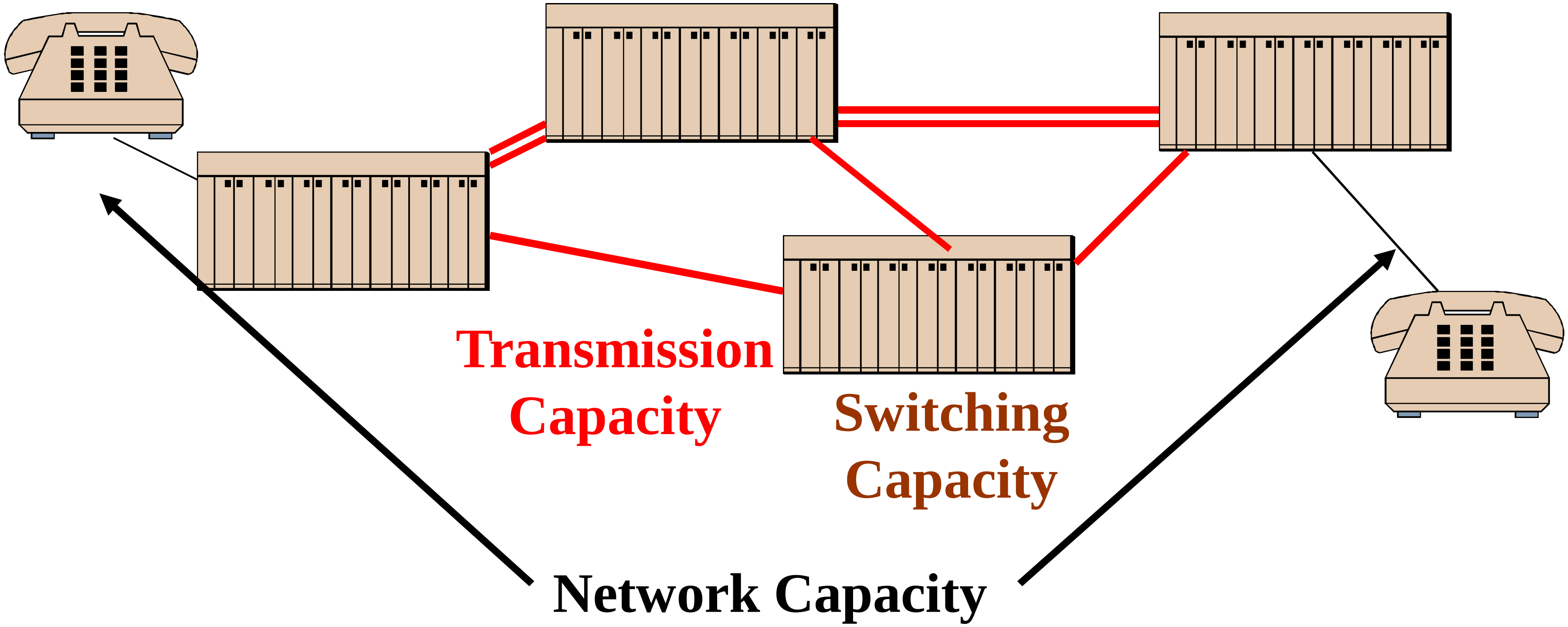
TRAFFIC DIMENSIONING

Lecture 9

Ir. Muhamad Asvial, MEng., PhD
Center for Information and Communication Engineering Research
Electrical Engineering Department – University of Indonesia
Kampus UI Depok, 16424 – Indonesia
asvial@ee.ui.ac.id
http://www.ee.ui.ac.id

Telecom Network Capacity



Basic Terminology

- **Attempt -** Any action that initiates the process of establishing a connection
- **Call -** Attempt that is processed and makes a bid for service
- **Messages -** Calls that are successfully completed to the receiving user
- **Holding time -** The amount of time an attempt is in the system, regardless of its final disposition
- **Minutes of use -** The length of time that a connection is actually established between users

Traffic Density

- **Erlang**
  All of the attempts and associated holding time in one hour expressed as a percentage of an hour
- **CCS**
  All of the attempts and associated holding time in an hour expressed as hundreds of call seconds

One Erlang = 36 CCS

Erlangs = Average Arrival Rate × Average Holding Time

Traffic Measurement Concepts

- Usage measures are interchangeable (Erlang and CCS)
- Both can be used to express demand density as well as capacity density
- The hourly base is related to a statistically significant time period, not necessarily on hourly boundaries

Significant Measurement Intervals

- Busy Hour - Busiest hour (not wall-clock hour) during which the system has the highest average business day load per access line

Call Blocking

- ***Grade of service*** - Probability of a call being blocked (*p*)
- Grade of service is effected by:
  - Call distribution in time
  - Duration of calls
  - Number of traffic sources
  - Number of paths available to service calls
  - Manner in which blockages are treated

Statistical Assumptions

- Poisson distributions have been found to be a fairly accurate model of call arrivals
- Designs are done on the basis of Busy Hour
- Assumes calls originate from a large number of independent sources with a limited number of trunks or servicing channels, call attempts are random

Is Poisson Modeling Reasonable?

