Reliability Overview of Air Traffic Reliability in the National Air Space

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This survey report is meant to look at the reliability and fatality rate of air traffic in the National US airspace (NAS). The author has queried reliability society leaders, air craft pilots, and made good use of the information compiled and available on the web. The main concern is to look ahead at the challenges facing air traffic reliability as the number of planes expands with increasing air traffic. What will be the impact on reliability and safety? What hazard mitigations do we have?

One significant improvement to aircraft control comes from The **Wide Area Augmentation System** (**WAAS**). " This is an air navigation aid developed by the Federal Aviation Administration to augment the Global Positioning System (GPS), with the goal of improving its accuracy, integrity, and availability. Essentially, WAAS is intended to enable aircraft to rely on GPS for all phases of flight, including precision approaches to any airport within its coverage area". (http://en.wikipedia.org/wiki/Wide_Area_Augmentation_System)." WAAS provides plane to have autonomous control to make Category 1 landings at airports. This alleviates the need for ground landing assets for such landings, providing more landing options for pilots and reducing the cost and maintenance needed for ground control assets at smaller airports. More landing options promote higher NAS reliability.

Aviation accidents are extremely rare, with the probability of a passenger being killed on a single flight at approximately one in eight million flights. If a passenger boarded a flight at random, once a day, everyday, it would statistically be over 21,000 years before he or she would be killed. http://www.planecrashinfo.com/rates.htm. Breakdown of cause of accidents is shown below, being reproduced from. http://www.planecrashinfo.com/cause.ht

STATISTICS

Causes of Fatal Accidents by Decade (percentage)

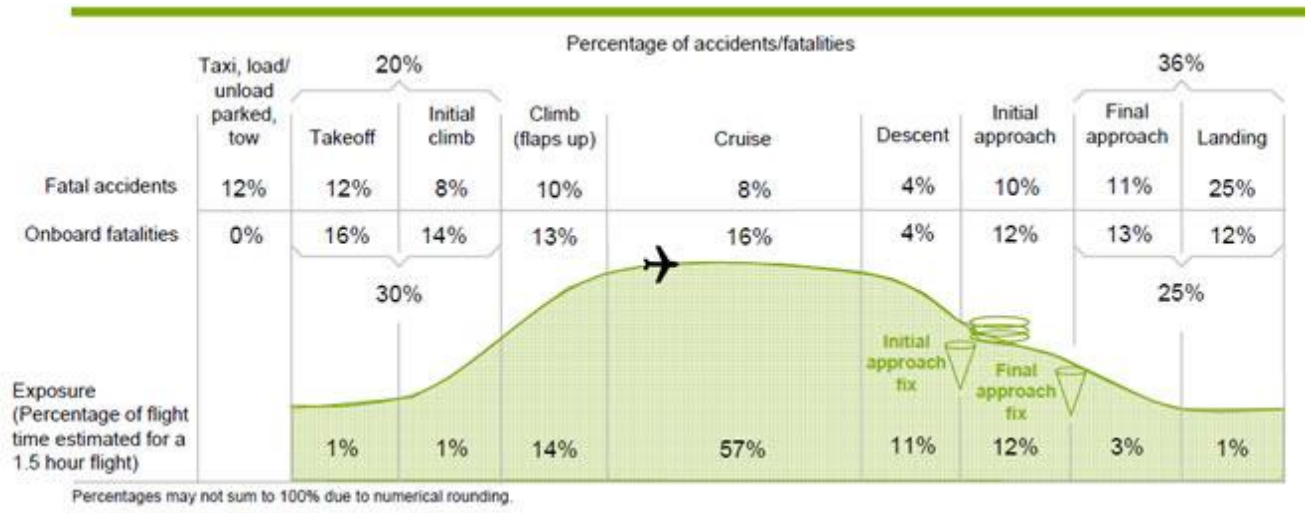
Cause	1950s	1960s	1970s	1980s	1990s	2000s	All
Pilot Error	40	32	24	25	27	26	29
Pilot Error (weather related)	11	18	14	17	21	17	16
Pilot Error (mechanical related)	7	5	4	2	4	3	5
Total Pilot Error	58	57	42	44	53	46	50
Other Human Error	0	8	9	6	8	8	6
Weather	16	10	13	15	9	9	12
Mechanical Failure	21	20	23	21	21	28	22
Sabotage	5	5	11	13	10	9	9
Other Cause	0	2	2	1	0	1	1

The table above is compiled from the PlaneCrashInfo.com accident database and represents 1,300 fatal accidents involving commercial aircraft, world-wide, from 1950 thru 2009 for which a specific cause is known. Aircraft with 10 or less people aboard, military aircraft , private aircraft and helicopters are not included.

