
(NAS)  
INFRASTRUCTURE  
MANAGEMENT OVERVIEW***

*October 14, 2004*

Instructor:  
Dr. Jasenka Rakas  
University of California, Berkeley



## *What is a System?*

“A *system* may be considered as constituting a nucleus of elements combined in such a manner as to accomplish a function in response to an identified need...A system must have a *functional* purpose, may include a mix of products and processes, and may be contained within some form of hierarchy...”

Logistics Engineering and Management, 5<sup>th</sup> Edition,  
Benjamin S. Blanchard, Prentice Hall Inc., 1998.



---

## *What is the National Airspace System ?*

“The common network of U.S. airspace; *air navigation facilities, equipment and services, airports or landing areas*; aeronautical charts, information and services; rules, regulations and procedures, technical information, and manpower and material. Included are system components shared jointly with the military.”



# *Background*



## *Why Do We Need Reliable and Modern Aviation Infrastructure?*

- The United States accounts for approximately 30 percent of all commercial aviation and 50 percent of all general aviation activity in the world.
- Prior to September 11, 2001 the NAS handled 1.9 million passengers traveling on 60,000 flights daily.
- NAS moves over 600 million passengers per year. Projected enplanements in year 2013 is over 900 million.
- NAS conducts over 26 million operations per year. Projected number of operations in 2013 is over 33 million.

