CT 1502

Planning and Design of Communication Networks

Demands Placed on Networks

Chapter 7

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Outlines

- Access Demands and Network Layout
- Use Demands and Traffic Volume
- Performance Demands

Access Demands and Network Layout

Access Demands and Network Layout

- **Access Demands(الطلب على النفاذ):** demand on the "ability"(إمكانية) of using the network
- Ex: get phone number, get mobile number

Access Demands

Time	Time Change	Time	t
		Present	t = 0
		Past	t < 0
		Future	t > 0
		Target year	t = T
Source Of Demand	Population/ users	Number in year (t)	P(t)
		Annual percent growth	p
		Source of demand change and time	$P(t) = P(0)[1+p]^t$

Table: 7-1 time factor demands source and its growth over the time

Access Demands

Current Status	Users capable to access percent	S(0)
	User percent: Access Level	L
	Current users	U = P(0).S(0).L
Current Demand	Required access level	I (0)
	Overall access demand	D(0) = P(0).S(0).I(0)
	Demand-based: wait to be served	W(0) = D(0) - U
Future Demand	Overall demand in target year (T)	D(T)= P(T).S(T).I(T)
	Increase demand	W(T) = D(T) - U
	The required annual increase mean(متوسط)	w(T) = W(T) / T

Table: 7-2 Current status, current demand an future demand factors

Access Demands

Network distribution		(1)	(2)	(3)	(4)	(5)
Current Status (t=0)	Source	P(0, 1)	P(0, 2)	P(0, 3)	P(0, 4)	P(0, 5)
		p(1)	p(2)	p(3)	p(4)	p(5)
	Usage	S(0,1)	S(0,2)	S(0,3)	S(0,4)	S(0,5)
		U(1)	U(2)	U(3)	U(4)	U(5)
		L(1)	L(2)	L(3)	L(4)	L(5)
	Demand	I(0,1)	I(0,2)	I(0,3)	I(0,4)	I(0,5)
		D(0,1)	D(0,2)	D(0,3)	D(0,4)	D(0,5)
		W(0,1)	W(0,2)	W(0,3)	W(0,4)	W(0,5)
Future (t=T)	Source	S(T,1)	S(T,2)	S(T,3)	S(T,4)	S(T,5)
		I(T,1)	I(T,2)	I(T,3)	I(T,4)	I(T,5)
	Demand	D(T,1)	D(T,2)	D(T,3)	D(T,4)	D(T,5)
		W(T,1)	W(T,2)	W(T,3)	W(T,4)	W(T,5)
		w(T,1)	w(T,2)	w(T,3)	w(T,4)	w(T,5)

Table: 7-3 studying access demand (present and future) over the network area

Network Layout

- Access demand can reach all the network covering area
- To calculate access demand, use the previous equations for each area

Investigations of Present Access Demands: *An Illustrative Example*

- A city with population of 2 million, Fined the following:

1. Access demand of houses landline phone:
   - Number of residents for each house is: 5 persons
   - Required access demand is: 1,5 phone per house
   - Number of landline phones is: 400,000 phone

Investigations of Present Access Demands: *An Illustrative Example*

Current Status of landline phone access service	population	P(0) = 2 million
	Access demand from houses, house percentage S(0)	S(0) = 1 / PH(0) PH(0) = 5 (Number of residents for each house)
		S(0) = (1/5) = 0.2
	Number of phones	U = 400 thousand
	Current access demand: One phone per house	L = U / (P(0).S(0))
		L=400,000/(2,000,000*0.2)=1
Current Demand	Required access level	I (0) = 1.5
	Overall access demand	D(0) = P(0).S(0).I(0) = 600000
	Demand-based: wait to be served	W(0) = D(0) – U = 200 thousand

Investigations of Present Access Demands: *An Illustrative Example*

- Houses landline phone:
- Overall access demand is: 600,000 phone line
- Since the current service provides 400,000 phone line, the required increase is 600,000-400,000= 200,000 phone line

Investigations of Present Access Demands: *An Illustrative Example*

2. Access demand of offices landline phone:
   - 40% of population are working
   - Mean worker for each office is 4 people
   - Required access demand is: 2 phone per office
   - Number of landline office phone is: 300,000 phone

