



<http://www.etsi.org/plugtests/Upcoming/GRID2007/GRID2007.htm>

**N-QUEENS COUNTING CHALLENGE**  
**30TH OCTOBER -1ST NOVEMBER 2007, BEIJING**  
**4TH EDITION**  
**RULES OF THE GAME**  
GRIDS@Work  
ETSI GRID Plugtests™

**Goal of the Challenge:**

The goal of the challenge is to write the best Grid distributed program to count a maximum number of solutions within a limited amount of time to the well known N-queens problem.

The event will take place at CNIC, Beijing, <http://www.etsi.org/plugtests/Upcoming/GRID2007/GRID2007.htm>

Each team competing will write a program able to work out solutions to the N-Queens problem using a Grid. This code will then be deployed using the ProActive middleware<sup>(1)</sup> on a worldwide Grid of interconnected processors (more than 4000 last year). It will then be executed on the Grid during a fixed time slot and evaluated according to its performance (number of solutions found, ability to use a maximum of grid nodes, cpu time, etc...).

Participation to this challenge as well as to all the preliminary tests and remote qualification tests are free of charge, however all teams wishing to participate to the face to face challenge in Beijing (30th October -1st November 2007) have to register and to pass the preliminary remote qualification tests.

This event is supported by ETSI [www.etsi.org](http://www.etsi.org) , ERCIM [www.ercim.org](http://www.ercim.org), INRIA [www.inria.fr](http://www.inria.fr) and the European project EchoGrid.

Contact [Patrick.Guillemain@etsi.org](mailto:Patrick.Guillemain@etsi.org) for the N-Queens challenge Cc: [plugtests@etsi.org](mailto:plugtests@etsi.org)

<sup>1</sup> Proactive Middleware info & download here: <http://www-sop.inria.fr/oasis/ProActive/>

## History

*The 8-Queens puzzle was originally proposed in 1848 by the chess player Max Bezzel, and over the years, many mathematicians, including Gauss and Georg Cantor, have worked on this puzzle and its generalized n-queens problem. The first solutions to the 8-Queens puzzle were provided by Franz Nauck in 1850. Nauck also extended the puzzle to n-queens problem. In 1874, S. Gunther proposed a method of finding solutions by using determinants, and J.W.L. Glaisher refined this approach.*

## What is the N-Queens problem?

*The N-queens puzzle is the problem of putting N chess queens on an NxN chessboard such that none of them is able to capture any other using the standard chess queen's moves. The colour of the queens is meaningless in this puzzle, and any queen is assumed to be able to attack any other. Thus, a solution requires that no two queens share the same row, column, or diagonal.*

## How to participate?

Teams willing to take part in the challenge will have to go through the following steps:

- Run some preliminary tests on their equipment (optional)
- **Pass the preliminary remote qualification phase** (starting just now - July 2007)
- **Participate to the face to face challenge** (30th Oct – 1st Nov, Beijing, China)
  - 3 days at the CNIC, (Beijing, China) during which all competitors will
    1. Execute their code on the Grid during a fixed and measured time slot to calculate the highest number of solutions as fast as possible..
    2. Provide their logs and source code to the jury
      - ➔ After the contest **all source code** produced by the challengers will be made available to all participants as **open source** code.

**Important notice:** all teams will be given access to the “test room” two days before the actual start of the challenge (i.e. room 514 will be open from Sunday 28th October 9:00am) for **preparation** purposes.  
This will give them the opportunity to tune and adapt their code in order to get it running on the Grid.

Note: After the challenge, the room will remain open to let participants run free Grid interoperability tests.

Advice: Consider the challenge as a grid computing **fest**, not as a formal event.

## PRELIMINARY TESTS (free)

These informal and optional tests are proposed to maximize your chance to succeed in the real-time face-to-face challenge.

To take part to these tests, send an email to: [patrick.guillemain@etsi.org](mailto:patrick.guillemain@etsi.org) Cc: [plugtests@etsi.org](mailto:plugtests@etsi.org) indicating:

- The name of your team
- Name and email of all team members
- Indicate the name of the person responsible (team contact person)

If you just want to play remotely without planning to attend the face to face event, or you want to discuss the challenge before taking part, subscribe to the mailing list that we have created **to communicate with all challengers**: [PLUGTESTS-GRID@LIST.ETSI.ORG](mailto:PLUGTESTS-GRID@LIST.ETSI.ORG)

To subscribe just send an email to [LISTSERV@LIST.ETSI.ORG](mailto:LISTSERV@LIST.ETSI.ORG) with only: *SUB PLUGTESTS-GRID your\_first\_name, your\_last\_name* in the body of the message.

Subscription to the list is free of charge and is open to anyone interested in this challenge.

## PRELIMINARY REMOTE QUALIFICATION (free)

Prior to register to the face to face challenge, all teams have to give the evidence, by the 7<sup>th</sup> of September, that their algorithm is able to respond correctly and quickly to a challenge question, and that their code will deploy correctly with the Proactive middleware<sup>(1)</sup>.

