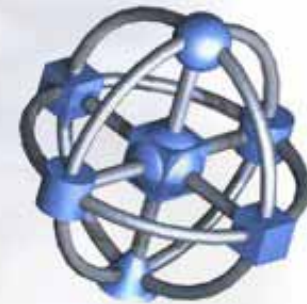


Grid Computing



ZetaGrid
Experiences with the Grid for everybody

Dr. Sebastian Wedeniwski
Consulting IT Architect



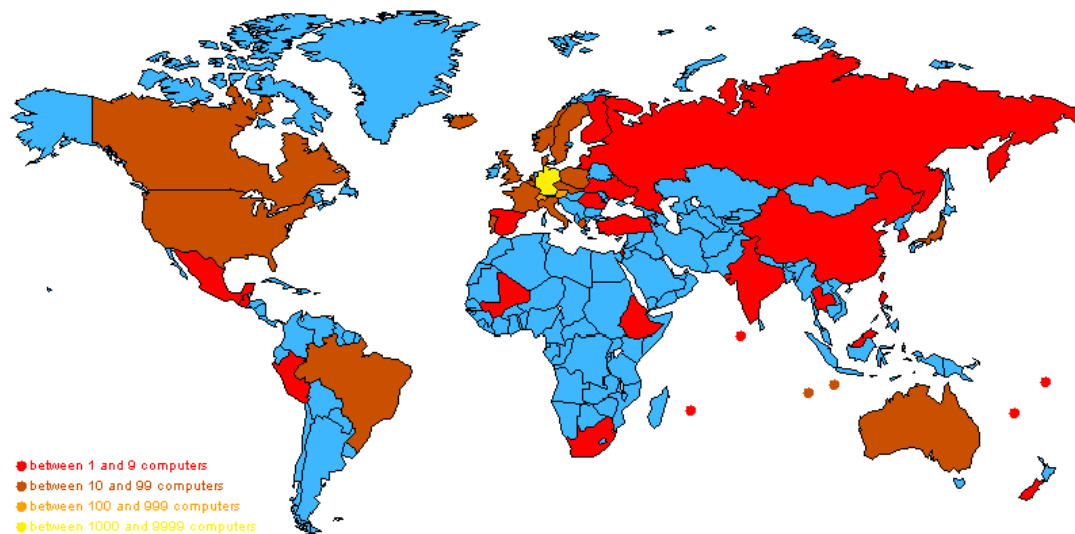
Agenda

1	Overview
2	Examples
3	Technical Details
4	Security & Privacy
5	ZetaGrid Directions



Worldwide dynamic computation

- ZetaGrid shows a real-life example of a Grid application platform as an outstanding contribution to the joint Böblingen Lab GRID activities.
- The first problem solved with this platform was a mathematical one - the zeta function. That's where the name comes from.
- ZetaGrid runs on more than 8,000 computers in more than 70 countries.





ZetaGrid platform

ZetaGrid distinguishes from traditional client-server solutions by:

- simultaneous use of large numbers of dynamic resources,
- dynamic resource requirements,
- use of resources from multiple administrative domains,
- complex communication structures,
- and stringent performance requirements.



ZetaGrid home

Introduction

Links to the communities

Summary of the statistics

ZetaGrid Homepage - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address <http://www.zetagrid.net/>

ZetaGrid

Welcome to ZetaGrid
*The Grid for everybody.
Take part, it is a winning game!*

What is ZetaGrid?
ZetaGrid is an open source and platform independent grid system that uses idle CPU cycles from participating computers. Grid computing can be used for any CPU intensive application which can be split into many separate steps and which would require very long computation times on a single computer. ZetaGrid can be run as a low-priority background process on various platforms like Windows, Linux, AIX, Solaris, and Mac OSX. On Windows systems it may also be run in screen saver mode.

ZetaGrid in practice:
At the IBM Development Laboratory in Böblingen ZetaGrid solves one problem in practice, running on six different platforms: The verification of [Riemann's Hypothesis](#) is considered to be one of modern mathematics most important problems. This implementation involves more than 7,000 workstations and has a peak performance rate of about 4028 GFLOPS. More than 1 billion zeros for the zeta function are calculated every day.

To learn more about ZetaGrid, you have two options:

- view grid monitoring data and statistics of the current implementation on our [performance](#) page.
- participate in the calculation of zeros for the Riemann zeta function and download the client code from our [software](#) page to be one of our [top producers](#) who maybe wins a [prize](#).

Technical details:
ZetaGrid provides a secure Java kernel, which does not allow access from the outside, and secures its communications and activities by restricted layer access with digital signatures (ElGamal public-key encryption) and key establishment protocols (half-certified Diffie-Hellman and ElGamal key agreement). The keys have a length of 1024 Bits. The framework of ZetaGrid provides management capabilities and is easy to use. Furthermore, it is supported on different platforms and has been proven to be stable. See the following [documents](#) for more details.

Verification of Riemann's Hypothesis
Currently participating:
7,898 computers:

5,720	x86 on Windows
2,022	x86 on Linux
861	ppc on AIX
62	ppc on Mac OS X
55	sparc on SunOS
10	ppc on Linux
10	alpha on Linux
6	sparc on Linux
5	s390 on Linux
4	ia64 on Linux

Performance
~719 GFLOPS

Top team (last 7 days)
[Debian Linux Users Everywhere](#)
1 active members
delivered 400,500,000 zeros
used 39 computer(s)

Top producer (last 7 days)
[Alessandro Polverini](#)
delivered 400,500,000 zeros
used 39 computer(s)

Active producer (random of last 24 h)
[matthew kowal](#)
delivered 300,000 zeros
used 1 computer(s)

Navigation Links:
Acknowledgement
Performance characteristics
Riemann Hypothesis
Prizes
Motivation
News **NEWS**
Statistics
Software
Publications
Forum
Links

This site is owned by Sebastian Wedeniwski

Sponsors
[IBM Deutschland Entwicklung GmbH](#)

Webhosting powered by [EDIS.at](#)

Do you need help?
Try the [ZetaGrid forum](#)



ZetaGrid reputation (7,810 Google results)

WOLFRAM RESEARCH mathworld.wolfram.com OTHER WOLFRAM SITES

ASTRONOMY BIOGRAPHY CHEMISTRY MATHEMATICS PHYSICS

Search Site

ERIC WEISSTEIN'S world of MATHEMATICS

INDEX BY SUBJECT

- Algebra
- Applied Mathematics
- Calculus and Analysis
- Discrete Mathematics
- Foundations of Mathematics
- Geometry
- History and Terminology
- Number Theory
- Probability and Statistics
- Recreational Mathematics
- Topology

ALPHABETICAL INDEX

ABOUT THIS SITE

Riemann Hypothesis

First published in Riemann (1859), the Riemann hypothesis states that the nontrivial [Riemann zeta function zeros](#) all lie on the "critical line" $\sigma = \Re[s] = 1/2$, where $\Re[s]$ denotes the [real part](#) of s . The Riemann hypothesis is also known as Artin's conjecture.

The hypothesis has thus far resisted all attempts to prove it. It has been computationally tested and found to be true for the first 200,000,001 zeros (Brent et al. 1982, which covered zeros $\sigma + it$ in the region $0 < t \leq 81,702,130.19$). More recently, S. Wedeniowski uses ZetaGrid, an internal computer cluster of IBM Corporation combined with external computations compiled on <http://www.zetagrid.net/> to prove that the first 250×10^9 nontrivial zeros of the $\zeta(s)$ lie on the critical line. This computation verifies that the Riemann hypothesis is true at least for all $t < 70,925,843,233.448$.