Source: ACE 2002



# Background

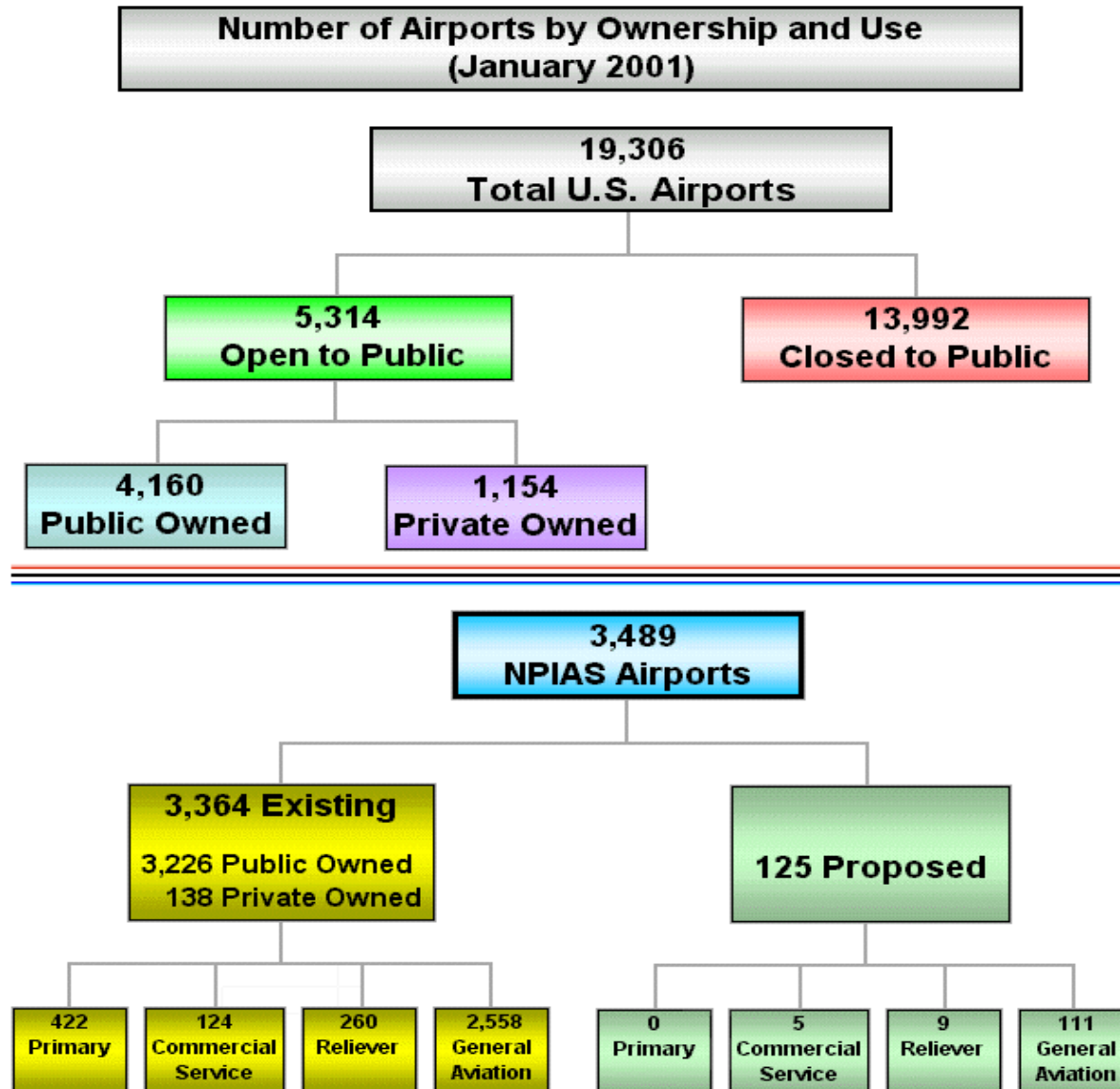


- 546 commercial service airports:
  - 422 have more than 10,000 enplanements and are classified as primary airports (Commercial service airports are defined as public airports receiving scheduled passenger service and having 2,500 or more enplaned passengers per year).
- 31 large hub airports account for 70 percent of all passenger enplanements.
- 37 medium hub airports account for 19 percent of all enplanements
- 74 small hub airports account for 8 percent of all enplanements