"Pilot error (weather related)" represents accidents in which pilot error was the cause but brought about by weather related phenomena. "Pilot error (mechanical related)" represents accidents in which pilot error was the cause but brought about by some type of mechanical failure. "Other human error" includes air traffic controller errors, improper loading of aircraft, fuel contamination and improper maintenance procedures. Sabotage includes explosive devices, shoot downs and hijackings. "Total pilot error" is the total of all three types of pilot error (in yellow). Where there were multiple causes, the most prominent cause was used.

Source: PlaneCrashInfo.com database

Accidents and Fatalities by Phase of Flight



Source: Statistical Summary of Commercial Jet Airplane Accidents, 1959 - 2008, Boeing

Which type of flying is safer

Type of Flight	Fatalities per million flight hours
Airliner (Scheduled and nonscheduled Part 121)	4.03
Commuter Airline (Scheduled Part 135)	10.74
Commuter Plane (Nonscheduled Part 135 - Air taxi on demand)	12.24
General Aviation (Private Part 91)	22.43

Sources: NTSB Accidents and Accident Rates by NTSB Classification 1998-2007

Odds of being involved in a fatal accident

Odds of being on an airline flight which results in at least one fatality	Odds of being killed on a single airline flight
Top 25 airlines with the best accident rates 1 in 5.4 million	Top 25 airlines with the best accident rates 1 in 9.2 million
Bottom 25 with the worst accident rates 1 in 159,119	Bottom 25 with the worst accident rates 1 in 843,744

Source: OAG Aviation & PlaneCrashInfo.com accident database, 1985 - 2009

Survival rate of passengers on aircraft involved in fatal accidents carrying 10+ passengers

Decade	% surviving
1930s	21
1940s	20
1950s	24
1960s	19
1970s	25
1980s	34
1990s	35
2000s	24

Survival rate of passengers on aircraft ditching during controlled flight	53%

Source: PlaneCrashInfo.com accident database

Notable Accident Causes by Category			
Bird Strikes			
10/04/1960	Boston, Massachusetts	Eastern AL	During takeoff the aircraft struck a flock of starlings lost three engines and crashed.
11/23/1962	Ellicott, Maryland	United AL	The aircraft struck a Whistling Swan tearing off the left horizontal stabilizer.
09/15/1988	Bahar Dar, Ethiopia	Ethiopian AL	Engine failure due to ingestion of 10-16 Columbia Guinea birds causing a crash.
04/18/1990	Off Panama	Aero Perlas	Crashed on takeoff due to engine failure caused by bird ingestion.
09/22/1995	Anchorage, Alaska	U.S. Air Force	Flew into a flock of 100 or more Canada Geese, lost two engines, and crashed.
04/19/2000	Pepo, Congo	Centrafricain Airlines	Crashed after losing its engines after striking birds.
01/15/2009	New York, New York	US Airways	Ditched in Hudson River after losing both engines after collision with Canadian Geese.
Air Traffic Control Error			
04/14/1958	Castel de Fels, Spain	Aviaco	Another aircraft was permitted to takeoff without knowing the exact position of the plane.
07/21/1961	Shemya, Alaska	Alaska AL	Lack of guidance from air traffic controller during last stages of flight.
02/08/1965	New York, New York	Eastern AL	Placement of the two aircraft on a near head on course causing one to crash.
03/05/1969	San Juan, Puerto Rico	Prinair	A trained vectored the aircraft into mountainous terrain under IFR conditions.
02/06/1970	Samarkand, USSR	Aeroflot	Misidentification of aircraft by the ATC causing the plane to impact a mountain.
12/20/1972	Chicago, Illinois	Delta/North Central	The ATC gave ambiguous instructions to the crew.
09/09/1976	Adler, Russia	Aeroflot / Aeroflot	Violation of separation rules.
08/11/1979	Dneprodzerzhinsk, USSR	Aeroflot	Separation error by the ATC causing a midair collision.
04/19/1983	Keninakan, Russia	Aeroflot	ATC procedural error in not identifying the planes position.
02/01/1991	Los Angeles, California	USAir/Skywest	ATC cleared a plane to land while the runway was occupied by another aircraft.
11/07/1996	Lagos, Nigeria	Aviation Dev. Corp.	The controller thought he had cleared to aircraft to the correct altitude but didn't.
09/26/1997	Buah Nabar, Indonesia	Garuda Indonesian AL	ATC error in directing the plane in the wrong direction into mountainous terrain.
07/01/2002	Uberlinger, Germany	Bashkirian AL / DHL	Conflicting information give to pilot by ATC and what he was receiving on his TCAS.