Investigations of Present Access Demands: *An Illustrative Example*

Current Status of landline phone access service	Access demand from office, office percentage S(0)	S(0) = WP(0) / WB(0) WP(0) = 0.4 is the percentage of working people WB(0) = 4 mean of worker for each office
		S(0) = (0.4/4) = 0.1
	Number of phones	U = 300 thousand
	Current access demand:	L = U / (P(0).S(0))
		L = 1.5/(2,000,000*0.1)=1.5
Current Demand	Required access level	I(0)=2
	Overall access demand	D(0) = P(0).S(0).I(0) =400,000
	Demand-based: wait to be served	W(0) = D(0) – U =100,000

Investigations of Present Access Demands: *An Illustrative Example*

- Offices landline phone:
- Overall access demand is: 400,000 phone line
- Since the current service provides 300,000 phone line, the required increase is 400,000-300,000= 100,000 phone line

Investigations of Present Access Demands: *An Illustrative Example*

3. Access demand of cellular phone
   - 70% of population are capable of using cell phone
   - Required access demand is: 90% of capable
   - Number of cell phones are 700,000 cell phone

Investigations of Present Access Demands: *An Illustrative Example*

Current Status of landline phone access service	Access demand from users capable of using cell phone and Percentage of population	S(0) = 0.70
	Current available service	U = 700 thousands
	Current access demand:	L = U / (P(0).S(0))
		L = 700,000/(2,000,000 *0.7)=0.5
Current Demand	Required access level	I (0) = 0.9
	Overall access demand	D(0) = P(0).S(0).I(0) =1260000
	Demand-based: wait to be served	W(0) = D(0) – U 560000=

Investigations of Present Access Demands: *An Illustrative Example*

- Cellular phone:
- Overall access demand is: 1,260,000
- Since the current service provides 700,000 cell phone, the required increase is 1,260,000-700,000=560,000 cell phone

Investigations of Future Access Demands: *An Illustrative Example*

Current Status	Population	P(0) = 2 million
	Current service	U = 700 thousand
First Future Orientation (التوجه المستقبلي الأول)	Annual population increase	p = 0.03 (3 %)
	Percentage of capable of using cell phone	S(T) = 0.7 (70 %)
	Access demand level	I (T) = 0.9 (90 %)
Second Future Orientation (التوجه المستقبلي الثاني)	Annual population increase	p = 0.03 (3 %)
	Percentage of capable of using cell phone	S(T) = 0.8 (80 %)
	Access demand level	I (T) = 1 (100 %)

Investigations of Future Access Demands: *An Illustrative Example*

- Fined:
- Population increase for first future orientation and second future orientation for the next 10 years
- Development of overall demand during those 10 years for both orientation
- The required annual increase to reach the required service

Investigations of Future Access Demands: *An Illustrative Example*

Target Year (T) (duration)	**Population P(T)** $=P(0)\,[1+p]^T$ (million)		**Overall demand D(T)** = P(T).S(T).I(T) (million)		**Annual increase W(T)** = (D(T) – U) / T (thousand)	
	First Orientation	Second Orientation	First Orientation	Second Orientation	First Orientation	Second Orientation
2	2.122	2.163	1.337	1.730	318.5	515

Population P(T) (First Orientation)

$= P(0)\,[1+p]^T$

$= 2{,}000{,}000 * [1+ 0.03]^2$

$= 2.122$

Population P(T) (Second Orientation)

$= P(0)\,[1+p]^T$

$= 2{,}000{,}000 * [1+ 0.03]^2$

$= 2.122$

Overall demand D(T) (First Orientation)

= P(T).S(T).I(T)

= 2.122 * 0.7 * 0.9

= 1.337

Overall demand D(T) (Second Orientation)

= P(T).S(T).I(T)

= 2.163 * 0.7 *0.9

= 1.730

Investigations of Future Access Demands: *An Illustrative Example*

Target Year (T) (duration)	**Population P(T)** $=P(0)\,[1+p]^T$ (million)		**Overall demand D(T)** = P(T).S(T).I(T) (million)		**Annual increase W(T)** = (D(T) – U) / T (thousand)	
	First Orientation	Second Orientation	First Orientation	Second Orientation	First Orientation	Second Orientation
2	2.122	2.163	1.337	1.730	318.5	515

Annual increase W(T) (First Orientation)

= **(D(T) – U) / T**

= (1337000 - 700,000) / 2

= 318500

Annual increase W(T) (Second Orientation)

