PEMODELAN MATEMATIKA UNTUK TRAFIK

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Pokok Bahasan

1. Distribusi Holding Time
2. Distribusi Kedatangan Panggilan
3. Mean, Standard Deviasi, Varians dan Variance to Mean Ratio
4. Extended Erlang B

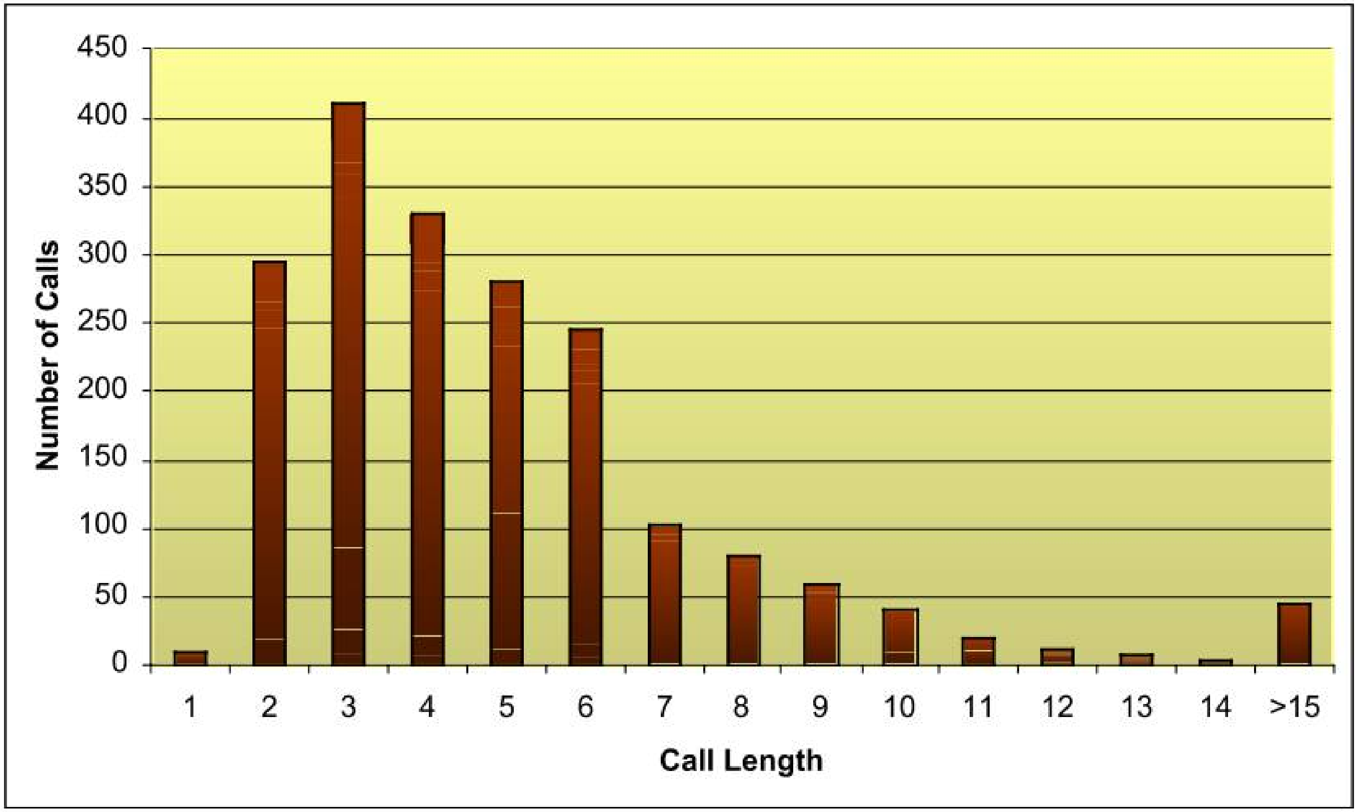
Distribusi Holding Time (1)

Holding Time adalah lamanya waktu panggilan, overhead panggilan, serta waktu antrian (jika ada). Overhead adalah aktifitas yang dibutuhkan disisi pengiirim dan penerima.

