Art of Algorithm Design in time of increasing complexity & heterogeneity

Dr Deepak Garg

Thapar University,Patiala

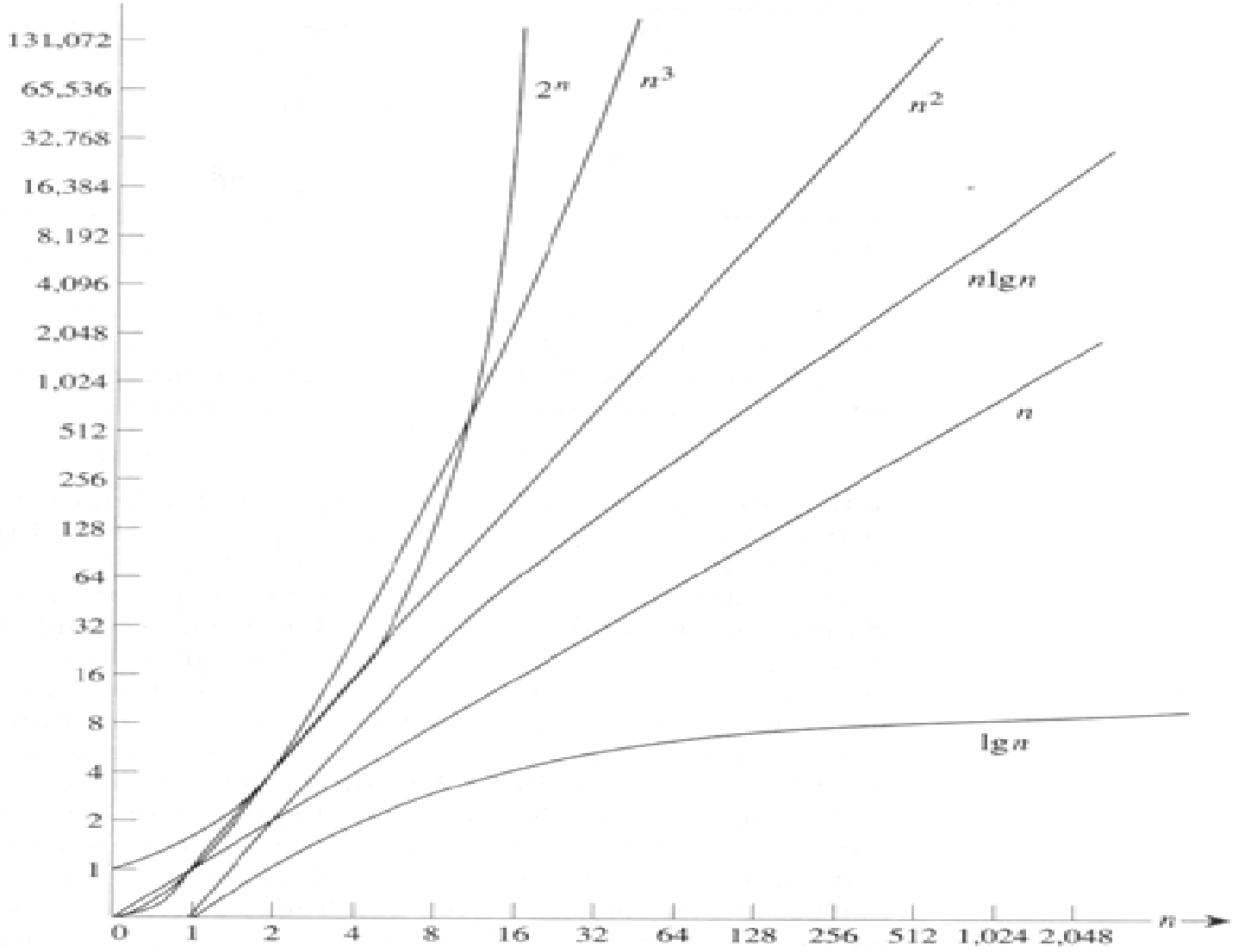
Space-Time Fight

- Memory increasingly becoming an issue again
- Space-Time trade off is not always true
- Gadget size, communication bandwidth are driving the market