Cargo Hold / Cabin Fire			
09/07/1945	Florence, South Carolina	Eastern AL	A fire of undetermined origin in the rear cargo compartment or lavatory.
08/02/1949	Jaquirana, Brazil	Varig	A fire broke out in cargo hold G.
01/09/1964	Zarate, Argentina	Aero Litoral Argentina	The crew was possibly overcome by fumes from a fire.
07/09/1964	Parrottsville, Tennesee	United AL	An uncontrollable fire of unknown origin which started below the passenger floor and eventually involved the passenger cabin.
07/26/1969	Biskra, Algeria	Air Algerie	A fire in an electrical panel led to a cabin fire.
08/14/1972	Konigs, East Germany	Interflug	Melting insulation ignited flammable fluid which led to an uncontrollable fire that eventually weakened the structure until the tail fell off.
08/31/1972	Magnitogorsk, Russia	Aeroflot	Fire caused by spontaneous ignition of passenger baggage.
07/11/1973	Paris, Orly, France	Varig	A fire started in the aft right toilet either from an electrical short or discarded cigarette.
11/03/1973	Boston, Massachusetts	Pan American	Smoke in the cockpit and uncontrollable fire caused by spillage of nitric acid on sawdust packing in the cargo hold.
11/26/1979	Ta'if, Jeddah, Saudi Arabia	Pakistan Inter. AL	A fire may have been started by a passenger possibly from a leaking kerosene stove.
08/19/1980	Riyadh, Saudi Arabia	Saudi Arabian AL	A fire broke out in the aft cargo compartment.
12/24/1982	Guangzhou, China	CAAC	A passenger's cigarette caused a fire in the cabin which led to an oxygen tank exploding.
06/02/1983	Covington, Kentucky	Air Canada	An in-flight fire in the rear lavatory, of unknown origin.
07/02/1986	Syktyvar, Russia	Aeroflot	An in-flight fire was caused by baggage that ignited in the rear cargo hold.
05/09/1987	Warsaw, Poland	LOT	A fire in the cargo hold was not detected because of damage to the fire warning system.
11/28/1987	Mauritius, Indian Ocean	South African Airways	A fire originated in a front pallet on the right side in the upper deck cargo hold.
01/13/1990	Pervouralsk, Russia	Aeroflot	A fire broke out in the rear cargo hold.
05/11/1996	Everglades, Florida	ValuJjet	An in-flight fire caused by activation of oxygen generators in the forward cargo hold.
09/02/1998	Peggy's Cove, Nova Scotia	Swissair	A fire in the entertainment system wiring started in a hidden area above the cockpit ceiling

			when arcing ignited the cover material made of thermal insulation blankets.
Design Flaw			
03/31/1931	Bazaar, Kansas	Trans Cont. & West AW	Aileron flutter, brought about by moisture leaking into the wing's interior, weakening the glue that bonded the wooden spars.
10/24/1947	Bryce Canyon, Utah	United AL	Allowed vented fuel to be carried back into the cabin heater air intake causing a fire.
11/11/1947	Gallup, New Mexico	American AL	Allowed vented fuel to be carried back into the cabin heater air intake causing a fire.
06/17/1948	Mt. Carmel, Pennsylvania	United AL	Design flaw allowed carbon dioxide used to suppress a fire to leak into the cockpit and asphyxiate the crew.
08/29/1948	Winona, Minnesota	Northwest Orient AL	Loss of the outer panel of the left wing which separated as a result of a fatigue crack which was induced by a faulty design of a wing flange.
01/10/1954	Elba, Italy	British Overseas AW	Metal fatigue due to a design flaw.
04/08/1954	Off Stromboli, Italy	Trans Canada AL	Metal fatigue due to a design flaw.
02/05/1955	Calabar, Nigeria	West African AW	A design flaw in the wing led to fatigue cracks and wing failure.
09/29/1959	Buffalo, Texas	Braniff AL	A design flaw caused an oscillation known as mode to transfer propeller wobble to the outboard nacelles and induce flutter in the wing which led to the separation of the wing.
03/17/1960	Tell City, Indiana	Northwest Orient AL	A design flaw caused an oscillation known as mode to transfer propeller wobble to the outboard nacelles and induce flutter in the wing which led to the separation of the wing.
07/05/1970	Toronto, Canada	Air Canada	Faulty design by allowing the spoiler handle to perform two different unrelated tasks.
03/03/1974	Ermenonville, France	Turkish AL	A defect in the latching mechanism on the cargo door.
07/06/1982	Moscow, Russia	Aeroflot	Failure of the aircraft's power plant fire warning system due to design deficiencies which resulted in false fire indications in both engines.
04/06/1993	Over the Pacific Ocean	China Eastern AL	Inadequate design of flap/slat actuation handle that allowed it to be inadvertently dislodged from the UP/RET position causing extension of the leading edge slats.
03/03/1991	Colorado Springs, Colorado	United AL	Uncommanded deflection of the rudder caused by the jamming of the main rudder PUC servo