ITEM	Outgoing call	Incoming call
Dialing time (DTMF)	1 - 7 seconds [1]	1 second [1]
Dialing time (Rotary)	5 - 12 seconds [1]	5 seconds (@ 10 pulse/sec)
Network call setup	1-3 seconds [2]	1-3 seconds
Ringing time	12 seconds (2 rings)	12 seconds (2 rings)
Operator Answer	5-8 seconds	5-8 seconds
Ringing at station	12 seconds (2 rings)	12 seconds (2 rings)
Conversation time	variable	variable

⇨ Overhead panggilan

Distribusi Holding Time (2)



Distribusi Holding Time (distribusi eksponensial)

Distribusi Kedatangan Panggilan (1)

Jumlah kedatangan panggilan telepon dalam selang waktu tertentu memiliki distribusi poisson (distribusi untuk jumlah panggilan datang tak terhingga dan jumlah saluran yang disediakan terbatas), yaitu :

$$P(x) = \frac{\mu^x}{x!} e^{-\mu}$$

Dimana $P(x)$ =probabilitas panggilan yang datang

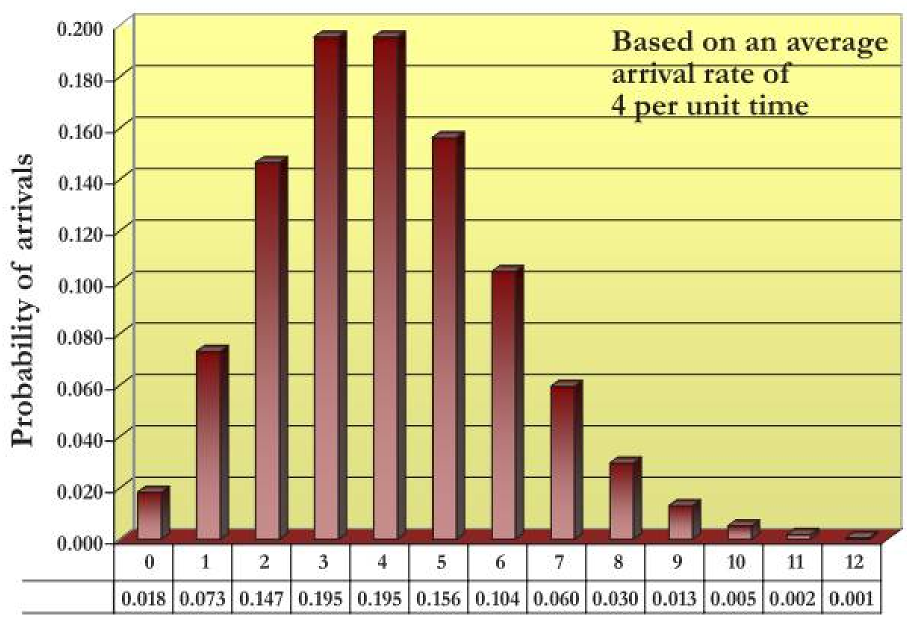
μ =rata-rata panggilan dalam waktu *T*

x =jumlah panggilan yang datang dalam waktu *T*

Distribusi Kedatangan Panggilan (2)

Gambar dibawah menunjukkan distribusi kedatangan panggilan dari :

- probabilitas kedatangan 1-12 panggilan
- Rata-rata panggilan yang datang dalam satu waktu adalah 4
- panggilan



Mean

Mean adalah nilai rata-rata dari beberapa data, dengan formula yang digunakan adalah :

$$\bar{X} = \sum_{i=1}^{n} x_i p_i$$

Dimana : $\bar{X}$: rata rata

x : data ke

p : probabilitas kemunculan

Standard Deviasi

Standar deviasi adalah rata-rata jarak penyimpangan titik-titik data diukur dari nilai rata-rata data tersebut.

$$s = \sqrt{\frac{\sum(x-\bar{x})^2}{N}}$$

Jika ada nilai 4,5,6, 8 dan 9 maka nilai standar deviasinya adalah

$$s = \sqrt{\frac{(4-6.5)^2 + (5-6.5)^2 + (8-6.5)^2 + (9-6.5)^2}{4}}$$

$$s = \sqrt{\frac{(6.25) + (2.25) + (2.25) + (6.25)}{4}}$$

$$s = \sqrt{\frac{17}{4}} \qquad s = 2.06$$

Varians

Varians adalah jumlah kuadrat dari selisih nilai data observasi dari nilai rata-ratanya, kemudian dibagi dengan jumlah observasinya. **Varians** digunakan untuk mengetahui seberapa jauh persebaran nilai hasil observarsi terhadap rata-rata.