- 50 airlines

Source: NPIAS



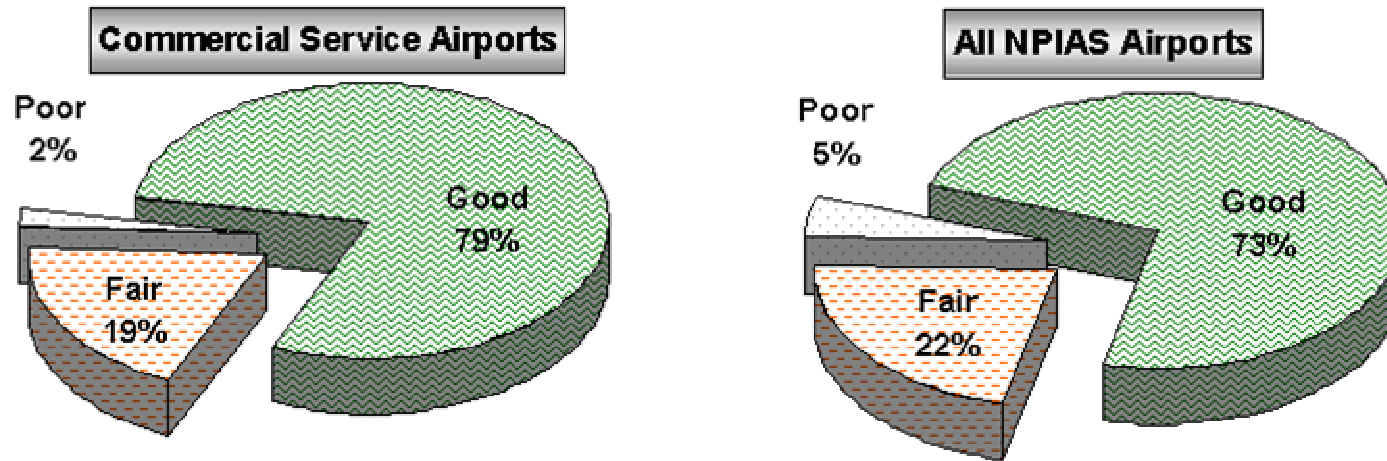
# Background



Source: NPIAS



## Runway Pavement Condition



## Runway Pavement Condition (2000)

Source: NPIAS





# Background



<b>Airport</b>	<b>Runway</b>	<b>FY Runway to Open</b>
Orlando (MCO)	17L/35R	2004
Cleveland (CLE)	6L/24R, Phase 2	2005
Minneapolis (MSP)	17/35	2006
Cincinnati (CVG)	17/35	2006
St. Louis (STL)	12R/30L	2006
Atlanta (ATL)	10/28	2006
Boston (BOS)	14/32	2006
Washington (IAD)	1W/19W	2008
Seattle (SEA)	16W/34W	2009