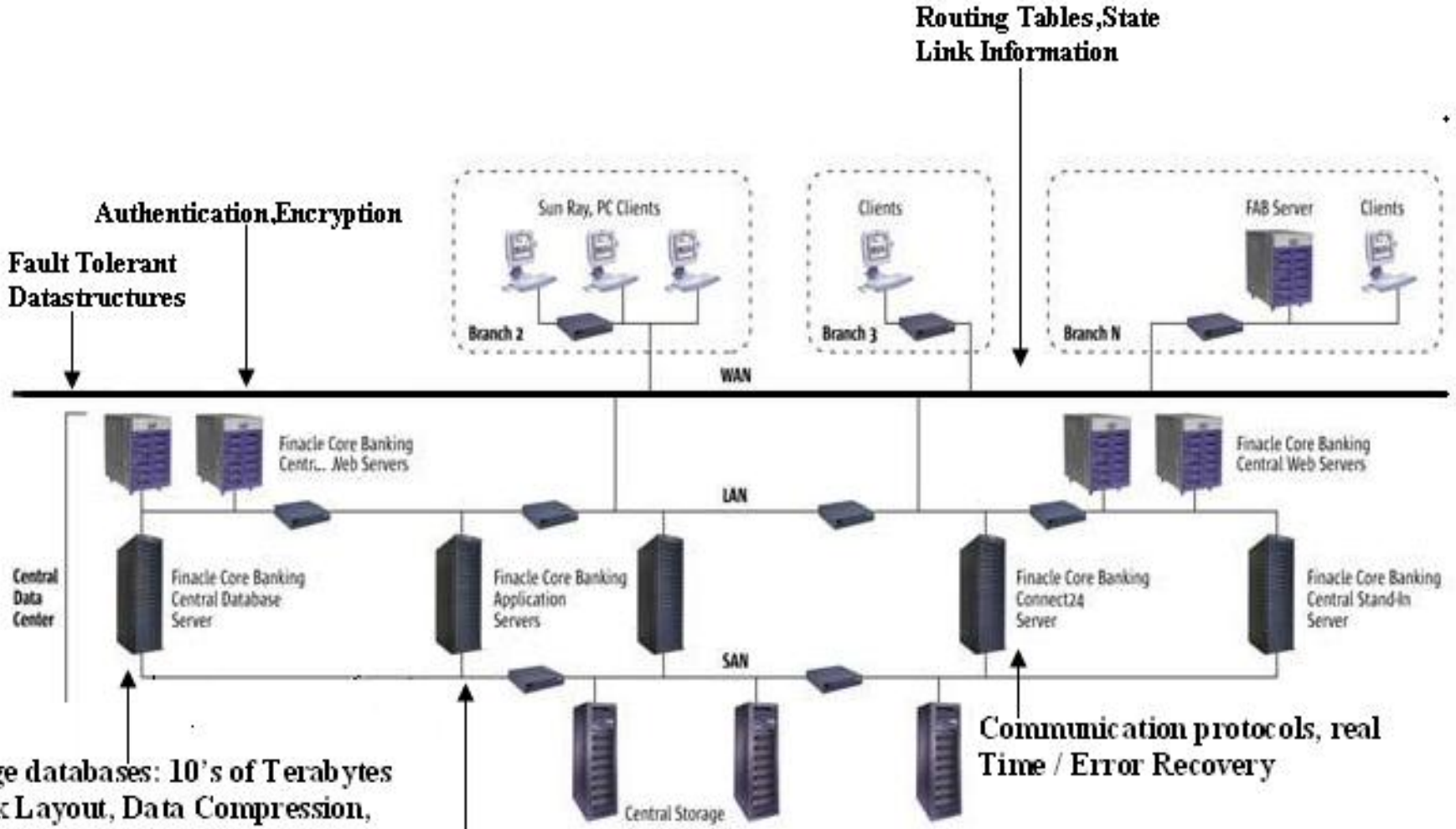
Algorithm Analysis-different processes

- Micro-macro analysis
- Apriori-posterior empirical analysis
- Best ,average ,worst case analysis
- Lower, upper and tight bounds
- Amortized analysis using aggregate, potential or accounting method