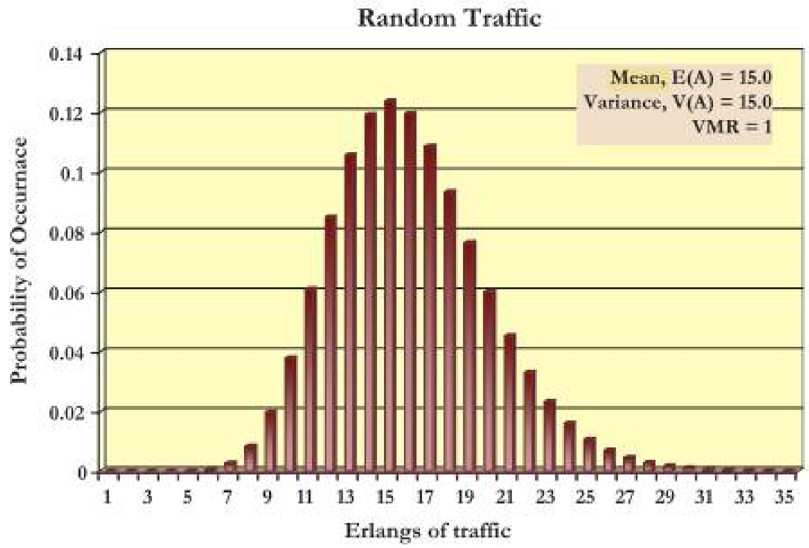
$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}$$

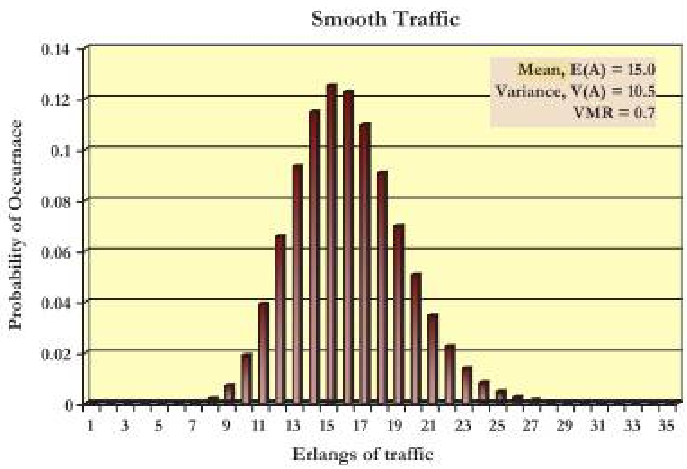
Variance to Mean Ratio (VMR) (1)

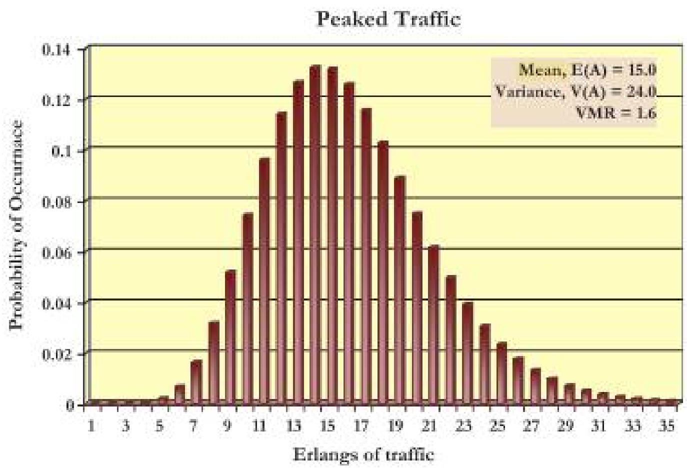
VMR digunakan untuk mengukur puncak trafik, dan biasanya digunakan untuk menghitung kecondongan ketidakacakan trafik.

$$\mathbf{VMR} = \frac{\mathbf{V(A)}}{\mathbf{E(A)}}$$

Variance to Mean Ratio (VMR) (2)