## New Runways in OEP

Source: OEP



# *Background*



National Airspace System is:

- highly technical
  - highly integrated
  - extremely complex.
- It is the largest of all civil infrastructure systems.
  - It operates 24 hours per day, 7 days a week and contributes to the air transportation commerce that constitutes six percent of the nation's gross domestic product.

Source: <http://www.faa.gov/nasarchitecture/blueprnt/nasmod2.htm>



# *Background*



## NAS Inventory

- NAS has about 44,000 pieces of equipment and services that provide air traffic management (ATM) services.

Source: <http://www.faa.gov/ats/aaf/>

- NAS' large inventory of capital assets are in various stages of approaching physical or technical obsolescence.



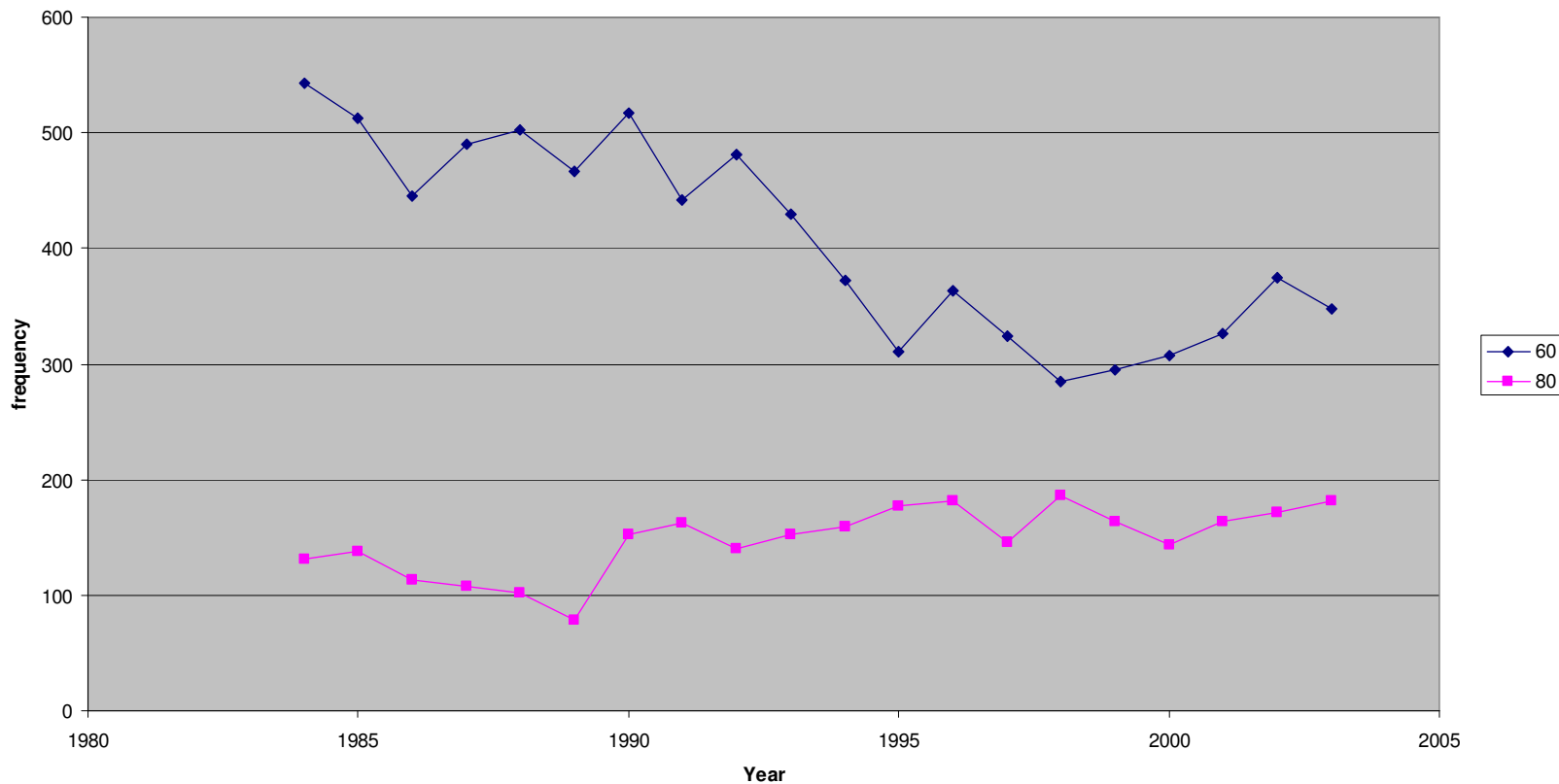
# Background



## NAS Inventory

Source: NAPRS data

Cause Code 60 (scheduled) and 80 (unscheduled) outages for ASR



Frequencies of Scheduled (Cause Code 60) and Unscheduled Outages (Cause Code 80) for Airport Surveillance Radars (ASR)