			valve. Design flaw.
09/08/1994	Aliquippa, Pennsylvania	USair	Uncommanded deflection of the rudder caused by the jamming of the main rudder PUC servo valve. Design flaw.
12/05/1997	Irkutsk, Russia	Russian Air Force	Design flaw which led to uncoordinated operation of the high-pressure compressors.
Sabotage / Explosive Device			
03/28/1933	Dixmude, Belgium	Imperial AW	Fire started by a passenger in an attempt to commit suicide.
10/10/1933	Chesterton, Indiana	United AL	Explosive device placed in the cargo hold, nitro-glycerin with timing device.
05/07/1949	Sibuyan Sea, Philippines	Phillipine AL	Bomb placed aboard to kill the husband of a woman involved with another man.
09/09/1949	Sault-aux-Cochons, Canada	Canadian Pacific AL	Bomb placed aboard by husband to collect insurance on wife.
08/12/1952	Palmeria de Goias, Brazil	Trans Aero Nac.	A bomb exploded aboard killing everyone aboard.
04/11/1955	Great Natuna Island, Sarawak	Air India	An aircraft worker placed an incendiary device in the starboard wheel well.
11/01/1955	Longmont, Colorado	United AL	Jack Graham placed a bomb aboard to collect insurance on the death of his mother.
07/25/1957	Daggett, California	Western AL	Jeweler Saul Binstock detonated a bomb in lavatory in suicide for insurance plot.
04/17/1959	Puerto Kino,Mexico	Tigres Voladores	A bomb is believed to have exploded onboard.
09/08/1959	Poza Rica, Mexico	Mexicana	A passenger, who was believed to have been carrying a bomb, fell from the airplane.
11/16/1959	Gulf of Mexico	National AL	Explosion of a bomb aboard was strongly suspected.
01/06/1960	Bolivia, North Carolina	National AL	A passenger detonated a bomb under his seat in suicide for insurance plot.
05/10/1961	In Amenas, Libya	Air France	Detonation of a nitrocellulose bomb.
05/22/1962	Unionville, Missouri	Continental AL	Detonation of a dynamite bomb in the right rear lavatory in a towel bin.
12/08/1964	Tripuani, Bolivia	Aerolineas Abaroa	Detonation of a bomb in the tail section. A suicide for insurance plot was suspected.
07/08/1965	Dog Creek, British Columbia	Canadian Pacific AL	A bomb exploded in the cabin. Acid and gunpowder may have been poured in toilet.
11/22/1966	Aden, Yemen	Aden AW	Detonation of an explosive device placed in hand luggage in the cabin.
02/09/1967	Mexico City, Mexico	Cubana	Crashed due to bomb explosion.

