Capacity of Airport Passenger Buildings

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Defining Capacity of Airport Passenger Buildings

- **Objectives:**
  - To Present and Explain “Capacity” of Terminals
  - Describe latest IATA recommendations
- **Topics**
  - **Concepts of Capacity**
  - **Design Tradeoff: Levels of Service (LOS) <-> Cost**
  - **IATA LOS Standards (traditional and 2004 Versions)**
  - **IATA 2014 Recommendations**
  - **Importance of “Dwell Time”**
  - **Flow Standards**
  - **Summary of KEY POINTS**

Two Concepts of Capacity

1. **Static: Storage Potential of Facility**
   - How much can space hold at any moment?
2. **Dynamic: Ability of Facility to Process Flows**
   - How much can we move through this space?
   - ✈ **Central Concept for Design of Terminals**
   - ✈ **Passengers, bags, cargo always Move through Services (for example: Check-in, inspections, departures lounges, etc.)**

Dynamic Capacity

Dynamic Capacity can be:

1. **Sustained: Flow over a significant period**
   Example: 3 or 4 hours morning departure of hub-based aircraft, as at Singapore
2. **Maximum: Flow over a brief peak period**
   Example: passengers of 1 A380 at customs

Why this difference?

Because:

- **Delays are what makes flow uncomfortable**
- **It takes time for queues to build up**

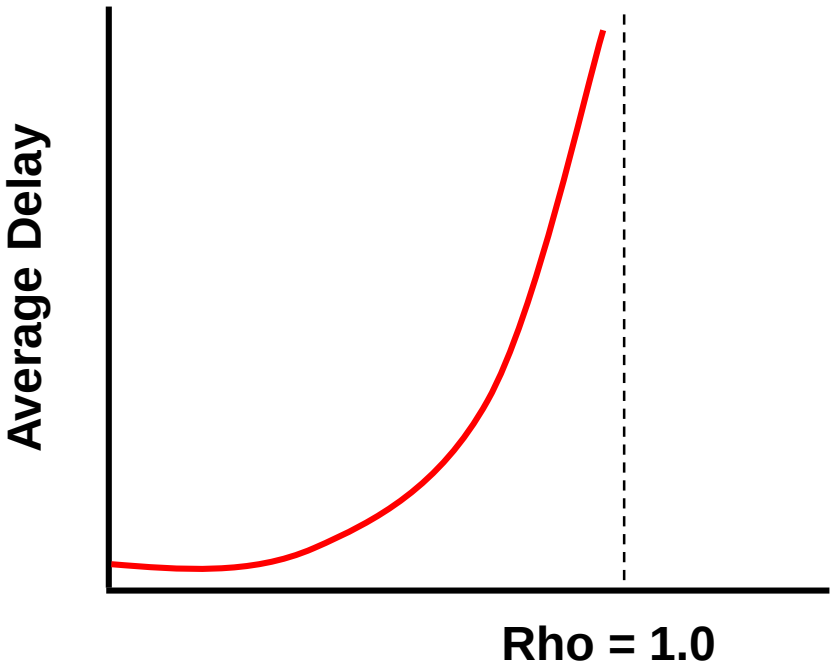
Dynamic Capacity is variable

- **Dynamic Capacity not a fixed amount! Differs from definite Static Capacity See demo with glass**
- **It depends on "Level of Service", its quality.**
  - **Delays – when traffic is high, queues and delays build up, system seems 'full', even if more could jam in**
  - **Unreliability – queues vary, service then unreliable, unsuitable for hub connections**
  - **Crowding – example: what is bus capacity?**