To have a good chance of participating in the face to face challenge your program written for a GRID should be able to re-calculate (count) all solutions for N=8 to N=20 in less than a few hours If it does, then:

- Before the 7<sup>th</sup> of September, send your test results (computed by your program for N=8 to 20) to [Patrick.guillemain@etsi.org](mailto:Patrick.guillemain@etsi.org) Cc: [plugtests@etsi.org](mailto:plugtests@etsi.org) with your **Team Name** in the subject of the mail.
- Attach you log file(s) (txt, word, ps or pdf) or their URL containing
  - Challenge Question<sup>(2)</sup> like **“8 1”, “8 2”, “8 3”, “8 4”, .. to “20 9”, “20 10”**
  - Number of solutions found for each Challenge Question
  - start\_date\_time, end\_date\_time, elapsed\_time\_in\_seconds, total\_cpu\_time\_in\_seconds for each Challenge Question Calculation
  - number\_of\_computer\_involved (+ if possible a list of computer name + @IP)
  - Some architectural design information (bitwise computing, symmetrical approach)

**Participants will be informed of the pre-selection results by the 14<sup>th</sup> of September.**

<sup>1</sup> Proactive Middleware info & download here: <http://www-sop.inria.fr/oasis/ProActive/>

<sup>2</sup> Challenge Question: see annex of the present document

## 28/30 October -1 November 2007:

### Face to face CHALLENGE

*Participants to the face to face challenge will be given access to a worldwide Grid of interconnected processors (more than 4000 last year). Their piece of code will be installed on a local platform, distributed on the grid, executed during a limited time slot, and results will be evaluated by the jury.*

#### **How will challengers be evaluated?**

After the face to face contest the results of each team will be examined by a jury formed of Grid computing experts.

The main evaluation criterion is the total number of solutions found during the given time slot.

**Evaluation/analysis of the results and announcement of outcome of the contest is under the sole responsibility of the jury.**

In the (unlikely) case where several teams would be placed equal first, the jury may take other criteria into account to decide between one and the other: total cpu time used, number of grid nodes (or "workers") involved/activated, algorithm efficiency...

Although participation to the face to face N-Queens contest is free of charge, challengers have to have passed the preliminary remote qualification tests and to be registered<sup>(1)</sup>:

Challengers will:

- Use the **preparation days (28-29 Oct)** to warm-up, get familiar with the local platform and the Grid. This will give them the opportunity to tune and adapt their code in order to get it running smoothly on the Grid.
- Use their time slot<sup>(2)</sup> during the **challenge (30 Oct – 1 Nov)** to execute their code in real time on the Grid:
  - Count the exact number of "highest order solutions"<sup>(3)</sup> to the n-queens counting problem.
  - Compute the exact results in the minimum elapsed time and total CPU time (compared to the other participants). This requires participant to really count the solution, this will be checked
- Disclose their source code and method to all participants after the game

The time slots schedule (participation order) will be announced at the beginning of the event. If a team is not ready at the time of its time slot, that team will be re-scheduled after all other participants.

Note: it is planned to schedule the "official challenge" time slots during day time and to let participants access the Grid at night for training purposes. This of course depends on 1) the authorization to access the room at night 2) the number of teams registered: a high number of teams may cause some challenge time slots to be scheduled at night as well, thus preventing other teams to access the Grid for training.

**Although Java is the programming language commonly used by participants, it is perfectly acceptable to use non-Java code, provided all deployments and communications between machines and nodes use the ProActive library.**

1 Registration page: <http://www.etsi.org/plugtests/Upcoming/GRID2007/GRID2007.htm>

2 time slot : 1 hour.

3 Highest order solutions: see annex of the present document

## Annex: definition, examples, useful information

### Definition of Challenge Question

« **Counting the total number of solutions to the N-Queens problem beginning with <p> first queens positioned in the first <p> column at lines <C1 C2 ... Cp> for <N> queens** ». This will use the notation « **N C1 C2 ... Cp** »

Example:

- « **8 1** », means counting the number of solutions to the eight queens problem with the first queen positioned in the first line, the result is **4** solutions. You **should not** list the solutions, you **do not have to store them**, for information in this case the 4 solutions are 1 5 8 6 3 7 2 4 , 1 6 8 3 7 4 2 5 , 1 7 4 6 8 2 5 3 and 1 7 5 8 2 4 6 3 .
- « **17** », this means counting all solutions for 17 queens on a 17x17 chessboard, the answer is **95 815 104** and can be counted in **less than 41 seconds** on a single computer
- « **22 1** » answer is **56 624 964 700** and can take hours or days on a single computer or only few seconds on a Grid?
- « **23 1** » is not yet known but « **23** » answer is **24 233 937 684 440** « **24** », « **24 1** », « **24 2** », « **24 3** » ... « **24 12** » are to be explored

### Definition of highest order solution to the Challenge Question:

**The highest the answer value is, the highest order the challenge question is**

Example:

- The answer to “**22 1**” challenge question is 56 624 964 700, this question is of a “lower order” than the “**21**” challenge question (which answer is 314 666 222 712).