= **(D(T) – U) / T**

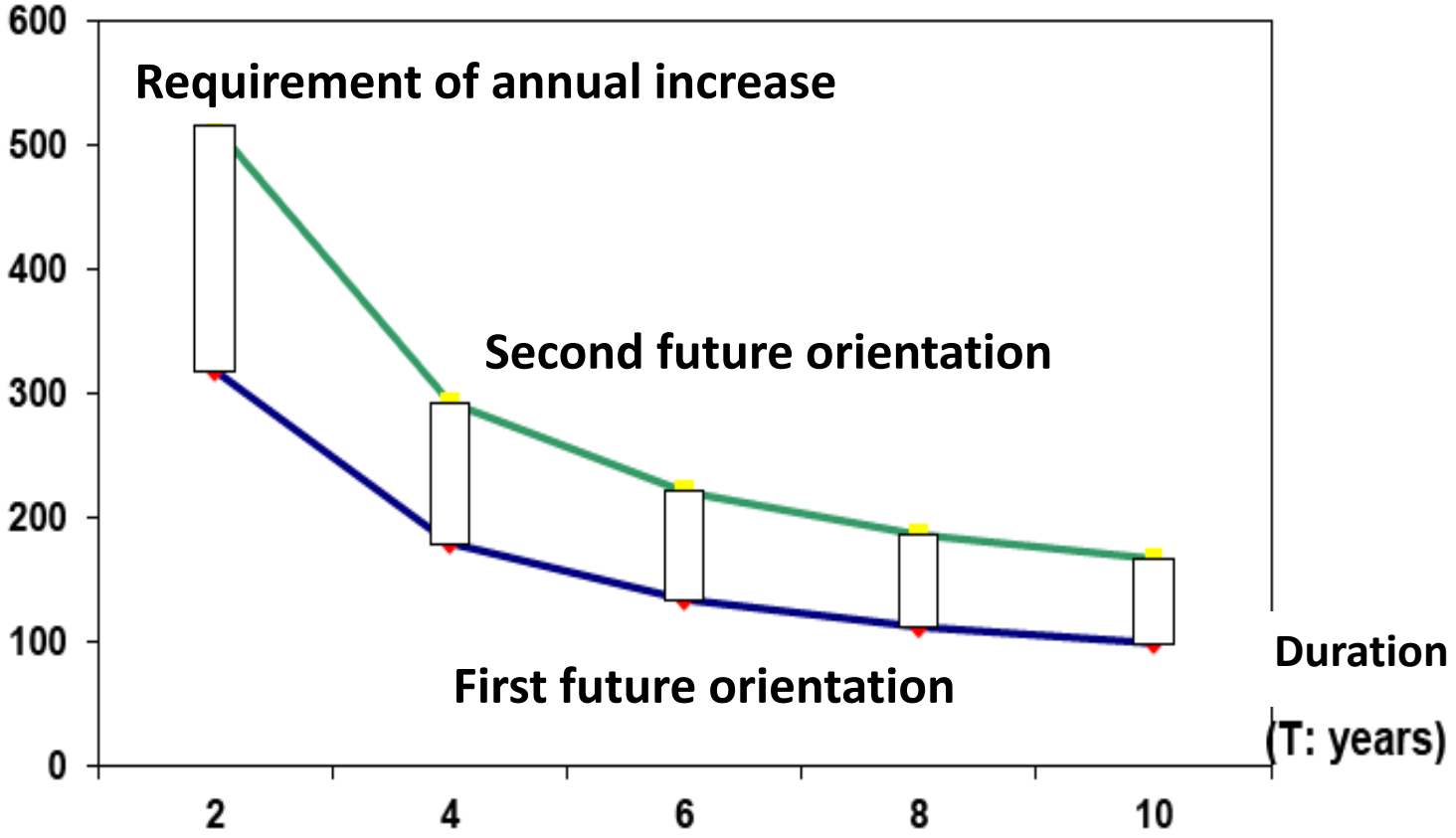
= (1730000 - 700,000) / 2

= 515000

Investigations of Future Access Demands: *An Illustrative Example*

Target Year (T) (duration)	**Population P(T)** $=P(0)\,[1+p]^T$ (million)		**Overall demand D(T)** = P(T).S(T).I(T) (million)		**Annual increase W(T)** = (D(T) – U) / T (thousand)	
	First Orientation	Second Orientation	First Orientation	Second Orientation	First Orientation	Second Orientation
2	2.122	2.163	1.337	1.730	318.5	515
4	2.251	2.340	1.418	1.872	179.5	293
6	2.388	2,531	1.504	2.025	134	220.8
8	2.533	2,737	1.596	2.190	112	186.25
10	2.688	2.960	1.693	2.368	99.3	166.8

