Distributions for Complex Systems

Proceedings of Winter Simulation Conference

(2004) Willinger, Alderson, Doyle and Li

	Gaussian	**Scaling**
Variance	finite	infinite
Invariant Properties	aggregation marginalization	aggregation marginalization maximization mixtures
Examples	Exponential Normal Triangular Uniform	Lognormal Weibull Pareto (1st kind) Pareto (2nd kind)

Internet Router Network Performance Measures

(2005) Li, Alderson, Tanaka, Doyle and Willinger

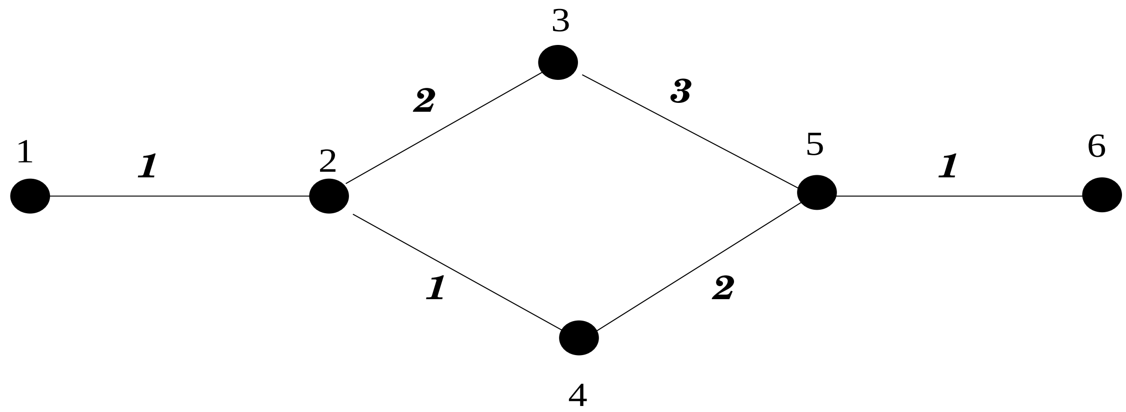
Throughput is denoted by P(g)

$$P(g) = \max_{\rho} \sum_{i,j} \rho x_i x_j$$

subject to

$$RX \leq C$$

x_i is bandwidth demand at (node) router i, flow i to j is approximated by $f_{ij} = \rho x_i x_j$, X is a vector concatenating f_{ij} for all i and j, R is a routing matrix and C are the router bandwidth capacities



	12	13	14	15	16	23	24	25	26	34	35	36	45	46	56
1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
2	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
3	0	1	0	0	0	1	0	0	0	1	1	1	0	0	0
4	0	0	1	1	1	0	1	1	1	1	0	0	1	1	0
5	0	0	0	1	1	0	0	1	1	0	1	1	1	1	1
6	0	0	0	0	1	0	0	0	1	0	0	1	0	1	1

Gravity Model and Constraints to Determine ρ

Node (row) 1:

$$f_{12} + f_{13} + f_{14} + f_{15} + f_{16} \leq C_1$$

$$\rho(x_1x_2 + x_1x_3 + x_1x_4 + x_1x_5 + x_1x_6) \leq C_1$$

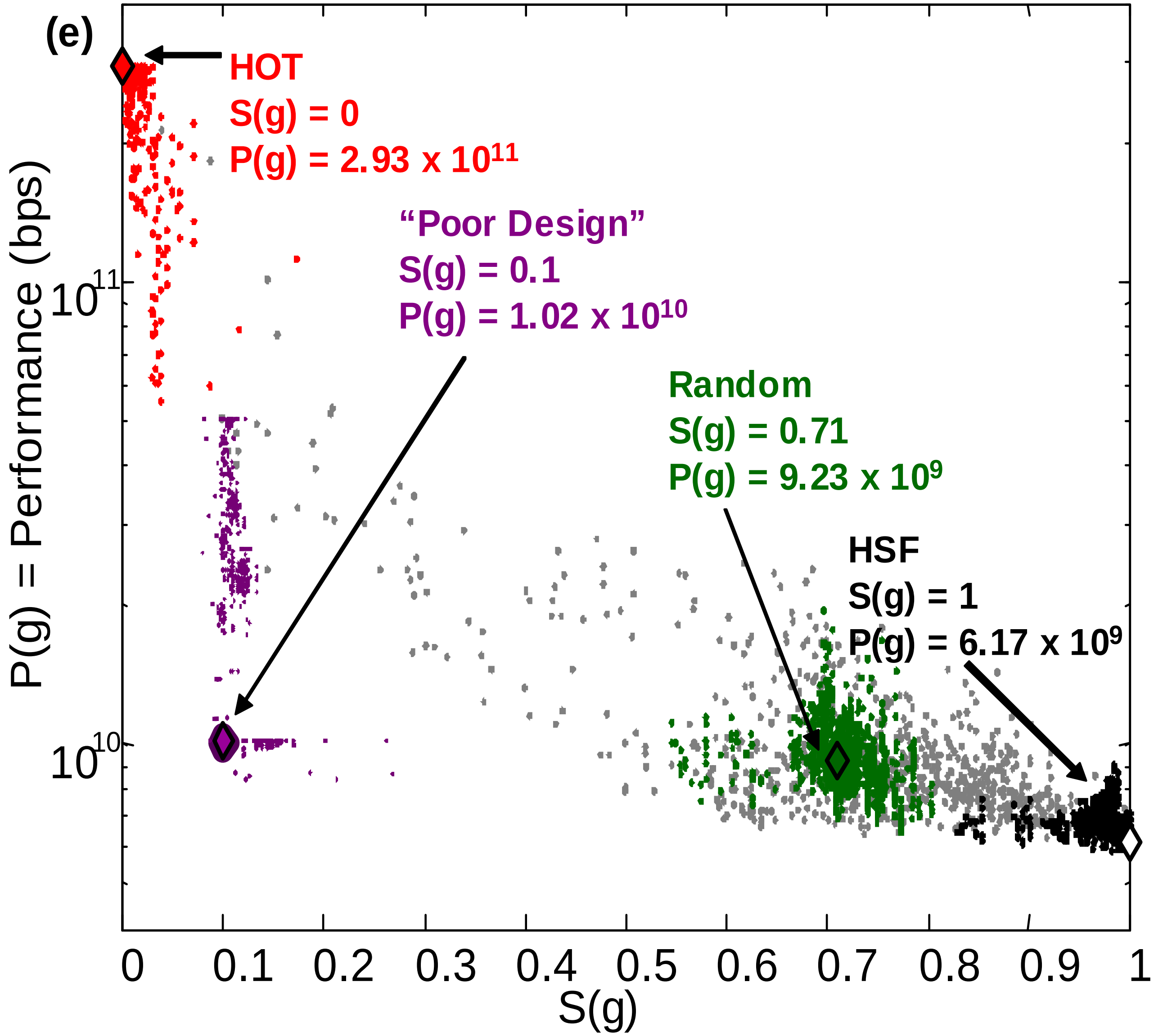
Node (row) 2:

$$f_{12} + f_{13} + f_{14} + f_{14} + f_{15} + f_{16} + f_{23} + f_{24} + f_{25} + f_{26} + f_{34} \leq C_2$$

$$\rho(x_1x_2+x_1x_3+x_1x_4+x_1x_5+x_1x_6+x_2x_3+x_2x_4+x_2x_5+x_2x_6+x_3x_4) \leq C_2$$

$$\rho = \min\{C_i/Sum_i\} \text{ for all } i = 1 \ldots 6$$

where Sum_i = sum of the x_ix_j products for each constraint i.


(e)
HOT
S(g) = 0
P(g) = 2.93 x 10^11
"Poor Design"
S(g) = 0.1
P(g) = 1.02 x 10^10
Random
S(g) = 0.71
P(g) = 9.23 x 10^9
HSF
S(g) = 1
P(g) = 6.17 x 10^9
P(g) = Performance (bps)
10^11
10^10
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1
S(g)