Basic Queuing Diagram: Delays

Delays ~ 1/rho

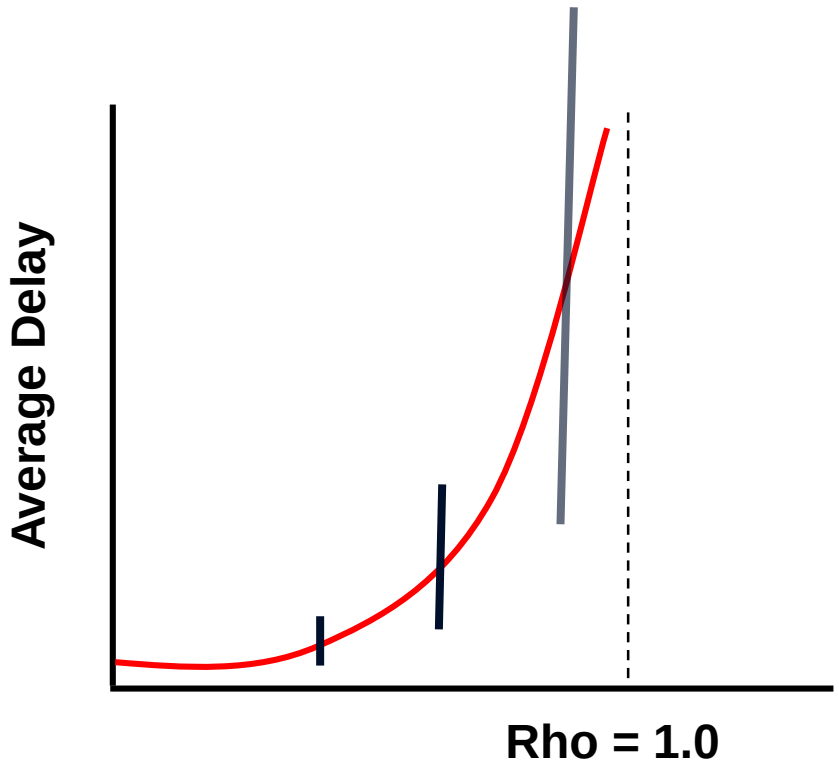
- Rho = ratio of actual load to nominal maximum capacity
- As loads on system increase, average delay increases exponentially
- So practical capacity = less than nominal maximum
- Caveat: this is steady-state, “sustained” situation…



Basic Queuing: Reliability

Moreover, variance in delays ~ 1/rho

- Variance in delays increases with 1/rho
- System thus becomes less reliable
- To insure meeting deadline (aircraft departure), reduce rho
- Denver Example: rho max ~ 40% for sustainable bag transfer system at this hub



Central Concepts for Design

- **"Capacity" determined by acceptable "Level of Service" (LOS)**
- **Acceptable LOS depends on client**
  - Premium Passengers demand better LOS
  - LCC Passengers satisfied with lower LOS
- **Design is tradeoff between**
  - Cost of facility against benefits of reduced delays and crowding
- **IATA recommends: balanced design**

Translating LOS into Design

- Basic reference: IATA Airport Development Manual
- Three Editions of development
- 1995: set LOS definitions in terms of space; gives good insights
- 2004: extends definitions
- 2014:
  - ✈ Adds Standards for Wait times
  - ✈ Directs Designs to LOS C

Level of Service Descriptions

- 6 Categories: A (best) to F (unacceptable)
- These describe Quality of Service based on Ease of Flow and Quality of Delays
- Traditional view, presented by IATA (Airport Development Manual):

LOS	Flows	Delays	Comfort
A - Excellent	Free	None	Excellent
B - High	Stable	Very Few	High
C - Good	Stable	Acceptable	Good
D - Adequate	Unstable	Passable	Adequate
E - Inadequate	Unstable	Unacceptable	Inadequate
F - Unacceptable	--- System Breakdown ---		Unacceptable

IATA LOS Space Standards

(1995 version: Airport Development Manual, 8th ed.)