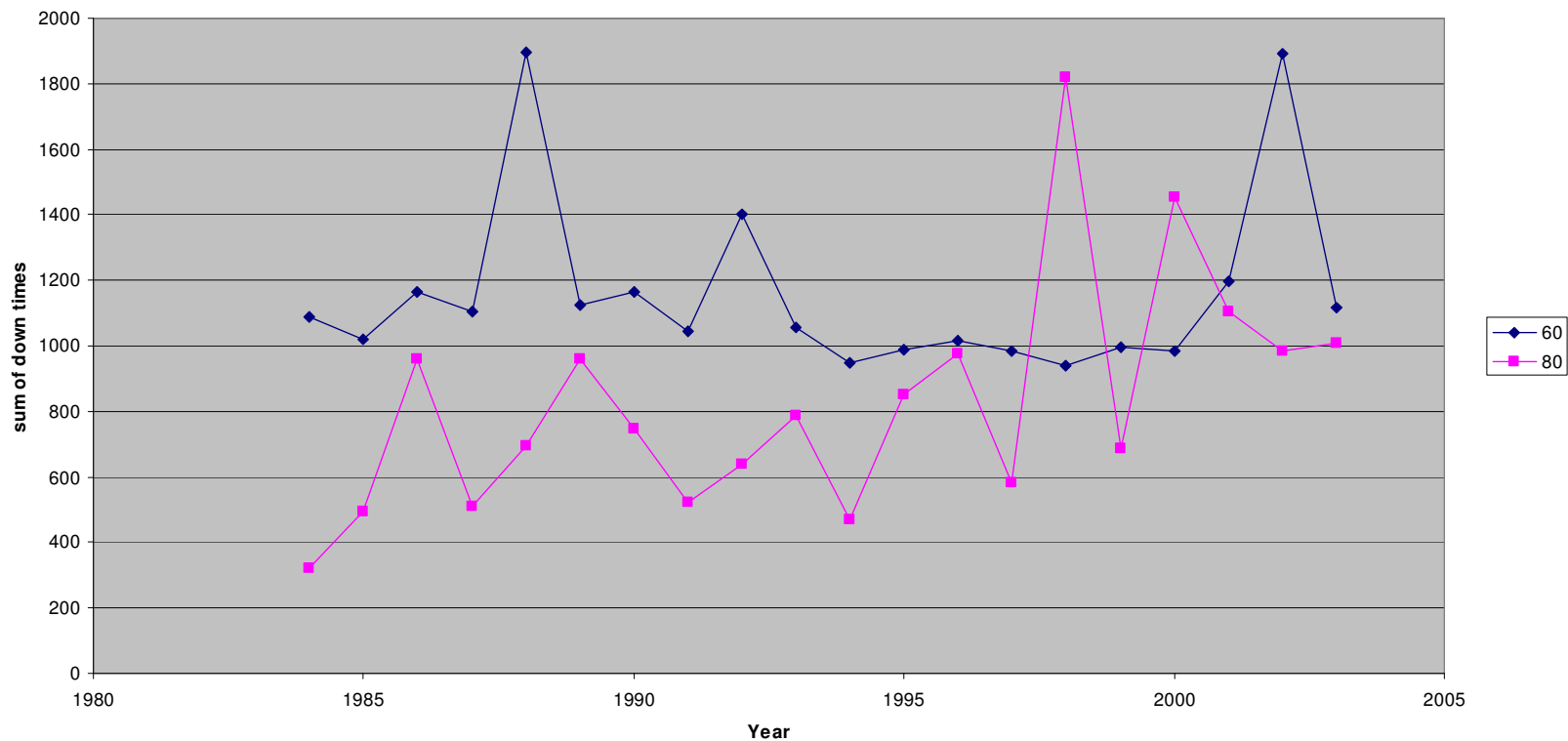
# Background



## NAS Inventory

Source: NAPRS data

Cause Code 60 (scheduled) and 80 (unscheduled) outages for ASR



Downtimes of Scheduled (Cause Code 60) and Unscheduled Outages (Cause Code 80) for Airport Surveillance Radars (ASR)

