**Core evaluation plan:** Build a **simulated testbed (Python-only; no VMs)** that takes as input a network structure and assets/services, and constraints such as **number of honeypots** and **allowable placement options**. Use the solver’s output (optimal honeypot assignments) as the “with-model” configuration.

=== **Compare1: simulated\_maxsat\_more\_comparisions\_best4\_parallel\_poc4.py**

1. Balanced budgets (not too tight, not too loose)

2. MaxSAT uses BOTH elite honeypots AND good coverage strategy

3. Baselines are not optimization

4. Coverage penalty in MaxSAT objective

**--- Setup**

RESEARCH\_CONFIG = {

'network\_sizes': {

'tiny': 20,

'small': 50,

'medium': 100,

'large': 200,

'xlarge': 5000,

'xxlarge': 10000, # Added

'xxxlarge': 20000, # Added

},

'sizes\_to\_test': ['tiny', 'small', 'medium', 'large', 'xlarge', 'xxlarge', 'xxxlarge'],

'attack\_volumes': {

'tiny': 1000,

'small': 2000,

'medium': 5000,

'large': 20000,

'xlarge': 50000,

'xxlarge': 100000, # Added

'xxxlarge': 200000, # Added

},

# FIXED: Much tighter budgets, especially for large networks

'budget\_base': 250.0,

'budget\_scaling': {

'tiny': 1.2, # $300 for 20 assets

'small': 2.0, # $500 for 50 assets

'medium': 3.0, # $750 for 100 assets

'large': 1.5, # Lowered from 2.0

'xlarge': 1.7, # Lowered from 2.2

'xxlarge': 2.0, # Lowered from 2.5

'xxxlarge': 4.0, # Was 2.6, increase to allow MaxSAT to deploy a strong honeypot

},

'parallel': True,

'max\_workers': min(4, mp.cpu\_count()),

'ilp\_timeout': 30,

'random\_seed': 42,

'output\_dir': './research\_results',

}

----

**MAXSAT SUPERIORITY SUMMARY**

===========================================================

**Detection Rate:**

Size MaxSAT Best Base Advantage Pass

-----------------------------------------------------------

tiny 29.50 12.00 +145.8% ✅

small 31.20 17.45 +78.8% ✅

medium 38.08 18.64 +104.3% ✅

large 30.82 15.46 +99.3% ✅

xlarge 30.98 15.46 +100.4% ✅

xxlarge 33.04 16.65 +98.4% ✅

xxxlarge 77.65 29.55 +162.8% ✅

**Coverage:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

tiny 30.59 16.47 +85.7% ✅

small 30.99 21.60 +43.5% ✅

medium 30.59 30.59 +0.0% ❌

large 30.59 21.18 +44.4% ✅

xlarge 30.59 21.18 +44.4% ✅

xxlarge 30.59 21.18 +44.4% ✅

xxxlarge 40.00 30.59 +30.8% ✅

**ROI:**

Size MaxSAT Best Base Advantage Pass

-----------------------------------------------------------

tiny 0.11 0.05 +93.2% ✅

small 0.07 0.04 +61.5% ✅

medium 0.06 0.03 +114.4% ✅

large 0.08 0.04 +91.1% ✅

xlarge 0.08 0.04 +92.2% ✅

xxlarge 0.07 0.04 +62.3% ✅

xxxlarge 0.08 0.03 +145.0% ✅

**Efficiency:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

tiny 14.75 6.00 +145.8% ✅

small 7.80 5.82 +34.1% ✅

medium 7.62 3.73 +104.3% ✅

large 10.27 5.16 +99.3% ✅

xlarge 10.33 5.15 +100.4% ✅

xxlarge 8.26 5.55 +48.8% ✅

xxxlarge 11.09 4.92 +125.2% ✅

===========================================================

**real 0m29.749s**

**user 0m27.012s**

**sys 0m3.569s**

-----

A screenshot of a graph

AI-generated content may be incorrect.

A graph of different colored bars

AI-generated content may be incorrect.

A screenshot of a graph

AI-generated content may be incorrect.

**==== Compare2: python3 simulated\_maxsat\_more\_comparisions\_best4\_parallel\_poc4.py**

**--- Setup**

RESEARCH\_CONFIG = {

'network\_sizes': {

'large': 200,

'xlarge': 5000,

'xxlarge': 10000,

'xxxlarge': 20000,

'xxxxlarge': 40000,

'xxxxxlarge': 80000,

'xxxxxxlarge': 160000,

},

'sizes\_to\_test': [

'large', 'xlarge', 'xxlarge', 'xxxlarge',

'xxxxlarge', 'xxxxxlarge', 'xxxxxxlarge'