- Traditional view states LOS standards entirely in term of space: square meters per person

Area	A	B	C	D	E	F
Wait/circulate	2.7	2.3	1.9	1.5	1.0	
Bag Claim	2.0	1.8	1.6	1.4	1.2	
Check-in Queue	1.8	1.6	1.4	1.2	1.0	
Hold-room Inspection	1.4	1.2	1.0	0.8	0.6	

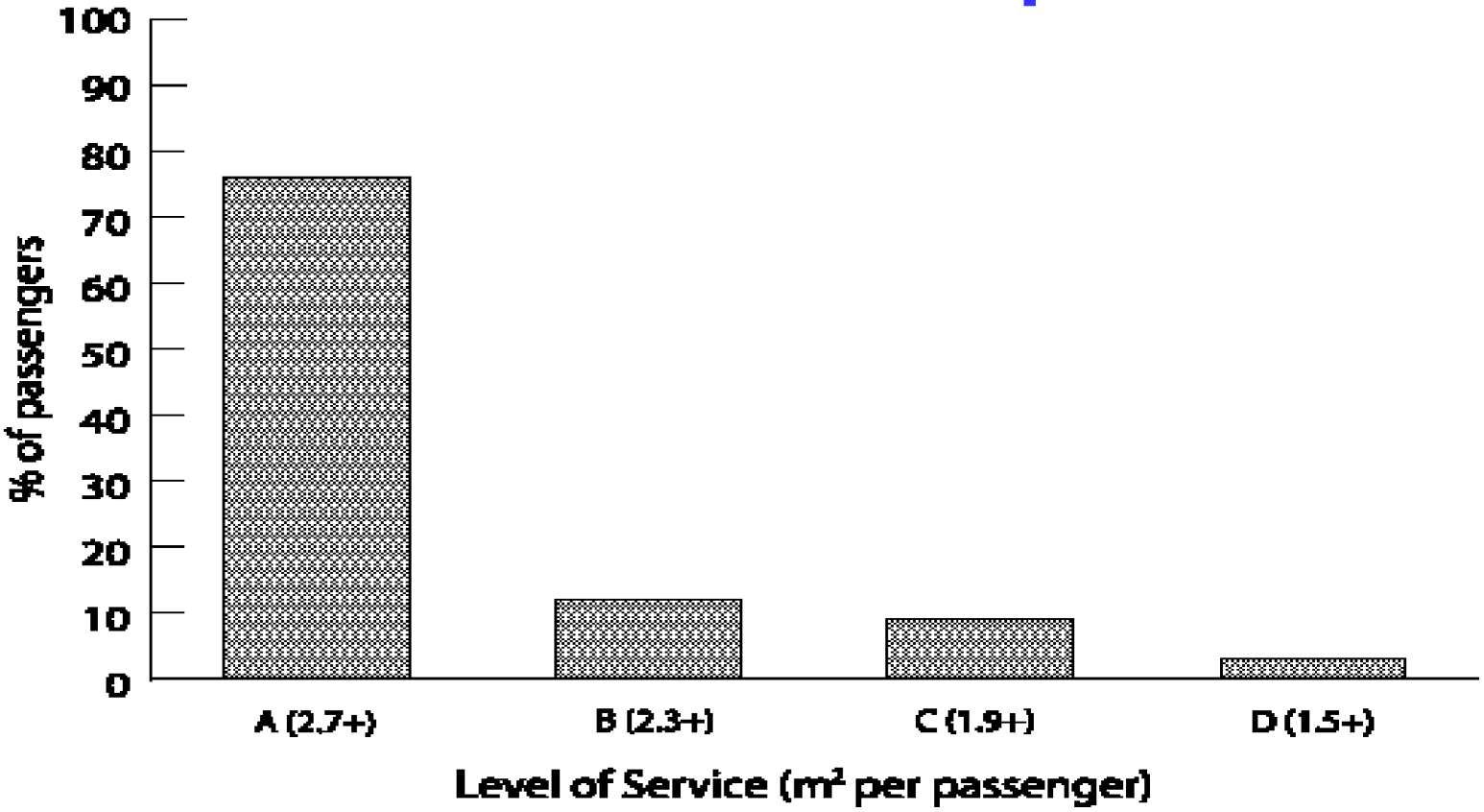
- Left to right: less space means lower LOS
- Top to bottom: more space necessary when people are moving and have bags

Snake Line at LOS = C

Snake line at LOS = E

LOS provided by any space varies

- Example Distribution from Toronto
- Poor LOS OK for short periods



IATA Standards: Wait / Circulate

(2004 version: Airport Development Manual, 9th ed.)

