ARTEMIS Project Call 2008

EMMON
Theoretical Network Performance

ARTEMIS
Project title: EMMON
EMbedded MONitoring

Shannon entropy H is a measure of information capacity, choice, and uncertainty

$$H = \sum_{i=1}^{i=N} p_i \text{ x } log_2(p_i)$$

where p_i is probability that i-th node will generate a signal. Signals from all nodes are considered as equally likely.

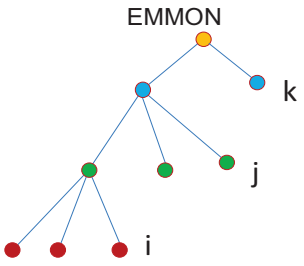
Shannon entropy H on the scale between 0 and 1 denotes network information capacity.

We first calculated Shannon entropy for 5 different topologies with 400 nodes each.

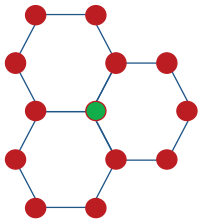
We then increased the number of nodes by an order of magnitude to approximately 4000 and recalculated Shannon entropy.

EMMON

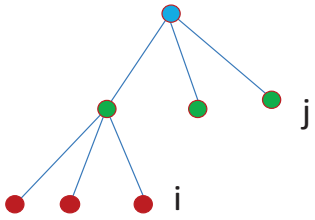
		p	log(p)	p x log(p)	Σ(p x log(p))
i	4	0.25	-2.00	-0.50	-200.000
j	10	0.10	-3.32	-0.33	-33.219
k	10	0.10	-3.32	-0.33	-3.322
N	400			H =	0.591
		p	log(p)	p x log(p)	Σ(p x log(p))
i	4	0.25	-2.00	-0.50	-1984.000
j	32	0.03	-5.00	-0.16	-155.000
k	31	0.03	-4.95	-0.16	-4.954
N	3968			H =	0.540



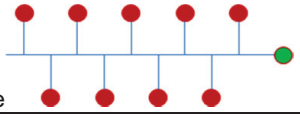
Hex Mesh



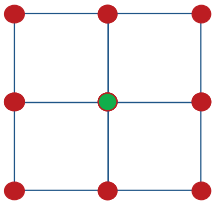
Tree



Backbone



Mesh



Results summary

Network type	*Size 1 400*	*Size 2 4000*	*H1*	*H2*	*(H2 - H1)/H1*	*Comment*
EMMON	400	3968	0.591	0.540	-8.6%	Network has high information capacity and is scalable
Tree	400	4000	0.517	0.502	-2.7%	Network has high information capacity and is scalable
Backbone	400	4000	0.022	0.003	-86.2%	Network has low information capacity and is not scalable
Mesh	400	4000	0.389	0.377	-3.1%	Network has moderate information capacity and is scalable
Hex Mesh	399	3999	0.546	0.531	-2.8%	Network has high information capacity and is scalable

The results show that after scaling up by an order of magnitude there is loss of information capacity of 8.6% in EMMON network, comparing with 2.7% loss in a tree network, 2.8% loss in a Hex Mesh network, 3.1% loss in a Mesh network and 86.2% loss in a Backbone.

The absolute value of Shannon entropy after the loss of 8.6% is still higher in EMMON than in any of the other topologies, which confirms EMMON network scalability.