Investigations of Future Access Demands: *An Illustrative Example*



The required annual increase the achieve the required service in specified period of time

Use Demands and Traffic

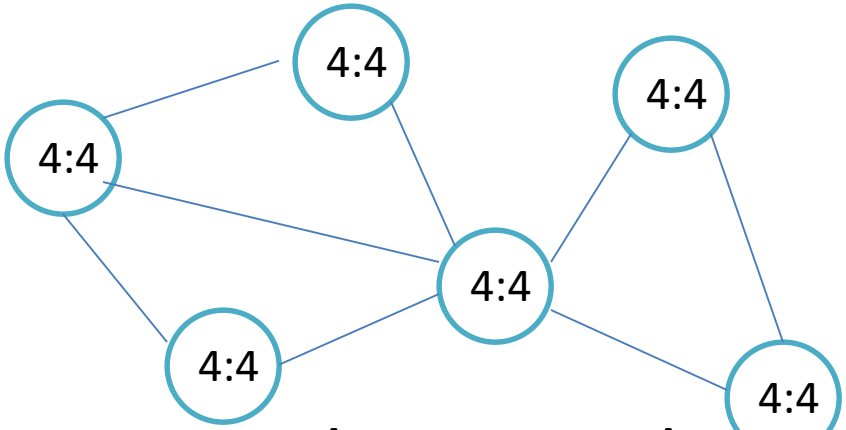
Volume

Use Demands and Traffic Volume

- Since you can access the network, you can share information, send or receive messages, as we call “Use Demand”(الطلب على الاستخدام)
- Can be measured by “Traffic Load” that cause by network users as they send receive information

Use Demands and Traffic Volume

- General Case: all sites traffic load are equal to each other



- Most networks are in this case

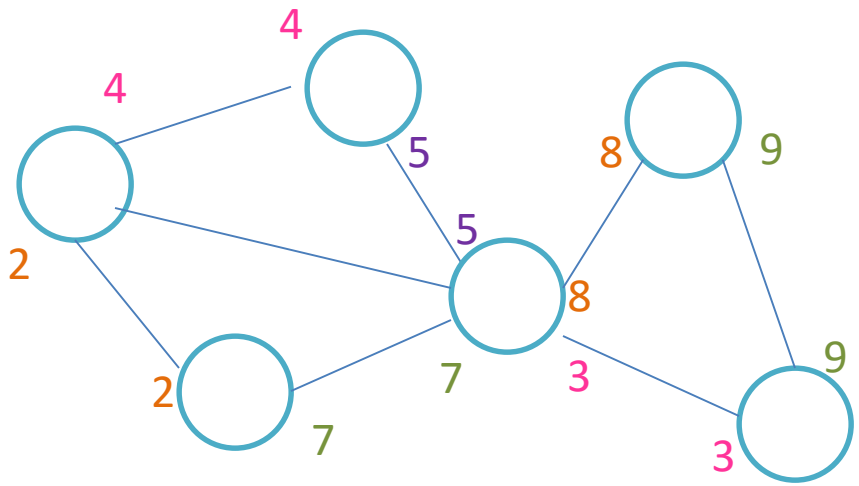
Use Demands and Traffic Volume

TO / FROM	A1	A2	A3	A4	A5	A6	A7	A8
A1	0	L1,2	L 1,3	L1,4	L1,5	L1,6	L1,7	L1,8
A2	L2,1	0	L2,3	L2,4	L2,5	L2,6	L2,7	L2,8
A3	L3,1	L3,2	0	L3,4	L3,5	L3,6	L3,7	L3,8
A4	L4,1	L4,2	L4,3	0	L4,5	L4,6	L4,7	L4,8
A5	L5,1	L5,2	L5,3	L5,4	0	L5,6	L5,7	L5,8
A6	L6,1	L6,2	L6,3	L6,4	L6,5	0	L6,7	L6,8
A7	L7,1	L7,2	L7,3	L7,4	L7,5	L7,6	0	L7,8
A8	L8,1	L8,2	L8,3	L8,4	L8,5	L8,6	L8,7	0

General case of traffic load between sites

Use Demands and Traffic Volume

- Symmetrical load(الحمل المتناظر) :traffic load from (1) to (2) is equal the load from (2) to (1)
- Ex: international phone network