- **Old:**

Square meters / Passenger for Level of Service				
A	B	C	D	E
2.7	2.3	1.9	1.5	1.0

- **New:**
  - ✈ Distinguishes locations, likelihood of carts
  - ✈ References speed

Location	Carts	Space M^2/pax	Speed m / sec
Airside	None	1.5	1.3
After check-in	Few	1.8	1.1
Departure area	many	2.3	0.9

IATA Standards: Passport / Hold

(2004 version: Airport Development Manual, 9th ed.)

- **Old:**

Square meters / Passenger for Level of Service				
A	B	C	D	E
1.4	1.2	1.0	0.8	0.6

- **New (for hold rooms only):**
  - ✈ Assumes 1.7 m^2/pax sitting, 1.2 m^2/ standee
  - ✈ LOS defined in terms of % of space used

Maximum Occupancy Rate (% of Capacity)				
A	B	C	D	E
40	50	65	80	95

IATA Standards: Bag Claim Area

(2004 version: Airport Development Manual, 9th ed.)

- **Old:**

Square meters / Passenger for Level of Service				
A	B	C	D	E
2.0	1.8	1.6	1.4	1.4

- **New:**
  - ✈ Assumes 40% of Passengers use carts
  - ✈ Has a wider range: more for A, less for E

Square meters / Passenger for Level of Service				
A	B	C	D	E
2.6	2.0	1.7	1.3	1.0

IATA Standards: Check-in Area

(2004 version: Airport Development Manual, 9th ed.)

- **Old:**

Square meters / Passenger for Level of Service				
A	B	C	D	E
1.8	1.6	1.4	1.2	1.0

- **New:**
  - ✈ **Reflects impact of number of bags, carts**

Row width	Carts bags	Square meters / Passenger for Level of Service				
		A	B	C	D	E
1.2m	few	1.7	1.4	1.2	1.1	0.9
	more	1.8	1.5	1.3	1.2	1.1
1.4 m	high	2.3	1.9	1.7	1.6	1.5
	heavy	2.6	2.3	2.0	1.9	1.8

2014 IATA LOS Standards

(Airport Development Manual, 10th ed.)