10/12/1967	Rhodes, Greece	British European AW	Destroyed by a detonation of a bomb within the cabin.
12/22/1969	Nha Trang, Vietnam	Air Vietnam	An explosive device was detonated in the cabin just as the aircraft was about to land.
02/21/1970	Zurich, Switzerland	Swissair	A bomb with an altimeter trigger was believed to have been placed in a mail package.
04/21/1970	Manila, Philippines	Philippine AL	Crashed into mountainous terrain after an explosion in the rear lavatory.
11/21/1971	Penhu Island, Taiwan	China AL	Detonation of an explosive device.
01/26/1972	Hermsdorf, Czechoslovakia	JAT	Detonation of a bomb in the forward cargo hold.
06/15/1972	Pleiku, Vietnam	Cathay Pacific AW	Detonation of an explosive device in the passenger cabin in a suitcase under a seat.
03/19/1973	Ben Me Thout, South Vietnam	Air Vietnam	Crashed after an explosion in the cargo hold.
12/17/1973	Rome, Italy	Pan American AW	Two phosphorus bombs were thrown into the aircraft prior to its departure.
09/08/1974	Ionian Sea, Greece	Trans World AL	Detonation of an explosive device in the aft cargo hold.
01/01/1976	Al Qaysumah, Saudi Arabia	Middle East AL	Detonation of an explosive device in the forward cargo compartment.
10/06/1976	Bridgetown, Barbados	Cubana	Detonation of an explosive device in the aft of the cabin.
02/19/1979	Barentu, Ethiopia	Ethiopian Airlines	Crashed after a bomb exploded aboard.
06/27/1980	Tyrrhenian Sea, Italy	Itavia	An explosive device aboard the aircraft causing the plane crash.
12/21/1980	Rio Hacha, Colombia	Trans. Aereos del Caribe	Explosion possibly caused by a bomb placed in the rear section of the aircraft.
09/23/1983	Mina Jebel Ali, UAE	Gulf Air	Detonation of an explosive device in the baggage compartment.
06/23/1985	Atlantic Ocean, Ireland	Air India	Detonation of an explosive device in the forward cargo hold.
04/02/1986	Athens, Greece	Trans World AL	Detonation of a explosive device in the cabin causing 4 passengers to be sucked out.
05/03/1986	Colombo, Sri Lanka	Air Lanka	Detonation of an explosive device in the rear section of the cabin while on the ground.
11/29/1987	Andaman Sea	Korean AL	Detonation of an explosive device in the passenger cabin.
03/01/1988	Johannesberg, South Africa	Comair	Detonation of a nitro-glycerine bomb in the cabin. Suicide for insurance.
08/17/1988	Bahawalpur, Pakistan	Pakistan Air Force	Detonation of a low level explosive device or incapacitating gas.
12/21/1988	Lockerbie, Scotland	Pan American AW	Detonation of an explosive device in the forward cargo area planted by terrorists.

09/19/1989	Bilma, Niger	Union des Trans. Aer.	Detonation of a bomb in a container location 13-R in the forward cargo hold.
11/27/1989	Bogota, Colombia	Avianca	Detonation of a bomb at seat 15F causing ignition of fuel vapors in an empty fuel tank.
07/19/1994	Colon, Panama	Alas Chiricanas	Crashed after a bomb exploded aboard.
07/09/1997	Suzano, Brazil	TAM	A small bomb containing only 7 oz. of explosives was placed under a passenger seat.
05/07/2002	Off Dalian, China	China Northern Airlines	Out of control fire after a passenger deliberately started a fire.
08/24/2004	Toula, Russia	Volga-Avia Express	Detonation of an explosive device aboard.
08/24/2004	Rostov-on-Don, Russia	Sibir Airlines	Detonation of an explosive device aboard.
Fuel Starvation			
05/18/1935	Knowles Flying Service	Flint, Michigan	Negligence on the pilot for not replenishing his fuel supply before it got dangerously low.
12/31/1935	Imperial Airways	Alexandria, Egypt	Ran out of fuel.
07/02/1937	Lae, New Guinea	Purdue Res. Found.	The aircraft had to be flown higher than expected due to storms which used extra fuel.
11/29/1938	Off Point Reyes, Calif.	United Air Lines	Ran out of fuel forcing a ditching at sea.
02/09/1943	Gander, Newfoundland	British Overseas AW	Ran out of fuel.
12/28/1946	Michigan City, Michigan	American AL	Ran out of fuel for unknown reasons.
01/05/1947	Carmel, New Jersey	Nationwide Air Trans.	Near fuel exhaustion forced the crew to carry out an emergency landing.
01/11/1947	Lympne, England	BOAC	Ran out of fuel because of poor weather conditions encountered throughout the flight.
01/07/1948	Savannah, Georgia	Coastal Air Lines	The fuel valves were positioned so that both engines were supplied from only one tank.
01/30/1948	Near Bermuda	British So. Am. AW	Ran into strong head winds in the Atlantic and ran out of fuel.
08/15/1949	Lurga Point, Ireland	Transocean Air Lines	Ran out of fuel and ditched in the Atlantic.
07/28/1950	Porte Alegre, Brazil	Penair do Brasil	Ran out of fuel while in a holding pattern.
04/30/1952	Delhi, India	Deccan, AW	Fuel starvation after the plane banked to make a turn and the tank was almost empty.
05/26/1952	Atar, Mauritania	British Overseas AW	Became lost in the desert and ran out of fuel.
06/19/1954	Folkestone, England	Swissair	Ditched into the Atlantic Ocean after running out of fuel.