This means that there are fewer solutions for 22 queens beginning with 1 than the total numbers of all solutions for 21 queens.

### 8-Queen board example:

		*					
					*		
			*				
	*						
							*
				*			
						*	
*							
1	5	8	6	3	7	2	4

1 5 8 6 3 7 2 4 is one of the 92 solutions to the 8-queens problem.

It is one of the 4 solutions to  $S1(8)$ , i.e. solutions starting with “1” for an 8 queens board, we use the notation  $S1(8)=4$  and call this the **Challenge Question “8 1”**

$S_i(N)$  for N=8 to 20 or Challenge Question "8 1", "8 2", "8 3", "8 4", .. to "20 9", "20 10"

N	8	9	10	11	12	13	14	15	16	17	18	19	20
S1	4	28	64	96	500	2 760	11 892	69 516	436 228	2 729 772	17 210 372	121 956 044	912 695 924
S2	8	30	48	219	806	3 799	16 488	98 156	569 531	3 321 745	22 038 667	154 458 256	1 134 501 243
S3	16	47	65	209	1 165	5 508	23 024	122 763	736 363	4 423 207	27 585 497	187 854 702	1 381 017 109
S4	18	44	93	295	1 359	6 023	27 494	157 034	892 999	5 172 708	33 297 967	230 334 612	1 649 528 539
S5	=S4(8)	54	92	346	1 631	7 346	32 163	175 296	1 050 762	6 214 709	39 005 536	263 322 762	1 925 960 786
S6	=S3(8)	=S4(9)	=S5(10)	350	1 639	7 385	34 760	201 164	1 160 280	6 787 111	43 698 287	300 359 104	2 158 815 033
S7	=S2(8)	=S3(9)	=S4(10)	=S5(11)	=S6(12)	8 070	36 977	206 294	1 249 262	7 546 991	47 802 996	328 342 530	2 388 912 956
S8	=S1(8)	=S2(9)	=S3(10)	=S4(11)	=S5(12)	=S6(13)	=S7(14)	218 738	1 290 831	7 698 195	50 523 766	351 816 544	2 563 311 029
S9		=S1(9)	=S2(10)	=S3(11)	=S4(12)	=S5(13)	=S6(14)	=S7(15)	=S8(16)	8 026 228	51 882 224	360 352 268	2 670 502 723
S10			=S1(10)	=S2(11)	=S3(12)	=S4(13)	=S5(14)	=S6(15)	=S7(16)	=S8(17)	=S9(18)	370 464 204	2 729 349 100
S11				=S1(11)	=S2(12)	=S3(13)	=S4(14)	=S5(15)	=S6(16)	=S7(17)	=S8(18)	=S9(19)	=S10(20)
Total	92	352	724	2 680	14 200	73 712	365 596	2 279 184	14 772 512	95 815 104	666 090 624	4 968 057 848	39 029 188 884

The table below lists the number solutions to the N-Queen problem for n=4 to N=25:

N	Known # Solutions N-queens problem	Challenge Question
4	2	"4"
5	10	"5"
6	4	"6"
7	40	"7"
8	92	"8"
9	352	"9"
10	724	"10"
11	2 680	"11"
12	14 200	"12"
13	73 712	"13"
14	365 596	"14"
15	2 279 184	"15"
16	14 772 512	"16"
17	95 815 104	"17"
18	666 090 624	"18"
19	4 968 057 848	"19"
20	39 029 188 884	"20"
21	314 666 222 712	"21"
22	2 691 008 701 644	"22"
23	24 233 937 684 440	"23"
24	227 514 171 973 736	"24"
25	2 207 893 435 808 352	"25"

<http://www-sop.inria.fr/oasis/ProActive/nqueens25.html> is today the world record owned by INRIA  
 The reference collection of records is maintained by Neil J. Sloane  
<http://www.research.att.com/cgi-bin/access.cgi/as/njas/sequences/eisA.cgi?Anum=000170>

**Reports from the past 3 N-Queen challenges (very useful reading):**

2006

<http://www.etsi.org/plugtests/Upcoming/GRID2007/Docs/N-QUEENS-TESTCASE-2006-v2.pdf>

2005

<http://www.etsi.org/plugtests/History/DOC/2ndGridPlugtestsReport%20final.pdf>

2004

[http://www.etsi.org/plugtests/History/DOC/1stGRIDplugtest\\_report.pdf](http://www.etsi.org/plugtests/History/DOC/1stGRIDplugtest_report.pdf)

Implementation example : <http://www-sop.inria.fr/oasis/ProActive/apps/nqueen.html>

Good luck, have fun!

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2007 4<sup>th</sup> Grid Plugtests Jury President

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