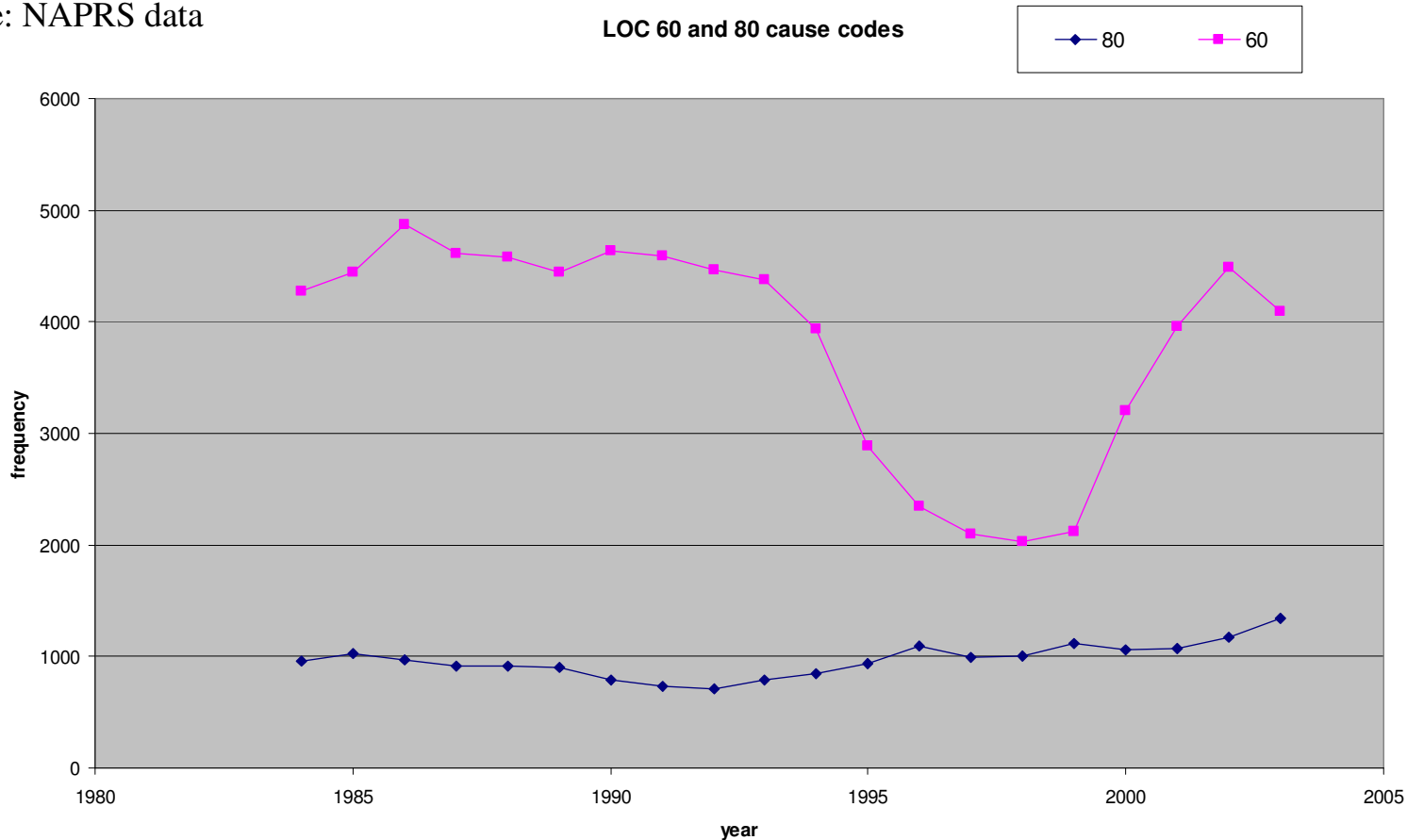


# Background

## NAS Inventory



Source: NAPRS data



Frequency of Scheduled (Cause Code 60) and Unscheduled Outages (Cause Code 80) for Localizers (LOC)



# Background



## NAS Inventory

plot of LOC 60 and 80 cause codes

Source: NAPRS data



Downtimes of Scheduled (Cause Code 60) and Unscheduled Outages (Cause Code 80) for Localizers (LOC)