12/22/1954	Pittsburgh, Pennsylvania	Johnson Flying Service	Ditched into the Monongahela River after running out of fuel.
05/02/1970	St. Croix, Virgin Islands	Antillian AL	Ran out of fuel and ditched into the Mediterranean Sea.
12/05/1970	Delhi, India	Jamair	The No. 2 engine failed on takeoff due to fuel starvation.
02/01/1972	Tegal, Indonesia	Penas	Due to a compass error the aircraft became lost and crashed due to fuel starvation.
07/24/1973	Honolulu, HI	Air Hawaii	Fuel starvation. Rear auxiliary tanks not serviced.
08/11/1974	Ouagadougou, Upper Volta	Air Mali	After being diverted and a navigation error the crew circled the wrong city.
10/20/1977	Gillsburg, Mississippi	L & J Company	A malfunction in the No.2 engine caused a higher than normal fuel consumption.
12/02/1977	Al Bayda, Lebanon	Balkan Bulgarian AL	Because of fog, the crew could not find the alternate airport and ran out of fuel.
12/28/1978	Portland, Oregon	United AL	Ran out of fuel while the crew was distracted with a landing gear problem.
09/04/1982	Rio Branco, Brazil	Cia Bras. de Tratores	Ran out of fuel on the third approach in poor weather.
07/23/1983	Gimli, Manitoba, Canada	Air Canada	Accidentally used pounds/liter for the specific gravity factor instead of kilograms/liter.
09/03/1989	Sao Jose do Xingu, Brazil	Varig	The crew flew in the wrong direction for two hours then ran out of fuel.
01/25/1990	Cove Neck, New York	Avianca	Put in series of holding patterns because of heavy traffic and ran out of fuel.
09/11/1990	Off Newfoundland, Canada	Faucett	Ran out of fuel and crashed into the Atlantic Ocean.
06/26/1991	Sokotu, Nigeria	Okada Air	After circling for an hour, unable to locate the air field, the plane ran out of fuel.
11/15/1993	Kerman, Iran	Magistralnye Avialinii	Ran out of fuel while in a holding pattern.
09/18/1994	Tamanrasset, Algeria	Oriental AL	After circling for1 1/2 hours and aborting four landing attempts the plane ran out of fuel.
09/26/1994	Vanavera, Russia	Cheremshanka AL	After three landing attempts, the crew diverted to their alternate but ran out of fuel.
09/11/1995	Jalalabad, Afghanistan	Ariana Afghan AL	Ran out of fuel.
10/31/1995	Piedras Negras, Mexico	TACSA	Ran out of fuel trying to land in fog.
04/05/1996	Petropavlovsk, Russia	Krasnoyarskie AV	Crashed into a mountain after running out of fuel.
01/13/1998	Tor Kach, Pakistan	Ariana Afghan AL	Crashed into a mountain after being diverted to their alternate due to bad weather.
03/24/2000	Kadirana, Sri Lanka	OMSK	After 2 messages they were low on fuel, the plane crashed while attempting to land.

08/12/2001	Lajes, Terceira, Azores	Air Transat	Improperly installed part caused a fuel leak and the plane to run out of fuel.
06/11/2002	Winnipeg, Manitoba	Keystone Air Services	Ran out of fuel.
11/11/2002	Manila, Philippines	Laoag Int. Airlines	Failure of the pilot and co-pilot to check the fuel valves.
08/13/2004	Cincinnati, Ohio	Air Tacoma	Flightcrew's failure to monitor the fuel gauges and to recognize a fuel imbalance.
08/06/2005	Off Palermo, Italy	Tuninter	The maintenance crew incorrectly installed a fuel gauge for a ATR-42 on the ATR-72.
Hijacking (resulting in fatalities)			
07/16/1948	Pacific Ocean	Cathay Pacific AW	Crashed after being hijacked and losing control during a struggle in the cockpit.
11/01/1958	Nipe Bay, Cuba	Cubana	Crashed after being hijacked and running out of fuel.
04/28/1960	Calabozo, Venezuela	Linea Aero. Venezolana	Detonation of a hand-grenade brought aboard by a Russian immigrant.
05/07/1964	San Ramon, California	Pacific AL	Francisco Gonzales, a passenger, shot both the pilot and first officer.
01/23/1971	Korean Air Lines	Sokcho, South Korea	A hijacker detonated grenades he was carrying.
12/06/1971	Tikaka, Sudan	Sudan AW	Hijacked and ran out of fuel.
05/18/1973	Chita, Russia	Aeroflot	Detonation of a bomb in the cabin being carried by a hijacker.
09/15/1974	Phan Rang, Vietnam	Air Vietnam	Detonation of two hand grenades in the passenger compartment by a hijacker.
05/23/1976	Zamboanga, Philippines	Philippine AL	A hijacker set off grenades in the cabin.
06/27/1976	Entebbe, Uganda	Air France	Seven passengers were killed during a commando raid by Israeli forces.
12/04/1977	Kampung Ladang, Malaysia	Malaysia AL	Hijacked with both pilots shot.
06/14/1985	Athens, Greece	Trans World AL	U.S. Navy diver Robert Stethem was murdered aboard by hijackers.
11/24/1985	Luqa, Malta	Egyptair	Several hand grenades were thrown into the cabin causing a fire.
09/05/1986	Karachi, Pakistan	Pan American AW	Hijackers opened fire on the passengers and crew and threw grenades among them.
12/25/1986	Ay, Saudi Arabia	Iraqi AW	Two hand grenades exploded in the cockpit causing the plane to lose control & crash.
07/24/1987	Geneva, Switzerland	Air Afrique	A hijacker killed one passenger before the plane was stormed by troops.
12/07/1987	San Luis Obispo, California	Pacific Southwest AL	David Burk, a fired employee, shot the pilot and first officer.