In 2000, Clay Mathematics Institute (<http://www.claymath.org/>) offered a \$1 million prize (http://www.claymath.org/Millennium_Prize_Problems/Riemann_etc/) for proof of the Riemann hypothesis. Interestingly, [disproof](#) of the Riemann hypothesis (e.g., by using a computer to actually find a zero off the [critical line](#)), does not earn the \$1 million award.

ct special Digitale Fotografie JETSET Nr. 16

Meldung vom 23.09.2002 14:21

news

[\[<< Vorige\]](#) [\[Nächste >>\]](#)

Belohnte Nullstellensuche

Wer sich mit seinem Computer an dem [ZetaGrid-Projekt](#) zur Suche und Überprüfung von Nullstellen der berühmten [Riemannschen Zeta-Funktion](#) beteiligt, dem winkt nicht nur Ruhm, sondern auch Bares. Man muss nur mit dem [ZetaGrid-Programm](#) zwei Nullstellen aufspüren, die weniger als 10^{-6} voneinander entfernt sind und schon hat man 10 US-Dollar verdient. Das hat jetzt das von IBM gesponserte ZetaGrid-Board unter Leitung von Dr. Sebastian Wedeniowski als Belohnung ausgesetzt. Ist der Abstand gar nur 10^{-7} gibt's schon 100 US-Dollar. Richtig spannend würde jedoch, wenn man eine nicht triviale Nullstelle findet, die sich nicht auf der so genannten kritischen Linie (mit einem Real-Wert von $1/2$) befindet. Dafür sind bereits 1000 Dollar ausgelobt. Und das ist allerdings, ob es überhaupt eine solche abweichende Nullstelle gibt. 761 Rechner ackern zur Zeit mit im ZetaGrid und haben bereits die ersten 100 Milliarden Nullstellen durchsucht, ohne allerdings eine einzige Abweichung zu finden.

Sollte das ZetaGrid-Projekt sogar dazu führen, dass Wedeniowski die [Riemannsche Vermutung](#) beweisen kann und die vom [Clay Mathematics Institute](#) dafür ausgelobten 1 Million Dollar zugesprochen bekommt, sollen die 100 aktivsten Teilnehmer (anteilig zur Zahl der überprüften Nullstellen) am Preis beteiligt werden. (as/ct)

[\[Version zum Drucken\]](#) [\[Per E-Mail versenden\]](#) [\[<< Vorige\]](#) [\[Nächste >>\]](#)

Magazin für Computer Technik
c't 26/2001

ZetaGrid

Die Rechenmacht des Internet haben auch die großen Firmen erkannt, allen voran IBM, die jetzt mit der primenet-Betreiberfirma entropia eine Partnerschaft eingegangen sind. IBM unterstützt auch andere mathematische 'Such-Projekte', so das im August 2001 gestartete ZetaGrid-Projekt. Bei diesem Projekt gehts um eine der größten aktuellen Herausforderungen der Zahlentheorie, nämlich um die seit über 140 Jahren unbewiesene Riemann'sche Vermutung. Diese besagt, dass alle nichttrivialen Nullstellen der komplexen Riemann'schen Zeta-Funktion

einen Realteil von $1/2$ besitzen. Auf dieser nahezu als gegeben angenommenen Vermutung beruht einer Unzahl weiterer mathematischer Ableitungen, sodass ihr eine immens große Bedeutung zukommt.

Mit dem vom bekannten 'Pionieren' Sebastian Wedeniowski geleiteten ZetaGrid-Projekt sind nun alle Interessierten eingeladen (www.hipilib.de/zeta/), so viele Nullstellen wie möglich zu überprüfen, über zehn Milliarden sind bereits abgecheckt. Einen möglichen Geldpreis gibts dafür noch nicht, doch eines ist sicher: wer eine abweichende Nullstelle findet und damit die Riemann'sche Vermutung falsifiziert, wird weltberühmt.

$$\zeta(s) = \sum_{k=1}^{\infty} \frac{1}{k^s}$$

Scientific American, Crunching Numbers,
May 2003

A volunteer effort is under way to verify the famous Riemann Hypothesis by using distributed computer software to search for the zeros of the Riemann zeta function. [German mathematician Bernhard Riemann hypothesized in 1859 that all the nontrivial zeros of the function fall on a particular line. See "Math's Most Wanted," Reviews, on page 84.] To date, more than 5,000 participating computers have found more than 300 billion zeros. For more information, visit www.zetagrid.net

PC Magazin 05/2003

Die fünf wichtigsten DC-Projekte

Einen gute Übersicht der gängigen DC-Projekte liefert www.rechenkraft.de. Unsere Liste stellt subjektiv die großen, die innovativen und die heimischen Projekte zusammen.

Name	Folding@home/ Genome@home	SETI@home	Zetagrid	Moneybee	Distributed.net
Kategorie	Medizin	Suche nach Außerirdischen	Mathematik	Finanzen	Verschlüsselung
Ziel	Simulation von Faltungsvorgängen bei Proteinen	Finden regelmäßiger Signale in Daten von Radioteleskopen	Verifizierung der Riemannschen Hypothese	Prognose von Aktienkursen, Indizes und anderen Wirtschaftsparametern	Finden des Schlüssels für eine RC5-72-kodierte Nachricht
Teilnehmer	186.241	4.276.801	4312 (Computer)	ca. 12.000	10.478
kommerziell	—	—	—	✓	—
Web	http://folding.stanford.edu/	www.setiathome.ssl.berkeley.edu/	www.zetagrid.net/	http://de.moneybee.net	www.distributed.net/rc5/index.html
Begründung	Große wissenschaftliche Erfolge	Hat DC wirklich publik gemacht	Relativ großes deutsches Projekt	Deutsches kommerzielles Projekt	Technische Neuerungen und Details für die Clientprogramme „erfunden“



ZetaGrid communities: 135 teams

ZetaGrid - Statistics - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites Media Print View Source

Address <http://www.zetagrid.net/servlet/service/teams> Go Links

ZetaGrid Statistics

Last update: 11/12/2003 09:09:49

Top teams:

place	team	age (days)	work units	members	computers used	zeros
1.	Gentoo Linux Users Everywhere	313	54,014	96	707	27,445,208,800
2.	rechenkraft.net - Germany	333	16,393	51	169	9,614,482,100
3.	Debian Linux Users Everywhere	170	11,004	2	64	9,592,803,600
4.	Performance Expert	331	14,336	6	24	8,702,204,000
5.	zittergritter	332	12,481	18	56	7,022,200,000
6.	e-PATOS	329	10,680	3	18	4,825,302,300
7.	Team USA	330	8,291	5	34	4,605,300,000
8.	Hochschulen Deutschlands	59	11,470	1	60	3,665,050,200
9.	Team Ese-Quadruplicate	280	4,529	3	14	3,185,700,000
10.	Team-TNT.net	305	7,835	15	80	3,074,300,000
11.	Zeta Team Spirit	394	4,895	8	27	3,012,494,800
12.	Planet Creta	265	5,608	4	52	2,776,917,900
13.	US Distributed	127	3,984	13	47	2,340,154,000
14.	raygina	223	2,872	3	17	2,276,500,000
15.	Team Zuerich Boeblingen	289	2,696	2	17	2,125,500,000
16.	ProArte	217	2,853	1	10	2,079,000,000
17.	LinacProject	270	4,196	1	33	1,838,400,000
18.	AI02 RockerCrew	223	2,536	2	28	1,710,700,000
19.	Free-DC	302	4,094	10	52	1,586,800,000
20.	Mads Comps	327	2,596	1	7	1,577,500,000
21.	Club Archimedes	257	3,304	2	6	1,538,700,000
22.	G-NET	143	4,702	14	50	1,499,500,000
23.	Wohnheim Hessenkolleg Frankfurt	331	1,917	1	17	1,389,476,100
24.	AMD Users	283	3,008	20	41	1,352,200,000
25.	tinygridders	294	3,216	18	37	1,154,600,000
26.	Pfeilcomputing	192	1,858	11	21	807,600,000
27.	suechtler	206	1,486	5	9	736,000,000

Internet



ZetaGrid communities

ZetaGrid Forum

Home » Forums

Welcome to our ZetaGrid online community. Please choose from one of the forums below or log-in to your user account to start using this service.

Welcome, *Guest*
[Login / Register](#)
[Guest Settings](#)

FORUM / CATEGORY NAME	TOPICS / MESSAGES	LAST POST
Member News [read only] <i>The latest from ZetaGrid on system status, features, bug info, rewards, and other news...</i>	9 / 9	Jul 3, 2003 11:08 PM by: admin
Known Issues [read only] <i>Known technical issues with the current release that will be fixed with a future release.</i>	6 / 12	Oct 1, 2003 10:40 PM by: admin
Start Here: The New Members Forum <i>Assistance for members who are new in the ZetaGrid community</i>	35 / 147	Nov 7, 2003 2:53 PM by: HermannG
Community-maintained FAQs [read only] <i>Frequently-Asked-Questions and other useful Readmes created and maintained by the member community.</i>	9 / 10	Jul 15, 2003 7:34 PM by: admin
Member-to-Member Support <i>For members to post questions and answers related to installing and running the ZetaGrid client, the message board and general advice on PCs running ZetaGrid.</i>	70 / 334	Nov 11, 2003 10:54 AM by: hustille
Suggestions / Feedback <i>Share your input on how to improve the ZetaGrid network.</i>	47 / 242	Nov 4, 2003 8:20 AM by: wedniws

Denotes new messages since your last visit.