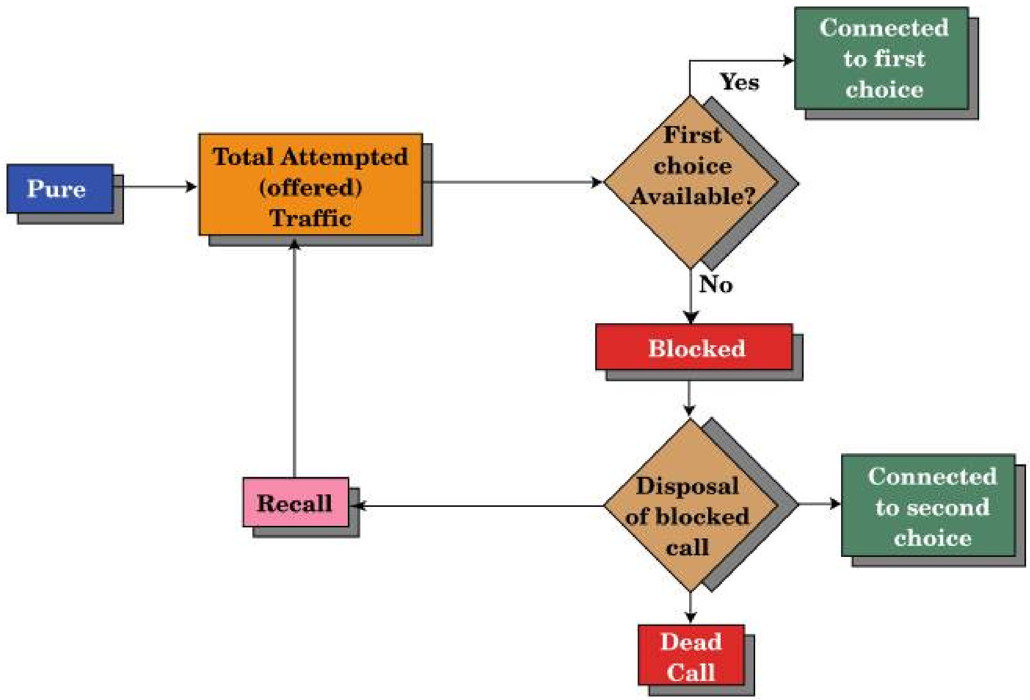






Extended Erlang B (EEB) (1)

Formula EEB digunakan untuk meningkatkan keakuratan dari Erlang B jika pemanggil yang ditolak berusaha melakukan panggilan kembali.



Extended Erlang B (EEB) (2)

Langkah-langkah EEB :

1. Hitung probability blocking dengan menggunakan Erlang B (misal A=3 N=6)
2. Hitung nilai-nilai berikut :

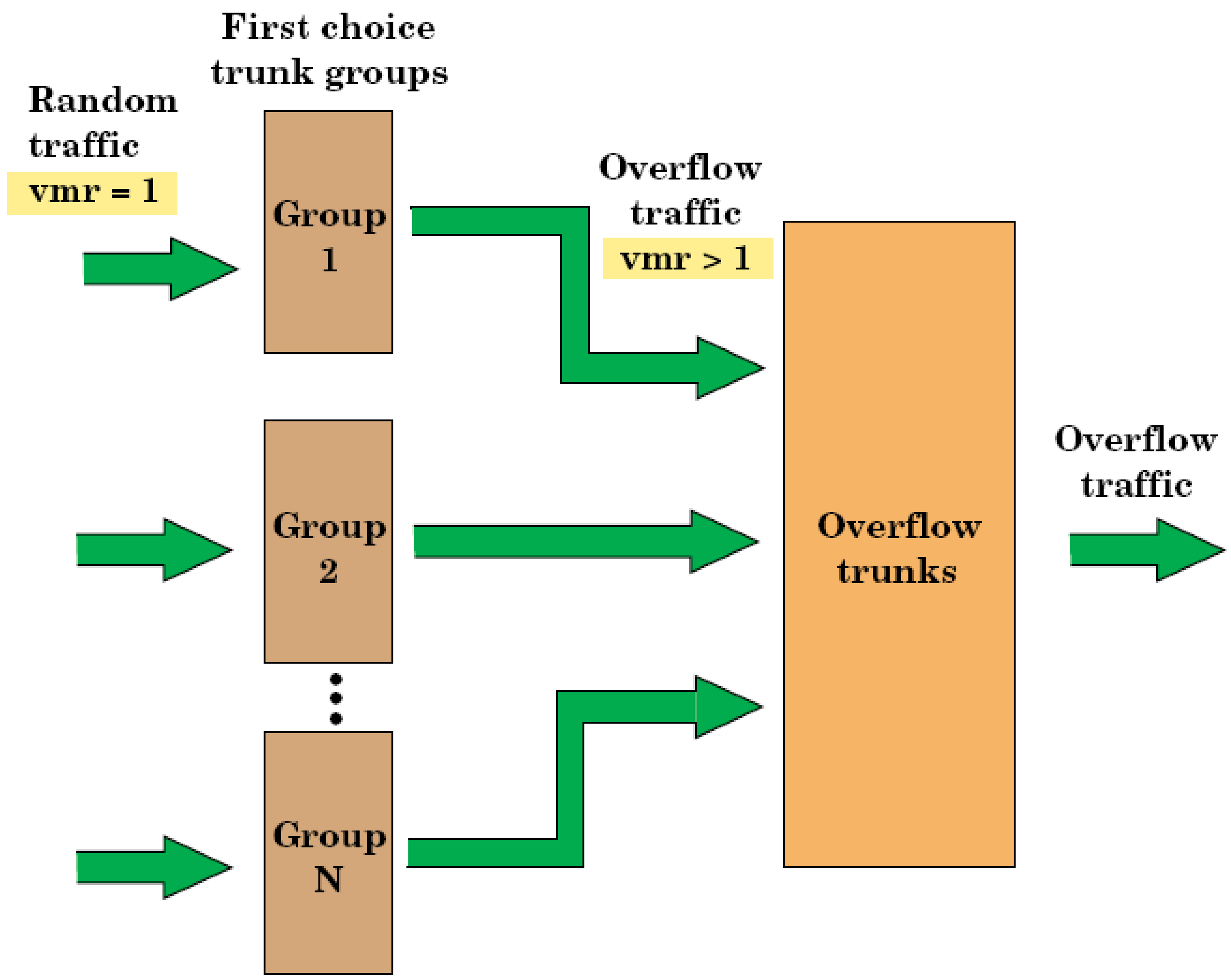
Be = N * Pb (e.g. 3 erlangs * Pb {.0522})
B = Be * Recall factor (e.g. .1566 * .5)
C = (N-Be)+R (e.g. 3 - .1566 Erlangs + .0782 {50% of Be})
R = Be * Recall factor (e.g. .1566 * .5 = .0782)
C+B = the carried traffic, plus the traffic that never returns
N+R = the original traffic, plus the recall traffic, which becomes the new offered load in the next iteration