F(n)=n	lg(n)	n	nlgn	n^2	n^3	2^n
10	0.003 µs	0.01 µs	0.033 µs	0.1 µs	1 µs	1 µs
20	0.004 µs	0.02 µs	0.086 µs	0.4 µs	8 µs	1 ms
30	0.005 µs	0.03 µs	0.147 µs	0.9 µs	27 µs	1 s
40	0.005 µs	0.04 µs	0.213 µs	1.6 µs	64 µs	18.3 min
50	0.006 µs	0.04 µs	0.282 µs	2.5 µs	125 µs	13 days
10^2	0.007 µs	0.10 µs	0.664 µs	10 µs	1 ms	4 X 10^{13} yrs
10^3	0.010 µs	1.0 µs	9.966 µs	1 ms	1 s	infinity
10^4	0.013 µs	10 µs	130 µs	100 ms	16.7 min	Infinity
10^5	0.017 µs	0.10 ms	1.67 ms	10 s	11.6 days	Infinity
10^6	0.020 µs	1 ms	19.93 ms	16.7 min	31.7 years	Infinity
10^7	0.023 µs	0.01 s	0.23 s	1.16 days	31,709 yrs	Infinity
10^8	0.027 µs	0.1 s	2.66 s	115.7 days	3.17 X 10^7 yrs	Infinity
10^9	0.030 µs	1 sec	29.90 s	31.7 years	infinity	infinity


131,072
65,536
32,768
16,384
8,192
4,096
2,048
1,024
512
256
128
64
32
16
8
4
2
1
0
1
2
4
8
16
32
64
128
256
512
1,024
2,048
n
2^n
n^3
n^2
$n \lg n$
n
$\lg n$

Running time	1 sec	1min	1hour	With a twice faster processor in an hour	With a 256 times faster processor in an hour
n	$1.0*10^6$	$6.0*10^7$	$3.6*10^9$	$6.1*10^9$	$9.2*10^{11}$
n^2	1414	10984	169744	339488	4073856
n^4	31	88	244	488	1952
2^n	19	25	31	32	39


Routing Tables,State
Link Information
Authentication,Encryption
Fault Tolerant
Datastructures
Sun Ray, PC Clients
Branch 2
Clients
Branch 3
FAB Server
Clients
Branch N
WAN
Finacle Core Banking
Centr... Web Servers
Finacle Core Banking
Central Web Servers
LAN
Central
Data
Center
Finacle Core Banking
Central Database
Server
Finacle Core Banking
Application
Servers
Finacle Core Banking
Connect24
Server
Finacle Core Banking
Central Stand-In
Server
SAN
Central Storage
Communication protocols, real
Time / Error Recovery
Huge databases: 10's of Terabytes
Disk Layout, Data Compression,
Database Optimization, Encryption
Fault tolerance (detect potential loss)
High Speed Rule-based System, with/without
State, 10K+ transactions/second
Financially accurate calculation (Rs 1 in Rs
1000,000 crores, one part in 10^{13})

Heterogeneous scenario-issues

Critical module	Parallelism	Serialism
Primary Modules	Back Up modules	Distributed Processing

Research Scope

- Selection of design strategy based on problem characteristics
- Selection of heuristics based on suitability of NP problems

Choosing a best Design strategies

- Brute Force
- Decrease and conquer
- Dynamic Programming
- Divide and conquer
- Greedy programming
- Backtracking
- Branch and bound
- Pruning strategy

Choosing a best Heuristics for a NP Problem

- Artificial intelligence
- Approximation algorithms
- Randomized Algorithms
- Swarm Intelligence
- Hill climbing
- Genetic Programming
- Neural Networks
- Linear Programming

- Thanks