[Forum Home](#) | [Register](#) | [Login](#) | [Search](#)
[[Powered by Jive Forums](#)]




ZetaGrid communities

Gentoo Forums :: View topic - Zetagrid GLUE-team --> We are in the TOP 2 (7 July 2003) - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Media Print Mail News RSS Feeds

Address <http://forums.gentoo.org/viewtopic.php?t=28511> Go Links

 **gentoo**
discussion forums

Quick Search:

[FAQ](#) | [Search](#) | [Memberlist](#) | [Usergroups](#) | [Statistics](#) | [Profile](#) | [Log in to check your private messages](#) | [Log in](#) | [Register](#)

Zetagrid GLUE-team --> We are in the TOP 2 (7 July 2003)

Goto page [1](#), [2](#), [3](#) ... [15](#), [16](#), [17](#) [Next](#)

[new topic](#) [postreply](#) [Gentoo Forums Forum Index](#) -> [Gentoo Chat](#)

[View previous topic](#) :: [View next topic](#)

Author	Message
Tantive n00b □□□□□ Joined: 14 May 2002 Posts: 69	<p>Posted: Fri Jan 03, 2003 2:56 pm Post subject: Zetagrid GLUE-team --> We are in the TOP 2 (7 July 2003) quote</p> <p>Hii</p> <p>I created a "Gentoo Linux Users Everywhere" team for zetagrid.</p> <p>What is ZetaGrid?</p> <p>ZetaGrid is an open source and platform independent grid system that uses idle CPU cycles from participating computers. It can be used for any CPU intensive application which can be split into many separate steps and which would run very long on a single computer. ZetaGrid can be run as a low-priority background process on various platforms like Windows, AIX, Linux for zSeries, Linux on Intel. On Windows systems it may also be run in screen saver mode.</p> <p>The current project zetagrid is used for is this one: The verification of Riemann's Hypothesis is considered to be one of modern mathematic's most important problems. This implementation involves about 2500 workstations and has a peak performance rate of about 530 GFLOPS. About 2 billions of zeros for the zeta function are calculated every day.</p> <p>Zetagrid can be found at www.zetagrid.net</p> <p>It would be great if many of you would use it and join our team! Installation is simple: Get the files from the homepage, unpack them, make sure you have java installed and edit the config file (zeta.config). Include your name, your e-mail and set the team to "Gentoo Linux Users Everywhere". After the completion of your first work unit you'll receive a e-mail for confirmation of joining the team.</p>

Done Internet




ZetaGrid communities


Rechenkraft.net - Die Infoseite über Distributed Computing Projekte (verteiltes Rechnen) - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites Media Print

Address <http://www.rechenkraft.de/> Go Links


Rechenkraft.net CLICK WERBUNG **ICEFIGHTER** ONLINE EISHOCKEY MANAGER 

Startseite Projekte Anleitung Clients Community Team-Stats Sonstiges Suchen **567704** 

Startseite Portal Forum Suchen Private Nachrichten Login Registrieren

Projektdetails

Logo



Überblick

Name	ZetaGrid
Kategorie	Mathematik
Ziel	Verifizierung der Riemann'schen Hypothese
Kommerziell	Nein
Homepage	http://www.zetagrid.net/
Plattform	-

Projektbeschreibung

Die Riemann'sche Zeta-Funktion ist definiert als

wobei s eine komplexe Zahl ist deren Realteil größer als 1 ist: $\text{Re}(s) > 1$.
 Die Riemann'sche Hypothese besagt, daß alle nichttrivialen Nullstellen der Zeta-Funktion auf einer Geraden g liegen, die durch $g = 1/2 + i \cdot t$ beschrieben wird. Dabei ist t eine reelle Zahl und i die imaginäre Zahl.

Die Verifikation dieser Hypothese ist eines der wichtigsten Probleme der modernen Mathematik. 1903 wurden die ersten 15 Nullstellen der Riemann'schen Zeta-Funktion berechnet. Damit war die Hypothese für den Bereich $0 < t < 65,801$ empirisch nachgewiesen.

Die Riemann'sche Hypothese ist deshalb so wichtig, weil viele andere Theoreme darauf beruhen und somit auch für diese Theoreme nicht bekannt ist, ob sie wahr oder falsch sind.

Projekt-Links

- Aktive Projekte
- Alle Projekte
- Beschreibungen
- Kategorien
- Providerliste
- Projekte mit Preisen

Projekt-Team

Unterstütze unser Team
[Rechenkraft.net - Germany](#)

Projekt-Forum

Diskutiere im zugehörigen Forum

Wer rechnet mit?

Schau einfach in unserer Computer-DB nach.

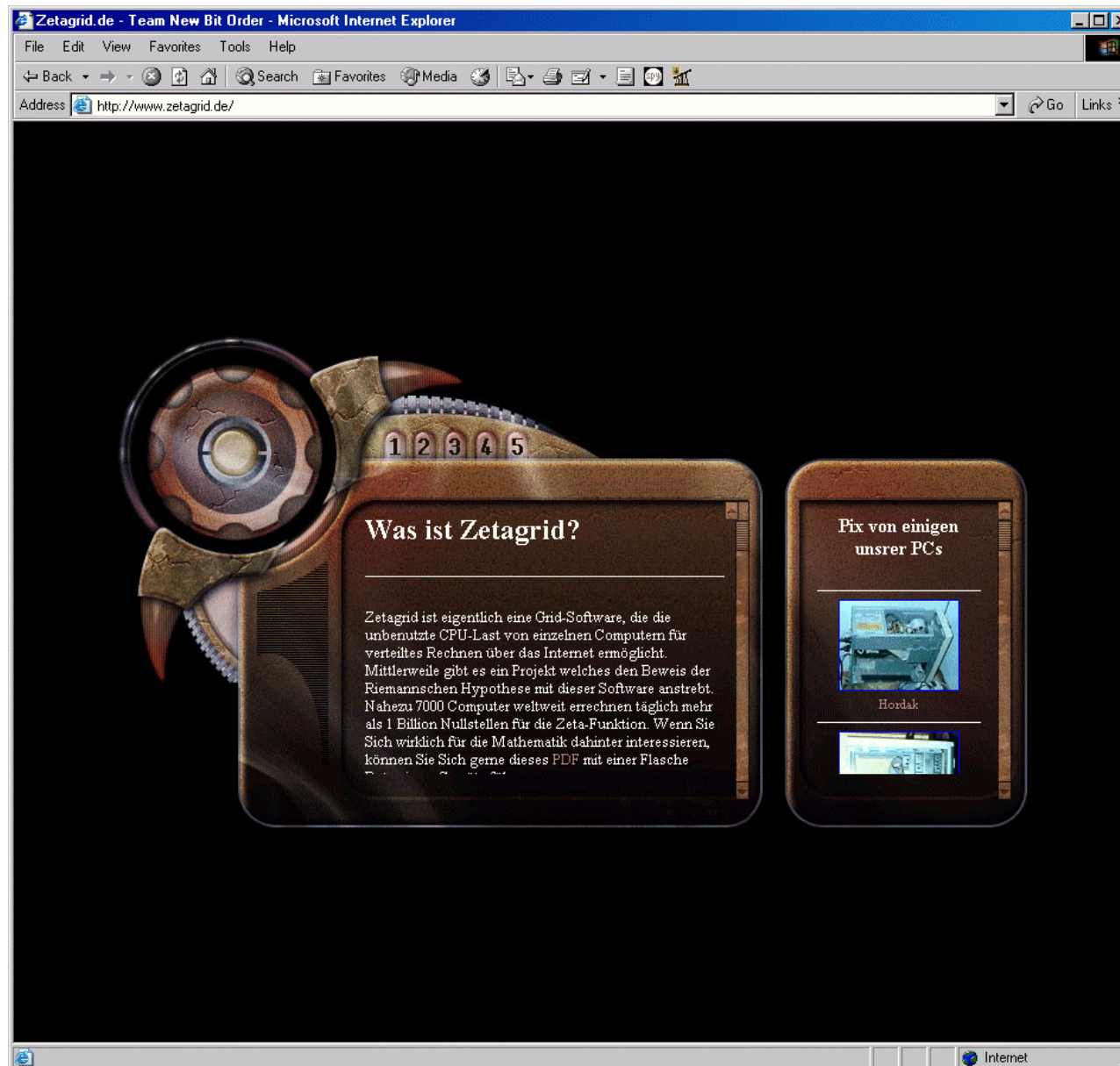
Gleiche Kategorie

- [15k*2^n-1](#)
- [3*2^n-1 search](#)
- [Catalans Vermutung](#)
- [Collatz Conjecture](#)
- [Collatz Problem \(3x+1\)](#)
- [Dual Sierpinski](#)