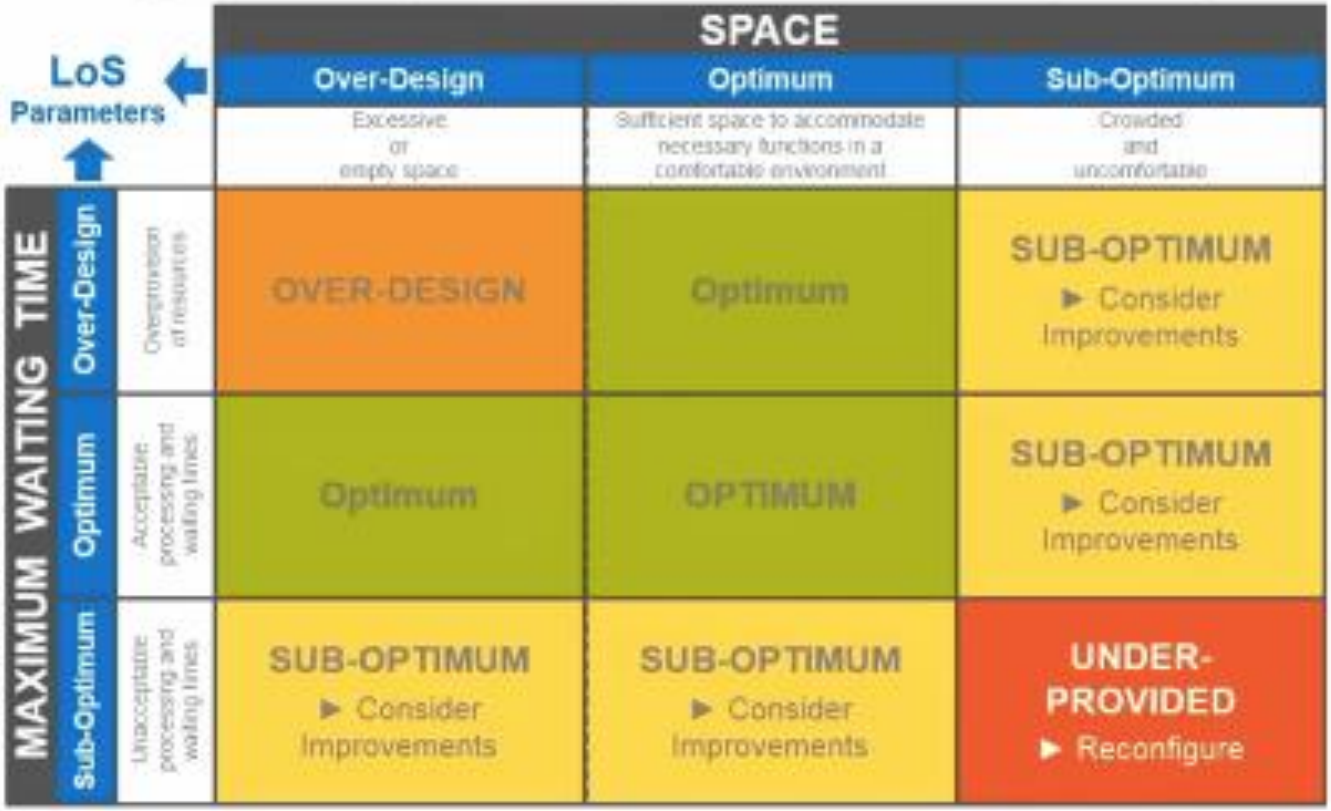
- **2 important contributions:**
  - ✈ Adds standards for waiting time
  - ✈ Directs designers to LOS "C"
- **Idea is to replace previous versions.**
- **Instead of tables, it proposes a computer simulation – Unfortunately this is not transparent, so designers have no easy way to check!**
- **Thus old standards still useful!**

2014 IATA LOS Time Standards

- **Sets waiting time standards**
  - For areas (departure halls, check-in, security, immigration, bag claim) as for space standards
  - For two classes: Economy ; Business/First
- **For example, for economy check-in**
  - LOS A, B: Wait time < 10 minutes
  - LOS C: Wait time between 10 to 20 minutes
  - LOS D, E: Wait time > 20 minutes
- **Note: Wait times must be estimated by simulation! Not verifiable on plans!**

2014 IATA LOS Space-Time Matrix

The NEW LoS framework is reflected in a **space-time matrix** to be used for defining the LoS at processing facilities and corresponding waiting areas.



Translating the code:
"optimum" = LOS C
"over design" = LOS A or B
"sub optimum" = LOS D or E

IDEA IS TO FOCUS DESIGNERS ON GOOD SERVICE WITHOUT BEING EXTRAVAGANT

Source: BrightTALK "Optimise your airport resources with the new Level of Service Concept" 1 December 2015

2014 IATA LOS References

- **IATA Airport Development Manual, 10th edition, 2014 (list price US$900)**
  - ✈ Gives complete tables for wait time standards
- **BrightTALK Dec. 2015 sales pitch presentation by IATA consultants:**
  - ✈ https://www.brighttalk.com/webcast/10625/173423?autoclick=true&utm_source=brighttalk-recommend&utm_campaign=network_weekly_email&utm_medium=email&utm_content=collab

Dwell Time Concept

- Determines Capacity of any space or process
- A Central Concept: **Source of Major Problems**
- Is Average Time a body is in a space or process
- When a person leaves a space, Replacement can use it
- As people move faster
  - ✈ Dwell time is shorter
  - ✈ More replacements can use space in any period

Formula for Space Required

- **Space Required, sq. meters =**
  (Load, pers./hour) (Std, sq.m./person) (Dwell time, hours)
  = (Persons/Time) (Area/Person) (Time) = Area

- **Example (from Australia):**

  What space required for passport control of 2000 passengers/hour when maximum wait is 20 minutes? Their answer: 2000 sq. m.