- Primary advantage is simplicity; based upon mean offered load
- In actual practice, has been found to be a reasonable estimate
- DOES NOT recognize non-random peaks and variability of load WITHIN an hour

Basic Voice Traffic Engineering: A Four-Step Process

- Step 1: Obtain traffic data
- Step 2: Profile traffic
  - Determine the busy hour
- Step 3: Determine number of physical trunks required too meet traffic
- Step 4: Determine the least-cost combination of trunks
  - Iterative comparison

Step 1: Obtain Traffic Data

- Conceptually simple; difficult in practice
- Sources of traffic information
  - –Carrier bills
    - •Shows only chargeable calls
  - –Carrier design studies or traffic reports
  - –Traffic reports from PBX
    - •CDR (Call Detail Report)
    - •Reports specific to manufacturer
  - –Third party software and hardware available for analysis

Step 2: Profiling the Traffic— Group into Categories

- Inbound vs. outbound
- Call distance
  - Local calls
  - Intrastate long distance
  - Interstate long distance
  - International
- Type of call

Defining the Traffic

$$A = C \times T$$

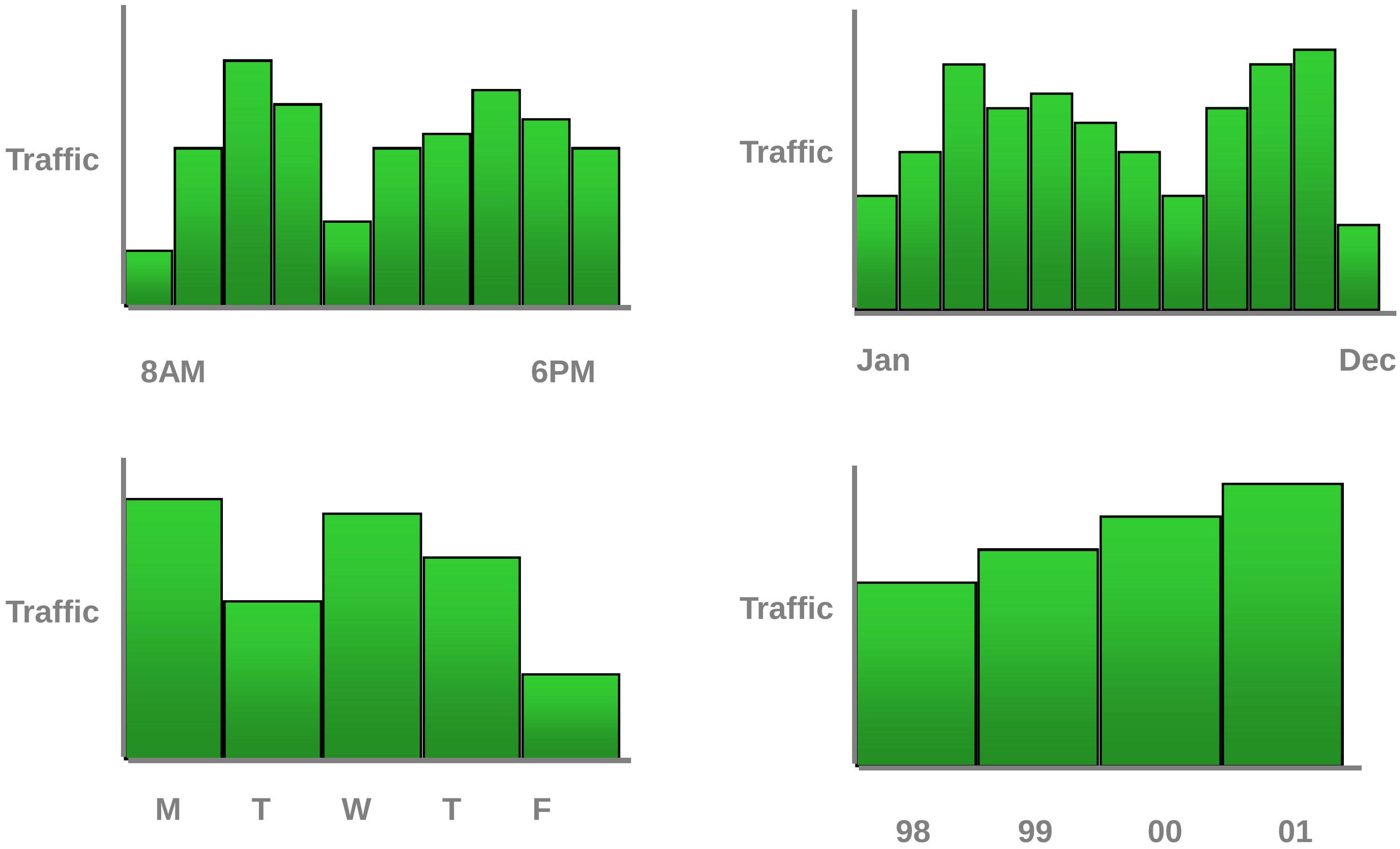
A, the Traffic Flow Is the Product of:

C the Number of Calls Originated During a Period of 1 Hour and T, the Average Holding Time of the Call

Converting to a Common Measurement

- Converting call-minutes to call-hours, divide by 60
- In our example: 400/60 = 6.67 call-hours
- Typically we use erlangs or the continuous use of a circuit for one hour
- Another common measurement is CCS (Centum Call Seconds)
  - 1 erlang = 36 CCS

Traffic Variation



Traffic Varies by Hour, Day, Month and Year

Busy Hour

- Busy hour =
  - Total traffic in a month x % in busy day x % in busy hour
- BH is always used to determine the required number of trunks

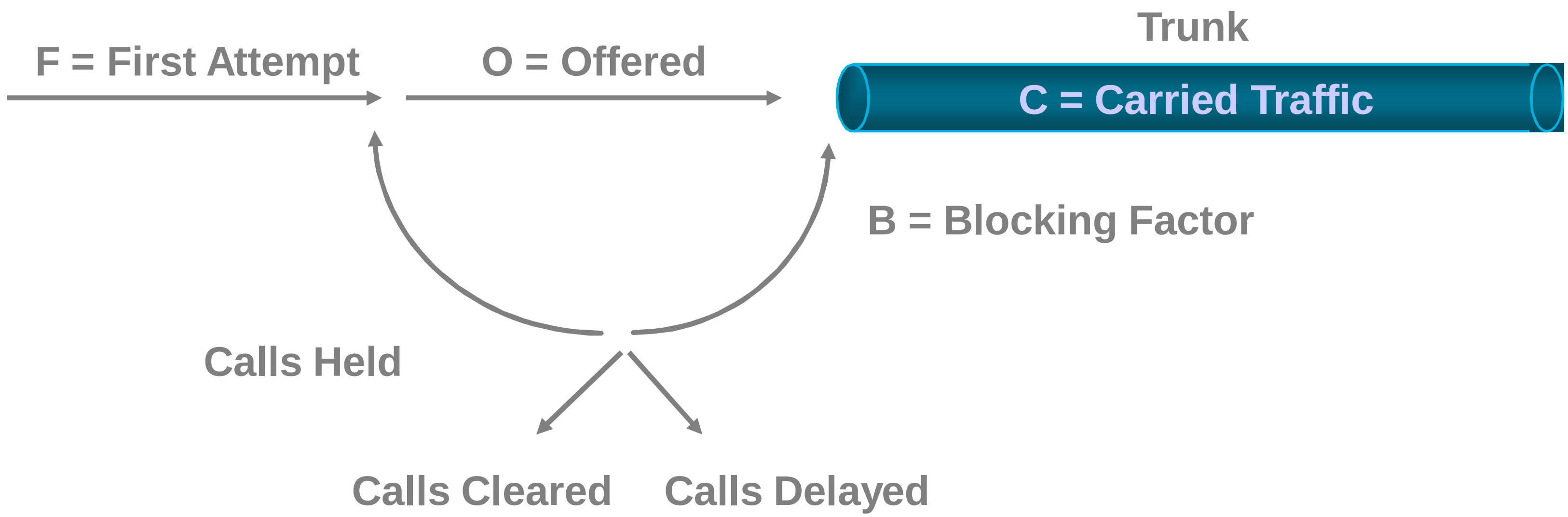
Adjusting the Holding Time

- Holding time = total time trunk in use
  - Dialing + Call Setup + Ringing + Conversation + Release
- Factors affecting holding time
  - Call processing may or may not be included
  - Telephone bills only have conversation time
  - Call timing data “in” varies by PBX manufacturer
  - Other sources of trunk use: Ring-no-answer, busy signal, etc.