(9 items remaining) Downloading picture http://www.rechenkraft.net/images/zeta_def.gif Internet



ZetaGrid communities





Agenda

1	Overview
2	Examples
3	Technical Details
4	Security & Privacy
5	ZetaGrid Directions



Some examples

- Verification of



- In cooperation with the University Freiburg, Institute for Biology (Zoology):
Deconvolution of images from microscopes in a Life Imaging Center.
- In cooperation with the University of Tübingen, Institute for Computer Science (Symbolic Computation):
Realization of a SAT Grid with the ZetaGrid platform for hardware verification.
- Proposal for distributed computational fluid dynamics for automotive industries, i.e. solving fluid flow problems.



Riemann zeta function

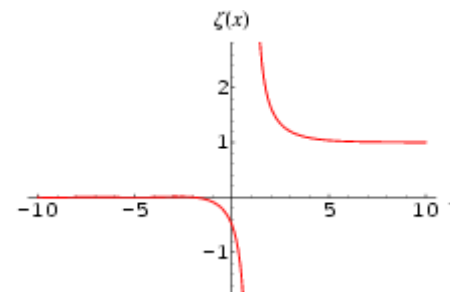
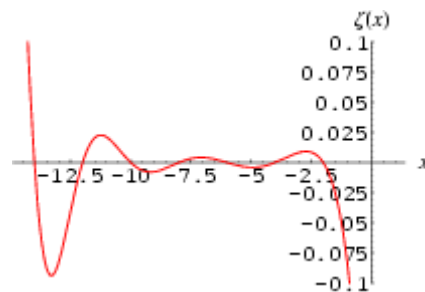
- Let s be a complex number with $\text{Re}(s) > 1$. Then the Riemann zeta function is defined by (Euler ~1730)



$$\zeta(s) = \sum_{k=1}^{\infty} \frac{1}{k^s}$$

and is extended to the rest of the complex plane (except for $s=1$) by analytic continuation.

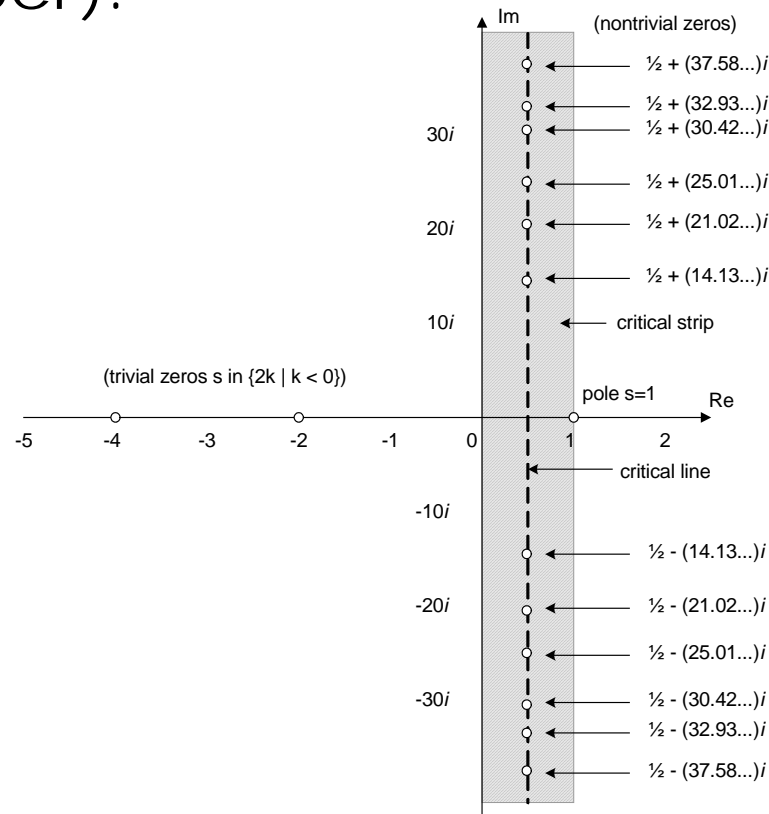
$$\zeta(1-s) = 2(2\pi)^{-s} \cos\left(\frac{1}{2}s\pi\right) \Gamma(s) \zeta(s)$$





The Riemann Hypothesis

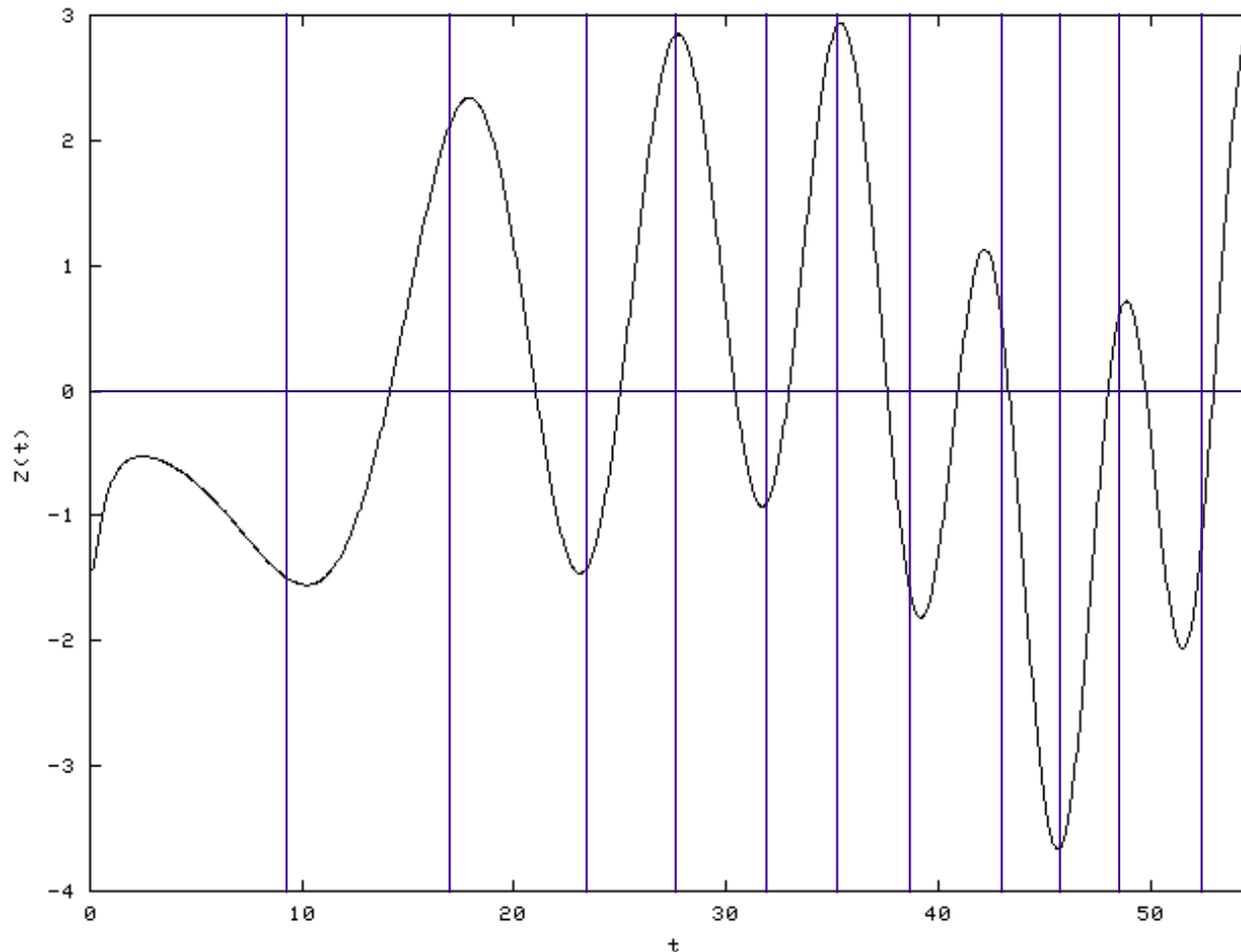
- The Riemann Hypothesis (formulated in 1859) asserts that all nontrivial zeros of the zeta function are on the critical line ($1/2 + it$ where t is a real number).