Space Needed = 2000 (1) (1/3) = 667 sq. m.

Formula for Capacity of a Space

- **Load, persons per hour =**

  (Space, sq. m.) / (Std, sq. m. per pers)(Dwell time, hrs)

- **Examples:**
  - **What is the recommended load (LOS =C) for a waiting room 30x50m, in which transit passengers average 90 minutes?**

Recommended load = (30) (50) / (1.9) (1.5) = 1500 / 2.85 = 527

  - **What is crush capacity (LOS = D) of same space?**

Crush load = (30) (50) / (1.5) (1.5) = 667 pers. per hr.

Flow Standards

In terms of PMM = Persons/Minute/Meter

Type of Passageway	Level of Service Standard					
	A	B	C	D	E	F
Corridor	10	12.5	20	28	37	More
Stairs	8	10	12.5	20	20	More

Assumptions of Flow Standards

- **Two Factors**
  1. Space per Person
     e.g.: 1.9 sq. m. per person for LOS = C
  2. Walking Speed
     e.g.: 66 meters/min = 4 km/hour
     => Low Dwell Time => High Capacity

- **Example:**

  Capacity of Corridor, 5m. wide, 40m. long

  Dwell time = 40 / 4000 = 0.01 hour

  Recommended Load, persons per hour

  = (5) (20) / (1.9) (0.01) = 5,000

Formula for Width of Corridors

- **Total Corridor Width Needed, meters = Effective Width + 1.5m. for edge effects**
- **Effective width = (Persons /Minute) / (PMM)**
- **Example:** *What is recommended width of corridor to handle 600 persons per quarter hour, in both directions?*

  Effective width = 80 / 20 = 4.0m
  Required width = 4.0 + 1.5 = 5.5m

- **Note: Corridor capacity is very great!**
  - ✈ **Most corridors are wider than needed ; Architectural considerations dominate**

Why Snake Queues?

- What is a Snake Queue? (S-band)
  - 1 longer line (leading to many servers) instead of many lines, one for each server
- Why might this be better?
  - No one stuck behind long delay for a server
- Why might be worse?
  - Long line does not look attractive
  - Wasted time going from head of queue to open server (can be fixed by pre-positioning of one or two persons in front of each server)

Snake Queue issues

- **Snake Queue can reduce average service rate by servers. Why is that?**
- **Think about how process works:**
  - ✈ Customer served
  - ✈ Agent signals for new customer from snake queue
  - ✈ New customer does not notice right away, then takes time to get to agent…
- **How do we solve issue?**
- **Small one or two person queues between agent and snake queue – becoming standard for US, Canadian immigration**

Note: Kiosks change process

- Kiosks = automated check-in machines => CUSS (Common Use Self Service) if common
- Speeds up check-in
  - ✈ Automated data entry (try to enter "de Neufville")
- Less Staff, Less counter Space
  - ✈ Large check-in halls becoming obsolete
- Disperses Queues
  - ✈ Check-in machines can be anywhere, also at home

Question: are kiosks faster than agents?

Not necessarily!

Key Take-aways

- **Concepts about capacity:**
  - **Management decision about tradeoffs between Cost and LOS (crowding, waits)**
- **IATA Evolution of standards**
  - **Tradition standards based on space**
  - **New standards adding wait time and requiring simulation**
- **Some technical details:**
  1. **Dwell time critical factor**
  2. **Through flows slash dwell time**
  3. **Capacity of corridors enormous**