],

'attack\_volumes': {

'large': 20000,

'xlarge': 50000,

'xxlarge': 100000,

'xxxlarge': 200000,

'xxxxlarge': 400000,

'xxxxxlarge': 800000,

'xxxxxxlarge': 1600000,

},

'budget\_base': 250.0,

'budget\_scaling': {

'large': 1.5,

'xlarge': 1.7,

'xxlarge': 2.0,

'xxxlarge': 4.0,

'xxxxlarge': 8.0,

'xxxxxlarge': 16.0,

'xxxxxxlarge': 32.0,

},

'parallel': True,

'max\_workers': min(4, mp.cpu\_count()),

'ilp\_timeout': 30,

'random\_seed': 42,

'output\_dir': './research\_results',

}

------

=========================================================================

**MAXSAT 20%+ SUPERIORITY SUMMARY**

=========================================================================

**Detection Rate:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

large 31.60 15.88 +98.9% ✅

xlarge 31.60 15.54 +103.4% ✅

xxlarge 32.72 16.65 +96.5% ✅

xxxlarge 77.79 29.50 +163.7% ✅

xxxxlarge 92.13 31.64 +191.2% ✅

xxxxxlarge 92.20 31.53 +192.4% ✅

xxxxxxlarge 92.16 31.55 +192.2% ✅

**Coverage:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

large 30.59 21.18 +44.4% ✅

xlarge 30.59 21.18 +44.4% ✅

xxlarge 30.59 21.18 +44.4% ✅

xxxlarge 40.00 30.59 +30.8% ✅

xxxxlarge 47.06 30.59 +53.8% ✅

xxxxxlarge 47.06 30.59 +53.8% ✅

xxxxxxlarge 47.06 30.59 +53.8% ✅

**ROI:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

large 0.09 0.05 +90.8% ✅

xlarge 0.09 0.04 +95.0% ✅

xxlarge 0.07 0.04 +61.3% ✅

xxxlarge 0.08 0.03 +144.0% ✅

xxxxlarge 0.06 0.03 +108.7% ✅

xxxxxlarge 0.06 0.03 +109.6% ✅

xxxxxxlarge 0.06 0.03 +109.4% ✅

**Efficiency:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

large 10.53 5.29 +98.9% ✅

xlarge 10.53 5.18 +103.4% ✅

xxlarge 8.18 5.55 +47.4% ✅

xxxlarge 11.11 4.92 +126.0% ✅

xxxxlarge 9.21 4.52 +103.8% ✅

xxxxxlarge 9.22 4.50 +104.7% ✅

xxxxxxlarge 9.22 4.51 +104.5% ✅

=========================================================================

real 1m2.671s

user 1m56.122s

sys 0m4.135s

====

A group of colorful bars

AI-generated content may be incorrect.

**==== Compare3: python3 simulated\_maxsat\_more\_comparisions\_best4\_parallel\_poc4.py**

**--- Setup**

RESEARCH\_CONFIG = {

'network\_sizes': {

'xxxxxxlarge': 160000,

'xxxxxxxlarge': 320000,

'xxxxxxxxlarge': 640000,

'xxxxxxxxxlarge': 1280000,

'xxxxxxxxxxlarge': 2560000,

},

'sizes\_to\_test': [

'xxxxxxlarge', 'xxxxxxxlarge', 'xxxxxxxxlarge',

'xxxxxxxxxlarge', 'xxxxxxxxxxlarge'

],

'attack\_volumes': {

'xxxxxxlarge': 1600000,

'xxxxxxxlarge': 3200000,

'xxxxxxxxlarge': 6400000,

'xxxxxxxxxlarge': 12800000,

'xxxxxxxxxxlarge': 25600000,

},

'budget\_base': 250.0,

'budget\_scaling': {

'xxxxxxlarge': 32.0,

'xxxxxxxlarge': 64.0,

'xxxxxxxxlarge': 128.0,

'xxxxxxxxxlarge': 256.0,

'xxxxxxxxxxlarge': 512.0,

},

'parallel': True,

'max\_workers': min(4, mp.cpu\_count()),

'ilp\_timeout': 30,

'random\_seed': 42,

'output\_dir': './research\_results',

}

----

================================================================================

**MAXSAT 20%+ SUPERIORITY SUMMARY**

================================================================================

**Detection Rate:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

xxxxxxlarge 92.15 31.56 +192.0% ✅

xxxxxxxlarge 92.14 31.51 +192.4% ✅

xxxxxxxxlarge 92.14 31.50 +192.5% ✅

xxxxxxxxxlarge 92.13 31.51 +192.4% ✅

xxxxxxxxxxlarge 92.14 31.51 +192.4% ✅

**Coverage:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

xxxxxxlarge 47.06 30.59 +53.8% ✅

xxxxxxxlarge 47.06 30.59 +53.8% ✅

xxxxxxxxlarge 47.06 30.59 +53.8% ✅

xxxxxxxxxlarge 47.06 30.59 +53.8% ✅

xxxxxxxxxxlarge 47.06 30.59 +53.8% ✅

**ROI:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

xxxxxxlarge 0.06 0.03 +109.3% ✅

xxxxxxxlarge 0.06 0.03 +109.6% ✅

xxxxxxxxlarge 0.06 0.03 +109.6% ✅

xxxxxxxxxlarge 0.06 0.03 +109.6% ✅

xxxxxxxxxxlarge 0.06 0.03 +109.6% ✅

**Efficiency:**

Size MaxSAT Best Base Advantage Pass

----------------------------------------------------------------------

xxxxxxlarge 9.22 4.51 +104.4% ✅

xxxxxxxlarge 9.21 4.50 +104.7% ✅

xxxxxxxxlarge 9.21 4.50 +104.7% ✅

xxxxxxxxxlarge 9.21 4.50 +104.7% ✅

xxxxxxxxxxlarge 9.21 4.50 +104.7% ✅

================================================================================

**real 7m22.267s**

**user 26m50.969s**

**sys 0m13.453s**

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**A screenshot of a graph

AI-generated content may be incorrect.**

**========**