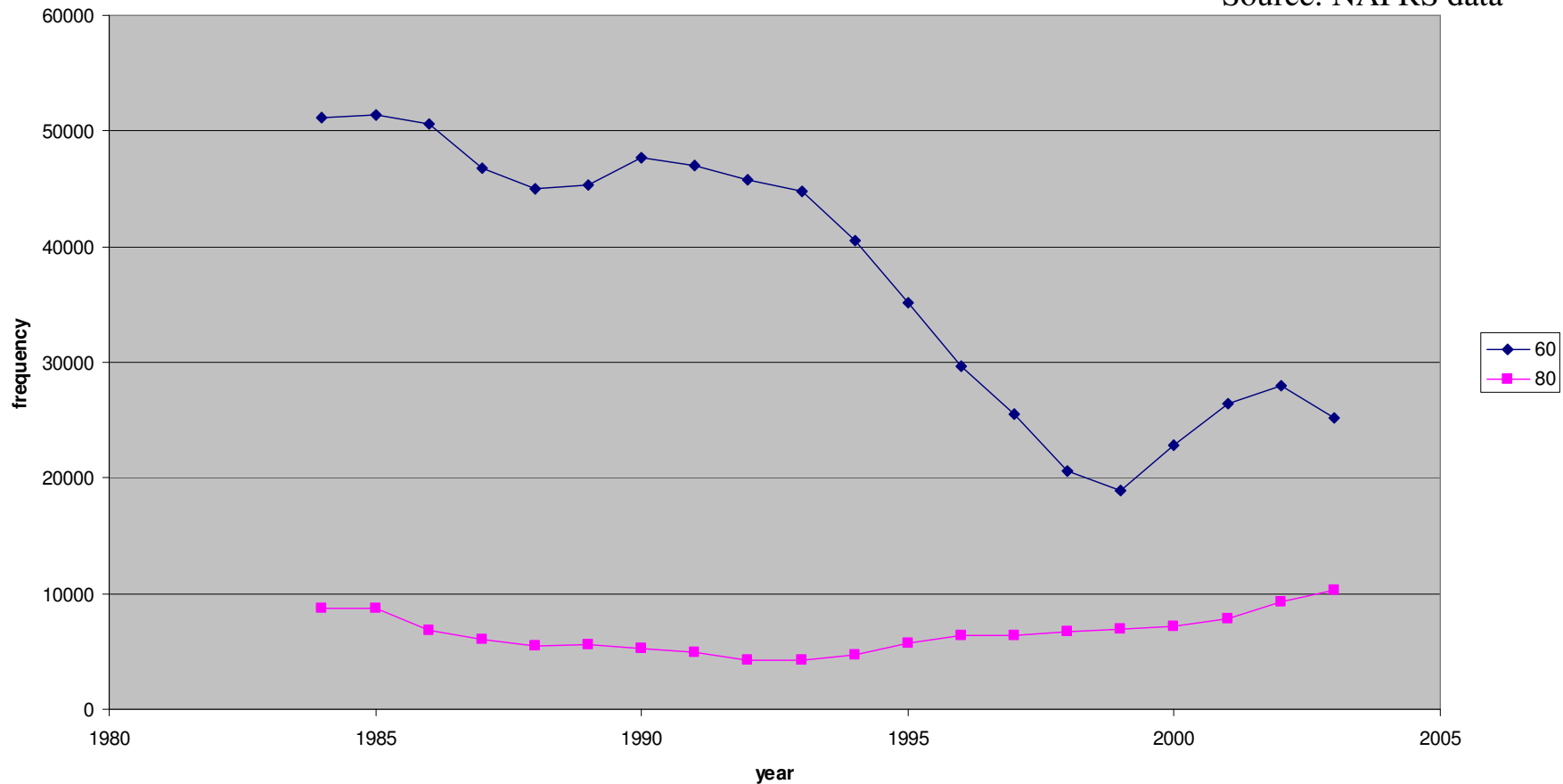
# Background



## NAS Inventory

60 and 80 for all NAPRS equipment

Source: NAPRS data



Frequency of Scheduled (Cause Code 60) and Unscheduled Outages (Cause Code 80) for All NAPRS Equipment