Extended Erlang B (EEB) (3)

Offered Load: 3 Erlangs, 6 Trunks, 50% recall factor

A	N	ERL-B		Be =N*Pb	B =Be*.5	C =(N-Be)+R	R =Be*.5	C+B	N+R
Iteration	Offered Load	No. of Trunks	Pb	Blocked Erlangs	Overflow Traffic	Carried Traffic	Recall Traffic	Carried & Overflow	Recall & Orig. Load
1	3.0000	6	.0522	.1566	.0782	2.8435	.0782	2.9218	3.0782
2	3.0782	6	.0565	.1740	.0870	2.9042	.0870	2.9912	3.0870
3	3.0870	6	.0570	.1760	.0880	2.9110	.0880	2.9990	3.0880
4	3.0880	6	.0571	.1762	.0881	2.9117	.0881	2.9999	3.0881
5	3.0881	6	.0571	.1764	.0882	2.9118	.0882	3.0000	3.0882

Equivalent Random Theory (ERT) (1)



Equivalent Random Theory (ERT) (2)

Avg Overflow = $\mathbf{E(A,N)*A}$

Variance of overflow = $\mathbf{Avg} * \left(\mathbf{1\text{-}Avg+}\ \dfrac{\mathbf{A}}{\mathbf{N+1+Avg\text{-}A}}\right)$

Dimana :

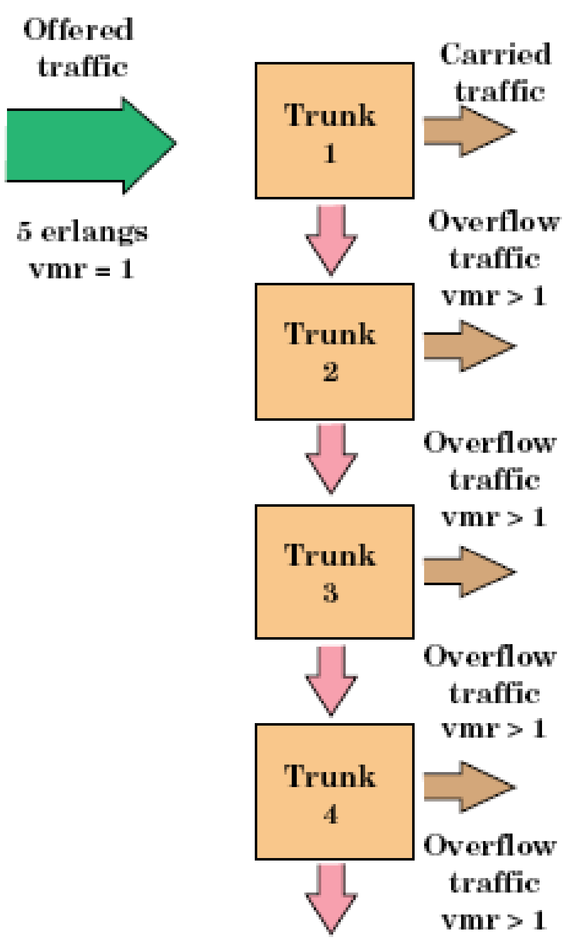
E(A,N)= Probability of blocking from Erlang B model