Traffic Probability

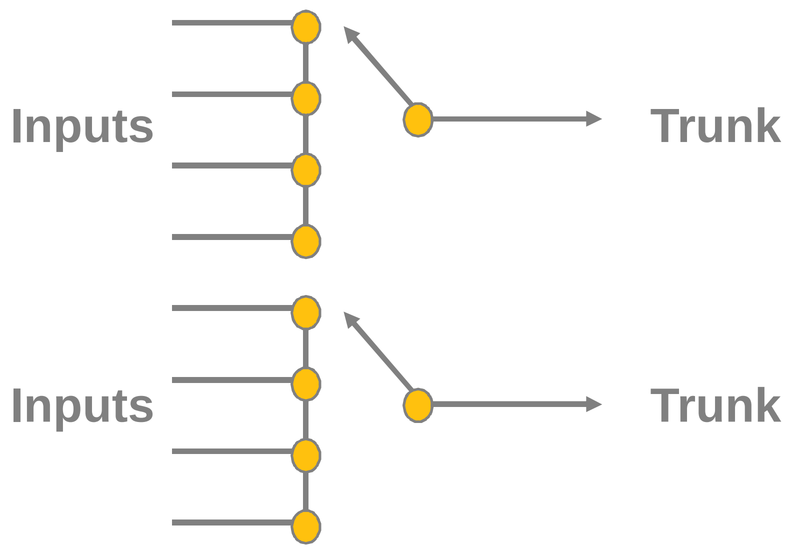
- Traffic source characteristics
- How lost calls are handled
- How the switch handles trunk allocation

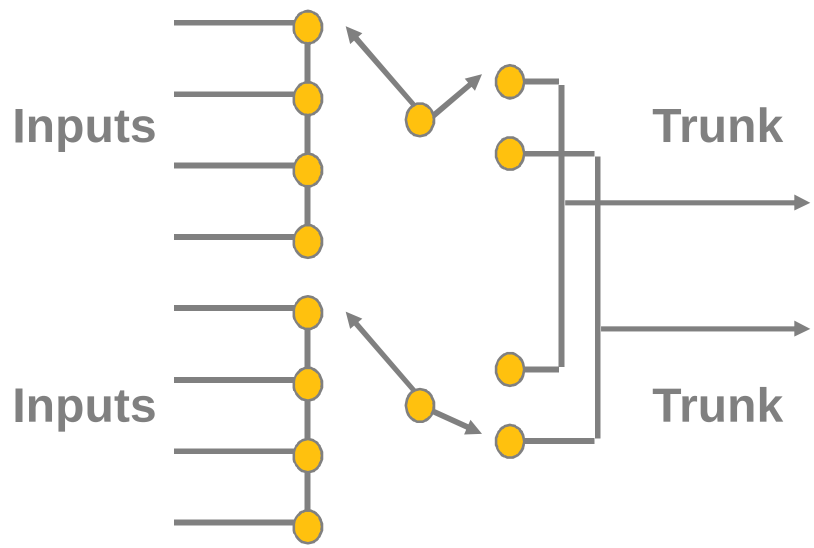
Handling Lost Calls



- Lost Calls Cleared (LCC)—Give up on a Busy Signal
- Lost Calls Held (LCH)—Redial on a Busy Signal
- Lost Calls Delayed (LCD)—Sent Somewhere Else When Busy

Switch Trunk Availability





Limited Availability

Full Availability

Step 3: Trunk Group Provisioning

- Theory of large trunk groups:
  - The larger the trunk group, the more efficient they are
  - The benefit of adding another trunk gets smaller as the trunk group gets larger

Trunks	Erlangs	Avg/Trunk	Traffic Increase	Traffic Increase
2	0.15	0.08		
4	0.87	0.22	480%	480%
8	3.15	0.39	2000%	262%

Defining Grade of Service

- Grade of Service
  - % of calls blocked, % of calls delayed
  - Average delay of all calls
  - Average delay of delayed calls
- Grade of Service is based on the busiest hour
  - BH is when the most traffic is offered
  - BH varies between days, weeks, and months

Determining Grade of Service

- GoS dependent on strategic objectives
- Acceptable grade of service unique to each organization
- Too poor can be more expensive than too good

Traffic Tables

- Eliminates the use of equations
  - Input: Given a volume of traffic and a GoS
  - Output: Number of trunks required
- Pick the model that best fits your application
  - Number of sources: Finite and infinite
  - Traffic characteristics: Random, smooth or rough
  - How blocked calls are handled
  - Switch availability

Erlang B

- Infinite sources
- Lost calls cleared
- Constant or exponential holding time
- Random traffic
- Application
  - Outbound trunks with overflow, i.e. alternate routes are used
- Used throughout the world as the standard

Poisson

- Infinite sources
- Lost calls held
- Constant or exponential holding time
- Random traffic
- Application
  - Outbound trunks with no overflow and queue, trunk group of last resort
- Overstates trunk requirements
  - Not heavily used outside of the U.S.

Extended Erlang B

- % of lost calls return
- Infinite sources
- Constant or exponential holding time
- Random traffic
- Application
  - Inbound trunks, e.g. 1–800
  - Outbound trunks with no overflow and queue
- Most Accurate, but hard to identify returned calls

Erlang C

- Lost calls delayed
- Infinite sources
- Exponential holding time
- Random traffic
- Calls served in arrival order
- Application
  - ACD agents, trunks with queuing but no overflow