The zeros of $Z(t)$

- There exists at least one zero between two values with different sign.



The first 11 non-trivial zeros:

$$\rho_1 \approx 1/2 + 14.135i$$

$$\rho_2 \approx 1/2 + 21.022i$$

$$\rho_3 \approx 1/2 + 25.011i$$

$$\rho_4 \approx 1/2 + 30.425i$$

$$\rho_5 \approx 1/2 + 32.935i$$

$$\rho_6 \approx 1/2 + 37.586i$$

$$\rho_7 \approx 1/2 + 40.919i$$

$$\rho_8 \approx 1/2 + 43.327i$$

$$\rho_9 \approx 1/2 + 48.005i$$

$$\rho_{10} \approx 1/2 + 49.774i$$

$$\rho_{11} \approx 1/2 + 52.970i$$



History and milestones of ZetaGrid

- Feb. 1998 to Nov. 2001: Working on the necessity of the Extended Riemann Hypothesis for Miller's primality test (Dissertation "Primality Tests on Commutator Curves")
- February 2001: First implementation of ZetaGrid and synchronization with the Fortran-Code of J. van de Lune, H. J. J. te Riele, D. T. Winter
- August 2001: Starting ZetaGrid on 10 computers in IBM Laboratory Böblingen
- February 2002: Distributing ZetaGrid on 500 computers in IBM Germany
- September 2002: Availability of ZetaGrid in the Internet at <http://www.zetagrid.net>



History of the verified zeros

Year	Author	Starting zero number	Number of zeros ρ with $\text{Im}(\rho) > 0$
1903	J. P. Gram	0	15
1914	R. J. Backlund	0	79
1925	J. I. Hutchinson	0	138
1935	E. C. Titchmarsh	0	1,041
1953	A. M. Turing	0	1,104
1955	D. H. Lehmer	0	10,000
1956	D. H. Lehmer	0	25,000
1958	N. A. Meller	0	35,337
1966	R. S. Lehman	0	250,000
1968	J. B. Rosser, J. M. Yohe, L. Schoenfeld	0	3,500,000
1977	R. P. Brent	0	40,000,000
1979	R. P. Brent	0	81,000,001
1982	R. P. Brent, J. van de Lune, H. J. J. te Riele, D. T. Winter	0	200,000,001
1983	J. van de Lune, H. J. J. te Riele	0	300,000,001
1986	J. van de Lune, H. J. J. te Riele, D. T. Winter	0	1,500,000,001
1989	A. M. Odlyzko	10^{20}	70,000,000
1992	A. M. Odlyzko	10^{20}	175,000,000
2001	A. M. Odlyzko	10^{22}	10,000,000,000
2001	J. van de Lune	0	10,000,000,000
2002	A. M. Odlyzko	10^{23}	20,000,000,000
2002	S. Wedeniwski	0	75,000,000,000
2003	S. Wedeniwski	0	200,000,000,000



Performance characteristics

- Participating in ZetaGrid (11/11/2003):
3,038 users and 7,899 computers
- 1.8×10^{19} floating-point operations for calculating about 561 billion zeros of the Riemann zeta function in 805 days
 - ~261 GFLOPS
 - ~29 days maximal performance of IBM ASCI White, 8192 Power3 375 MHz processors (place 2, 06/2002, www.top500.org)
 - ~2304 years maximal performance of one Intel Pentium 4 with 2 GHz processors, 250 MFLOPS