04/05/1988	Combi, Cyprus	Kuwait AW	Two hostages killed on the ground by hijackers.
10/02/1990	Guangzhou, China	Xiamen/China SW AL	After a struggle in the cockpit with a hijacker the pilot hit three parked planes.
08/28/1993	Khorag, Tajikistan	Tadzhikistan Nat. AL	The crew was coerced into taking off with an overloaded plane by armed hijackers.
12/26/1994	Algiers, Algeria	Air France	Three passengers and four hijackers were killed when the plane was stormed.
11/23/1996	Moroni, Comoros Islands	Ethiopian AL	The plane was hijacked and ran out of fuel crashing in the ocean.
07/23/1999	Tokyo, Japan	All Nippon AW	The plane crashed after the pilot was stabbed by a mentally ill passenger.
12/24/1999	Amritsar, India	Indian Airlines	One crew member was killed after the plane was hijacked.
05/25/2000	Manila, Philippines	Philippine Air Lines	A hijacker was killed after jumping out of plane with a homemade parachute.
03/15/2001	Medina, Saudi Arabia	Vnukovo Airlines	Three people were killed after the hijacked plane was stormed.
09/11/2001	New York, New York	American AL	Hijacked and flown into the twin towers in New York.
09/11/2001	New York, New York	United AL	Hijacked and flown into the twin towers in New York.
09/11/2001	Arlington, Virginia	American AL	Hijacked and flown into the Pentagon.
09/11/2001	Shanksville, Pennsylvania	United AL	Hijacked and flown into the ground in Pennsylvania.
Lightning			
09/03/1929	Mt. Taylor, New Mexico	Trans Con. Air Transport	Struck by lightning during a thunderstorm.
07/22/1938	Stulpica, Romania	LOT	Struck by lightning.
08/31/1940	Lovettsville, Virginia	Penn Central AL	Disabled pilots by a severe lightning discharge in vicinity of plane.
01/17/1951	Civitavecchia, Italy	Alitalia	Lightning ignited mixture of air and fuel fumes in the fuel tank.
06/26/1959	Varese, Italy	Trans World AL	Ignition of gasoline vapors emanating from the fuel tank vent pipes by static discharge.
07/19/1961	Azul, Brazil	Aerolineas Argentinas	Stuck by lightning and extreme turbulence.
12/19/1962	Warsaw, Poland	LOT	Stalled after being struck by lightning.
08/12/1963	Lyon, France	Air Inter	Possibility of a flash of lightning dazzling the crew and causing temporary blindness.
12/08/1963	Elkton, Maryland	Pan American AW	Lightning induced ignition of fuel tank vapors.