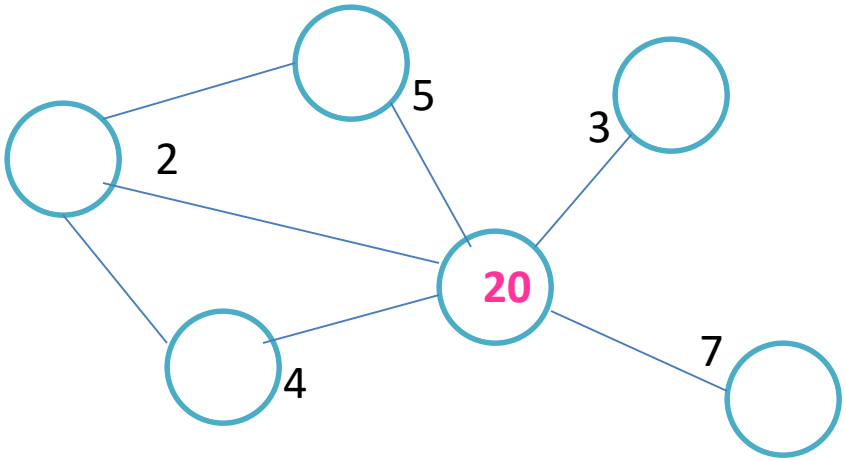
Use Demands and Traffic Volume

TO / FROM	A1	A2	A3	A4	A5	A6	A7	A8
A1	0	L1,2	L1,3	L1,4	L1,5	L1,6	L1,7	L1,8
A2	(L1,2)	0	L2,3	L2,4	L2,5	L2,6	L2,7	L2,8
A3	(L1,3)	(L2,3)	0	L3,4	L3,5	L3,6	L3,7	L3,8
A4	(L1,4)	(L2,4)	(L3,4)	0	L4,5	L4,6	L4,7	L4,8
A5	(L1,4)	(L2,5)	(L3,5)	(L4,5)	0	L5,6	L5,7	L5,8
A6	(L1,6)	(L2,6)	(L3,6)	(L4,6)	(L5,6)	0	L6,7	L6,8
A7	(L1,7)	(L2,7)	(L3,7)	(L4,7)	(L5,7)	(L6,7)	0	L7,8
A8	(L1,8)	(L2,8)	(L3,8)	(L4,8)	(L5,8)	(L6,8)	(L7,8)	0

Symmetrical load of traffic load between sites

Use Demands and Traffic Volume

- Central Use Load: a central site that all sites contact, sites can not contact each other directly



- Ex: private networks

Use Demands and Traffic Volume

TO / FROM	A1	A2	A3	A4	A5	A6	A7	A8
A1	0	0	0	0	L1,5	0	0	0
A2	0	0	0	0	L2,5	0	0	0
A3	0	0	0	0	L3,5	0	0	0
A4	0	0	0	0	L4,5	0	0	0
A5	L5,1	L5,2	L5,3	L5,4	·	L5,6	L5,7	L5,8
A6	0	0	0	0	L6,5	0	0	0
A7	0	0	0	0	L7,5	0	0	0
A8	0	0	0	0	L8,5	0	0	0

Central Traffic load: A5 is the center

Performance Demands

Performance Demands

- Three performance measurement:
  - Availability
  - Congestion
  - Delay

Availability

- Availability: network “readiness” (جاهزية) to serve a call.
- L: the taken time of availability duration
- S: is the duration of available time to the taken time

Availability	**Availability duration**	L
	Availability duration (within T)	S
	Non availability duration	(L – S)
	Availability measurement	V = S / T
	Non-congestion measurement	NV = (T - S) / T

Availability measurements

Congestion

- Congestion accurse when network is “available” and user demand to use the network, he get a message “Your call cannot be completed as dialed”

- No enough capacity
- No enough hardware
- Congestion= Rejected load/ total load

Congestion

Congestion	**Total load**	L
	Carried load	S
	Rejected load	(L – S)
	Congestion measurement	B = (L - S) / L
	Non-congestion measurement	NB = S / L

Congestion measurements

Delay

- Accurse in store-and-forward networks
- Accept the message, but “delaying” the receiving of the message
- No enough capacity

Delay	**Processing duration**	P
	Wait before send	W
	Sending duration	S
	Propagation duration	G
	Duration of transmitting from one site to an other	D = P + W + S + G


thank
you!