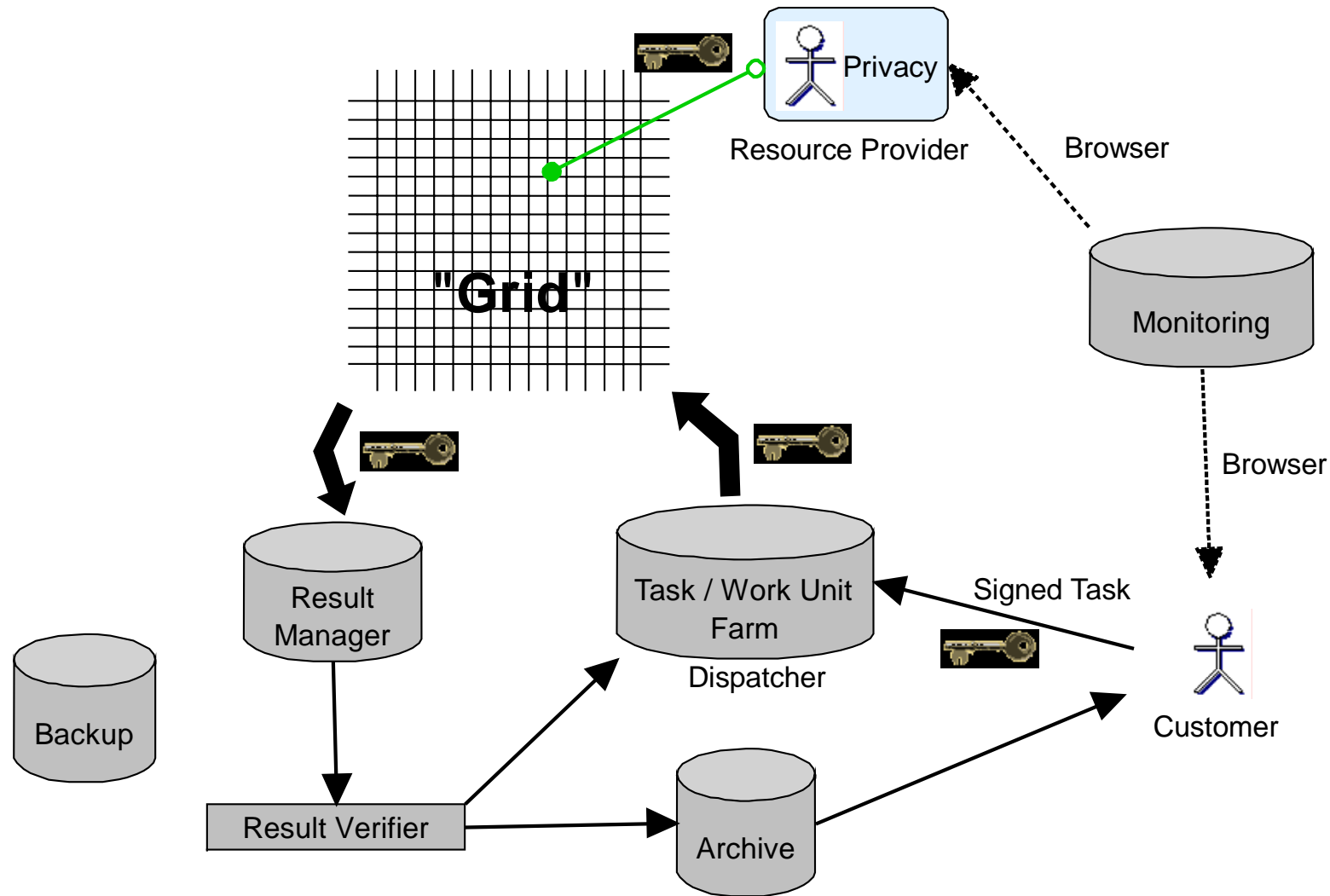


Agenda

1	Overview
2	Examples
3	Technical Details
4	Security & Privacy
5	ZetaGrid Directions



ZetaGrid architecture overview





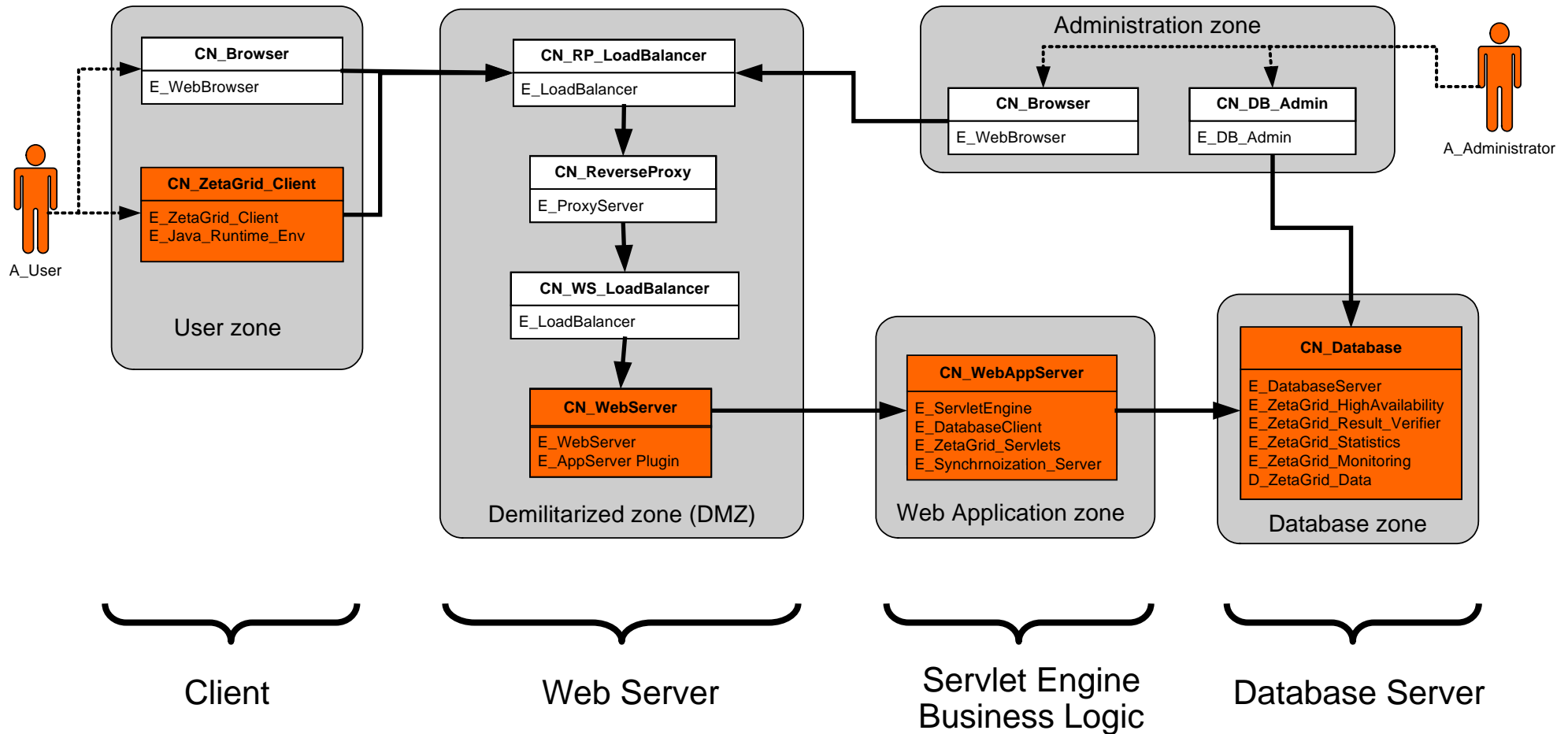
Operational model conceptual level

■ Consists four tiers

E: Execution Deployment Unit

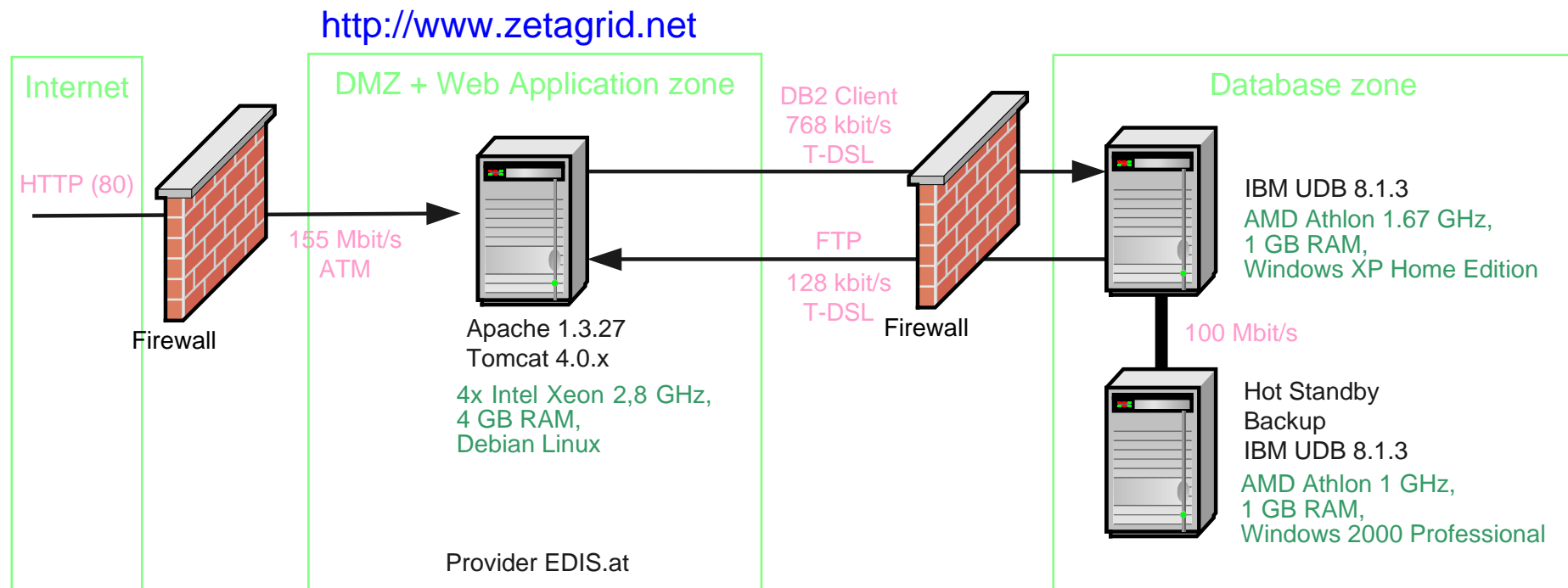
D: Persistence Deployment Unit

CN: Conceptual nodes represent logical nodes that host one or multiple deployment units