A = Offered Traffic

N = Number of Trunks

AVG = Avg of Overflow Traffic

Equivalent Random Theory (ERT) (3)



Consider this example:

5 Erlangs is presented to a 4 trunk, first attempt group. The previous formulas allow you to callculate the VMR and overflow for each trunk. Note that the overflow from the firt 2 trunks is 3.38 Erlangs, and the VMR is 1.25.

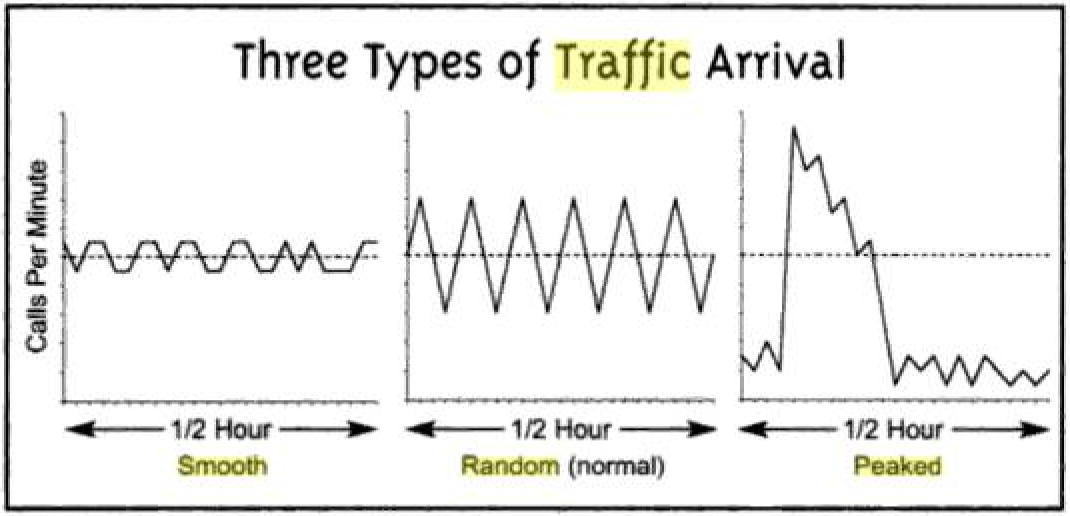
Traffic Summary

Trunk	Offered	Prob. of blocking	Overflow
Trunk 1	5 erl vmr = 1	.83	4.17 erl vmr = 1.12
Trunk 2	4.17 erl vmr = 1.12	.68	3.38 erl vmr = 1.25
Trunk 3	3.38 erl vmr = 1.25	.53	2.65 erl vmr = 1.39
Trunk 4	2.65 erl vmr = 1.39	.4	1.99 erl vmr = 1.52

Catatan

Smooth and Peaked Traffic

In addition to random or "normal" traffic, there are two other general types of traffic in the telecommunications world: "smooth" and "peaked." Telecommunications traffic engineers have assigned statistical "variance-to-mean" ratios to designate each type of traffic, but essentially the patterns for each look like this:



Smooth traffic is virtually non-existent in incoming call centers, but can apply in outbound environments. For example, a group of people may be assigned to make outbound calls, one after another after another for the duration of their shift. In that case, the number of circuits required is equal to the number of reps placing the calls.

Another type of call arrival, peaked traffic, is a reality in some incoming call centers. Many of us use the term "peak" in a general sense when referring to call traffic: What's your peak time of year? Peak day of

Television and radio ads will often generate peaked traffic. For example, QVC gets a surge of calls when new products are advertised on its home shopping channel. Service bureaus that handle everything from exercise equipment to ginzu knives get peaked traffic when those television ads are aired. The large centers that handle these calls can go from zero to hundreds of calls a minute, almost instantly.