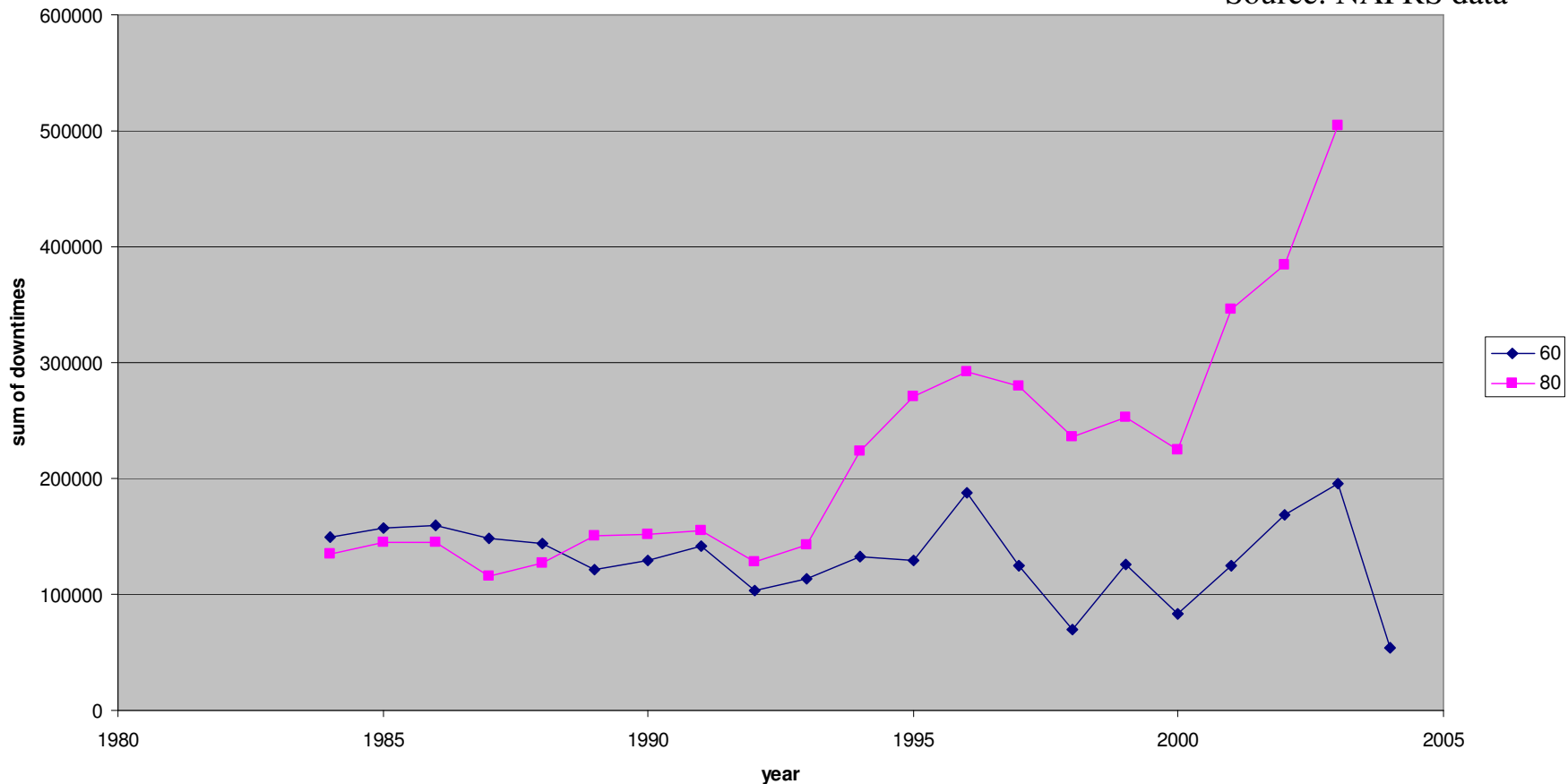
# Background



## NAS Inventory

60 and 80 cause codes for all NAPRS equipment

Source: NAPRS data



Downtimes of Scheduled (Cause Code 60) and Unscheduled Outages (Cause Code 80)  
for All NAPRS Equipment

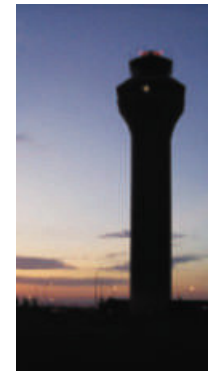


# *Background*



## NAS Inventory

- ~ 500 FAA Managed Air Traffic Control Towers
- ~ 180 Terminal Radar Control Centers (TRACONs)
- 22 Enroute Centers – Air Route Traffic Control Centers (ARTCC)
- > 730 Sectors with more than 100 additional sectors under consideration
- ~ 60 Flight Service Stations





# *Background*

---



## NAS Inventory

- 20,000 – 25,000 administrative and mission support computers
- 1,800 people to maintain and operate NAS software
- \$100 million contract costs to maintain NAS software



# *Background*



## NAS Infrastructure Management

- The maintenance of individual equipment or systems supporting air traffic control of the NAS requires technicians trained in many disciplines deployed over the entire country.
- Maintenance workforce is managed out of a national network of cost centers.
- Each cost center has a limited number of technicians who are responsible for providing scheduled and unscheduled maintenance and repair for the equipment assigned to that center.



# *Background*



## NAS Infrastructure Management

- Different types of equipment have different repair time characteristics.
- Technicians are trained to repair specific types of equipment.
- To date there is no centralized system for equipment maintenance.



# *Background*



## NAS Infrastructure Management

- Facilities are the equipment and systems which are serviced by technicians.
- A subset of specific facilities in the cost center comprise a service. For example, an Instrument Landing System (ILS) is composed of a glide slope (GS), localizer (LOC), inner marker (IM), middle marker (MM), outer marker (OM), distance measuring equipment (DME), runway visual range (RVR), and an approach lighting system (ALS).
- Technicians and facilities are grouped together into FAA-defined cost centers.



## Relevant NAS Measures of Performance and their Relations