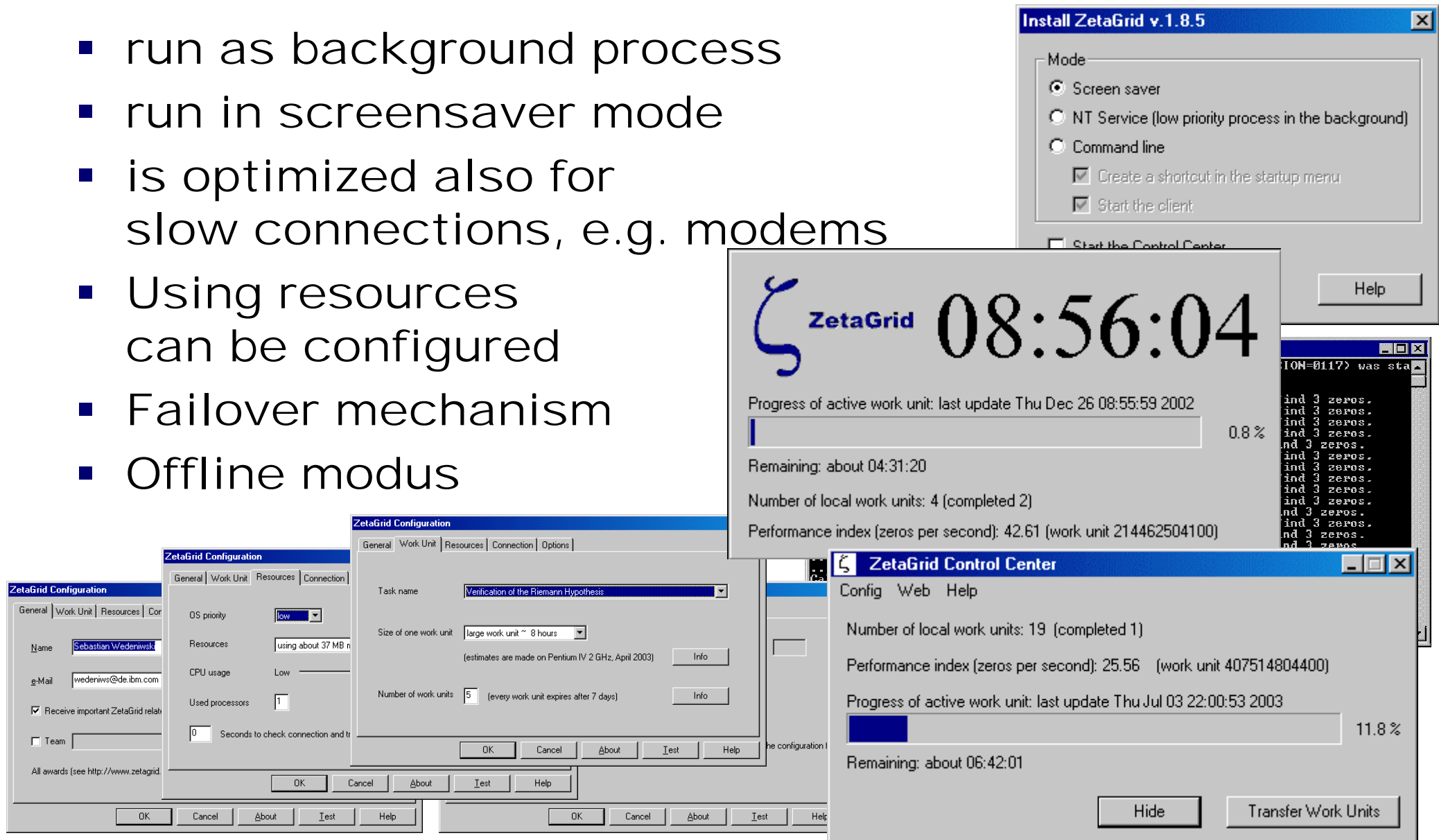
Operational model physical level





ZetaGrid client

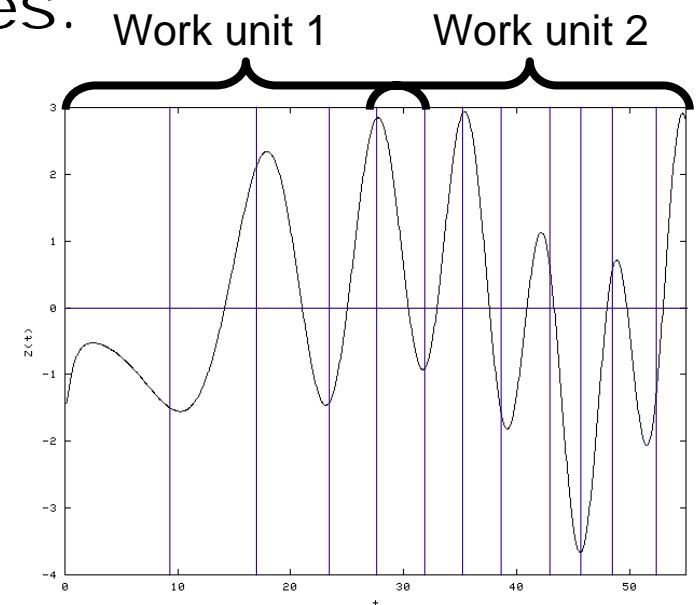
- run as background process
- run in screensaver mode
- is optimized also for slow connections, e.g. modems
- Using resources can be configured
- Failover mechanism
- Offline modus





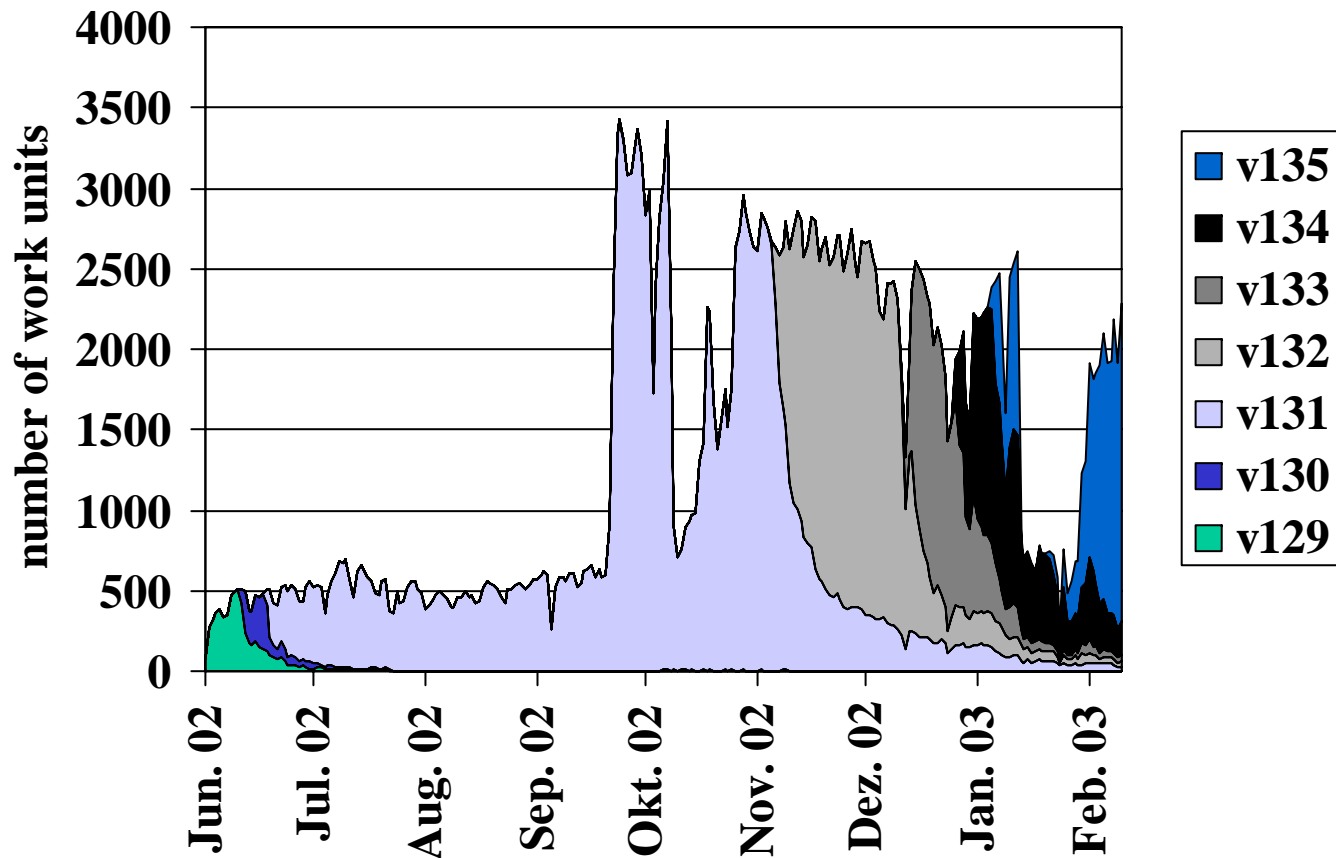
Task and work units

- A computational task can be split up into a configured number of independent work units.
- A task may depends on a specific hard- or software.
- Work units can be recomputed and redistributed.
- Work units must be traceable and monitored.
- Work units can have different sizes.
- Work units may have an overlap.
- A resource provider can request more than one work unit simultaneously (depends on his trust factor).