04/18/1967	Zarand, Iran	Iranian Air Force	Crashed after being struck by lightning.
12/24/1971	Puerto Inca, Peru	Lineas Aereas Nac.	Lightning caused a fire which led to the separation of the right wing.
05/09/1976	Madrid, Spain	Iran Air Force	Lightning caused an explosion in the No. 1 fuel tank which caused the left wing to fail.
09/05/1980	Montelimar, France	Kuwait Air Force	Struck by lightning.
02/08/1988	Mulheim, Germany	NFD	Struck by lightning and suffered a complete electrical failure.
06/22/2000	Shitai, China	Wuhan AL	Struck by lightning causing the plane to explode and crash.
10/10/2001	Off Valencia, Spain	Flightline	Electrical power was lost following a lightning strike.
12/27/2002	Anjouan, Comoros Islands	Ocean Airlines	Struck by lightining causing loss of artificial horizons and gyro compasses.
Pilot Incapacitation			
10/06/1955	Centennial, Wyoming	United AL	Incapacitation of crew by carbon monoxide emanating from a faulty cabin heater.
10/30/1959	Waynesborough, Virginia	Piedmont AL	Mental breakdown of captain during flight.
12/14/1962	Burbank, California	Flying Tiger Line	Incapacitation of the captain with a heart attack at a critical point in the approach.
04/22/1966	Ardmore, Oklahoma	American Flyers AL	Incapacitation of the captain with a heart attack during final stages of approach.
03/13/1967	East London, South Africa	South African AW	The captain suffered a heart attack and first officer could not regain control of aircraft.
01/14/1970	Mt. Pumacona, Peru	Faucett	The mental state of the pilot adversely affected his judgment and efficiency.
06/18/1972	Staines, Surrey, England	British European AW	Incapacitation of the captain due to a possible arterial hemorrhage.
10/13/1972	Krasnaya, Polyana, USSR	Aeroflot	Sudden incapacitation of the crew for reasons unknown.
02/09/1982	Tokyo, Japan	Japan AL	The captain, known to have mental problems, put the inboard engines into reverse.
03/31/1995	Balotesti, Romania	Trans. Aeriene Rom.	The captain was incapacitated shortly after taking off.
09/04/2000	Near Burketown, Australia	Central Air	Incapacitation of the captain due to depressurized cabin and lack of oxygen.
08/14/2005	Grammatikos, Greece	Helios Airways	Pressurization failure incapacitated the entire crew.

The following was received from an aerospace reliability leader:

“Just like the domestic power grid problem, to increase the amount of power available to the big cities you need to increase the number of power plants and increase the size and number of the distribution paths. To move more passengers we need to increase the size and number of the airports (in areas like LAX. ORD and JFK, we also need to increase ground access to new or bigger facilities). We also have to abandon the "airway" system of aircraft routing and rely on GPS direct routing to reduce the number of hours aircraft are in the sky, thereby reducing fuel consumption and decrease travel time. Any other plan that relies solely on efficiency improvement will not provide the needed throughput increases that this country needs over the next 20 years. “

Biggest limitation to increasing air traffic might be gate access (cycle time is long). Planes land every 90 seconds (Little's law) but this gets protracted in bad weather. The 90 second spacing is used for aircraft following a 'heavy' or big airplane during landing to reduce wake turbulence effect or risk on smaller following aircraft. It is not needed for smaller aircraft. This spacing does reduce runway availability.
National Airspace (NAS) is abundant except at LAX, OC, NY and a few others
Military takes up some of the NAS near airports mentioned above and could be moved away to free up space
Could extend arrival times beyond the 6am to midnight range currently applied - maybe move cargo traffic into the 6 hours black out
Airline "hub" system keeps planes in the air longer time, taking up NAS
The Wide Area Augmentation System (WAAS) is a GPS control system giving the airplane more control over its navigation and landing and signal integrity. WAAS can navigate a CAT 1 landing without ILS and like ground assets. Greater autonomous control for the aircraft will be needed as the flight lanes and separation decrease. WAAS thus provides some additional landing options, providing more NAS capacity for commercial airline traffic.

The challenge is in successfully managing the extremities:
1. High volume airports such as JFK, LAX, …
2. Extreme weather conditions
3. Peak periods of travel over holidays: Thanksgiving, Christmas, …
3. Accident or some calamity
4. Gate and ground capacity limitation for expanding flight density
5 The most challenging control region for aircraft is in the TRACON area. A Terminal Radar Approach Control (or TRACON) is an air traffic control facility usually located

within the vicinity of a large airport. Typically, the TRACON controls aircraft within a 30-50 nautical mile (56 to 93 km) radius of the airport between the surface and 10,000 to 15,000 feet (4,600 m). A TRACON is sometimes called Approach Control or Departure Control in radio transmissions. This challenge is indicated by the first figure showing the high rate of problems during initial descent and final descent. This is a small time in the flight profile with disproportionate number of accidents/incidents over time.

6. Increasing air traffic means more planes in closer proximity, is that increasing throughput is not only a reliability issue, but an "ility" issue. For example, someone jumps the line and breaks security - effect: airport terminal closed. Or computer/software reliability high - bandwith slow, therefore performance is in the tank for all automated systems that must interoperate/communicate, and thus the overall traffic management system must be slowed - delays. And safety (weather) and availability (enabled via fault tolerance and others) also play a role somehow.

This is much like being a sailor. Anyone can sail a boat 98% of the time. The true sailor, or challenge comes meeting the 2% extreme. We need to focus on and manage these conditions. We need to manage the above challenges to ensure a reliable, trustworthy airspace.