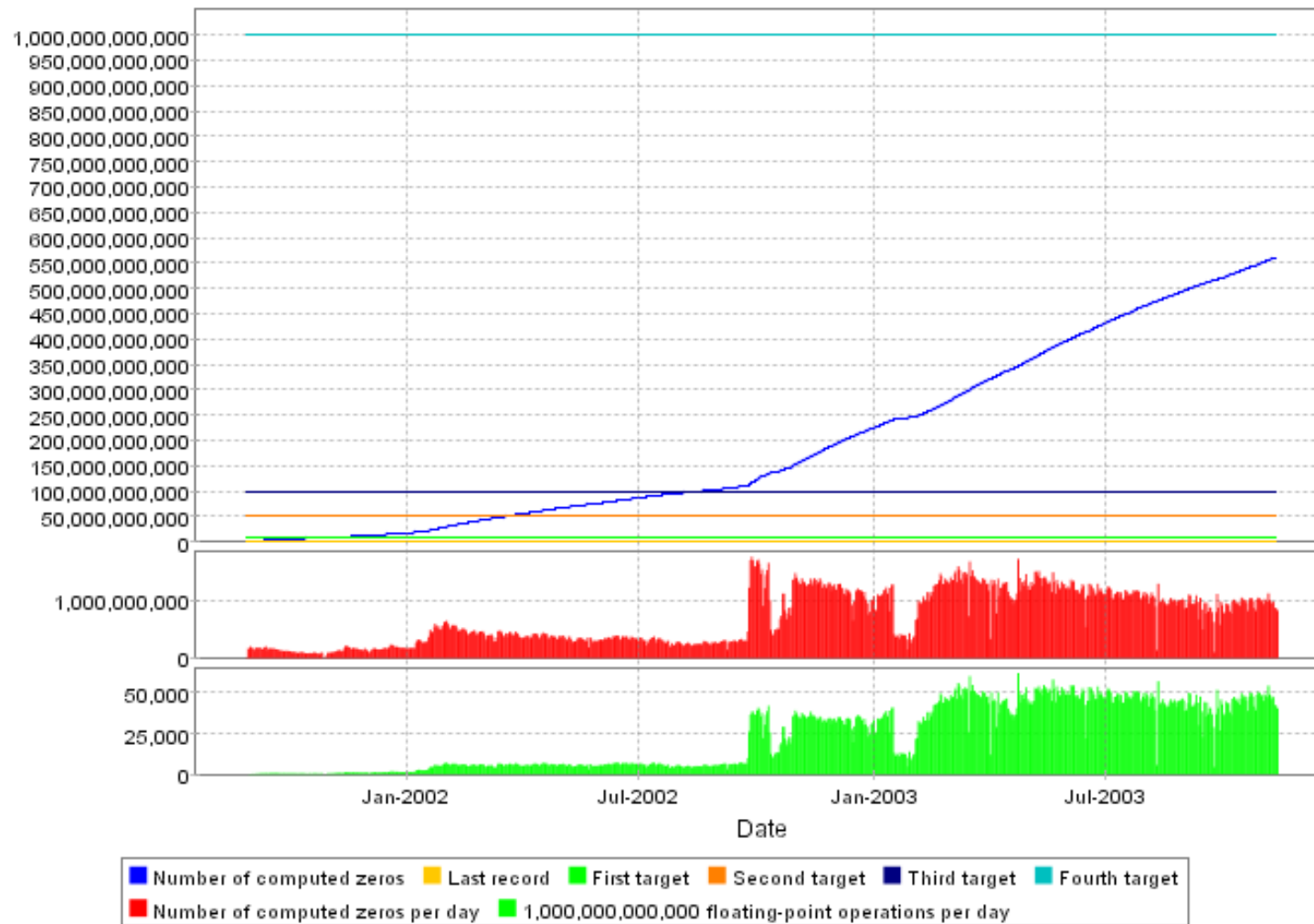
Version control





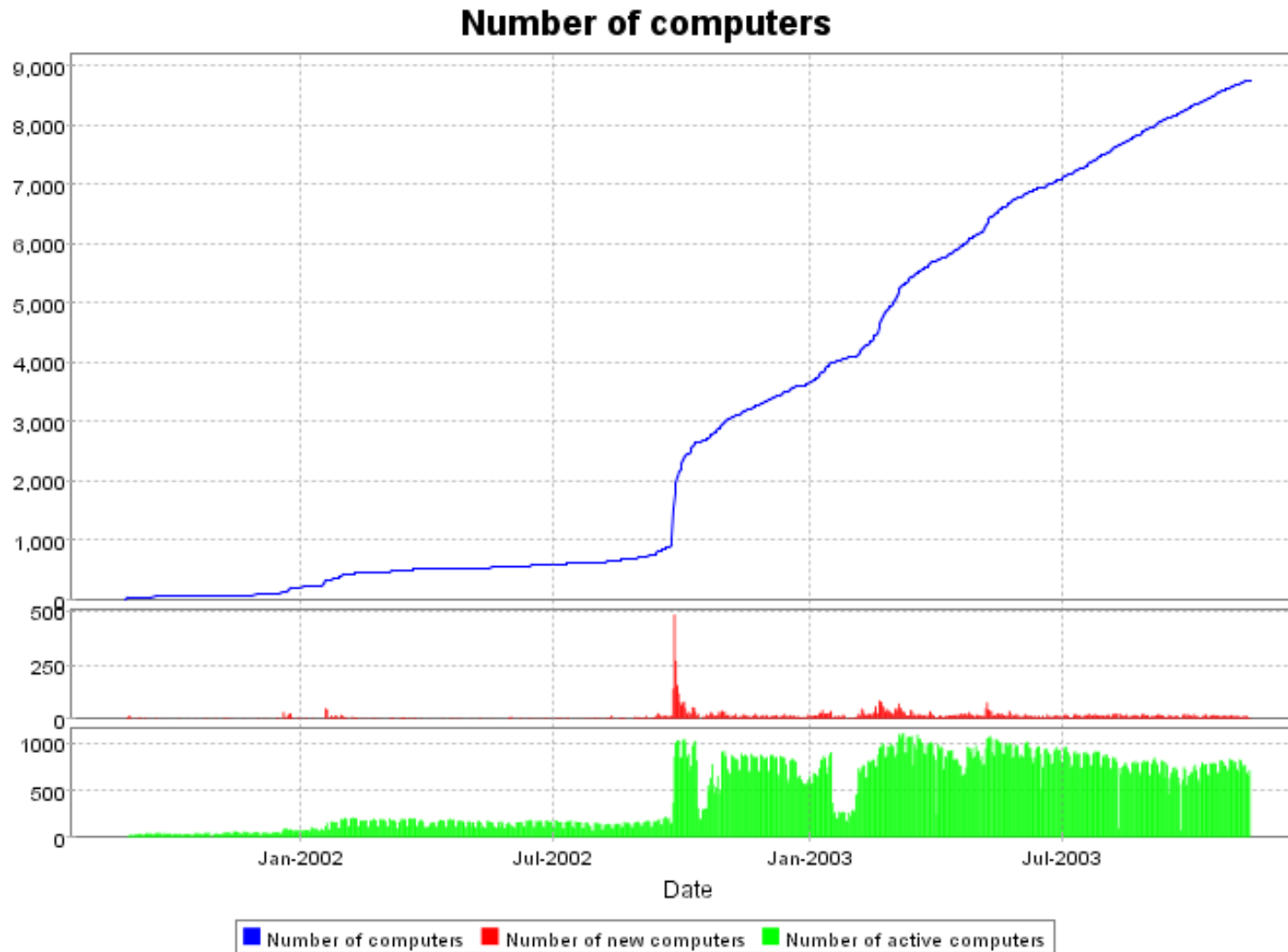
History of the computation

Summary of the computational results





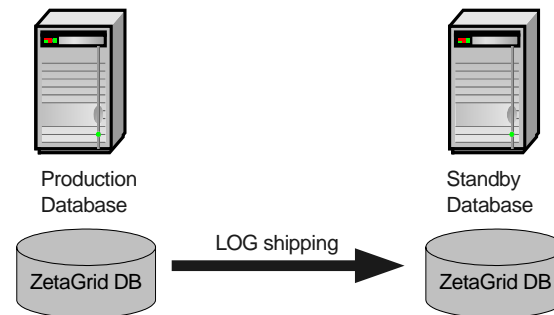
Number of computers





High availability of the back-end database

- Using log shipping to a standby database.



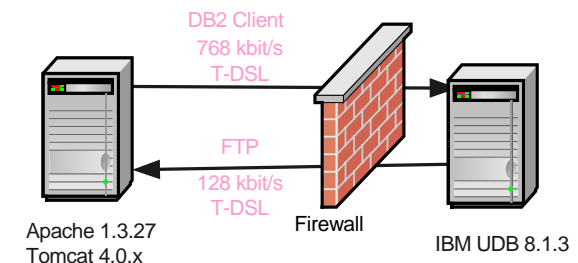
The standby database continuously rolls forward through the logs, ensuring that it is current up to the last successfully shipped log file.

- Daemon which checks and restarts the database process if specific communication errors occur.
- Daemon which kills and restarts the database process if "db2stop" hangs, e.g. UDB 8.1 FP3.
- Backup of the production database one time per day.



High availability of the DSL connection

- Using PPP over Ethernet dial-up connection, e.g. RASPPPOE.
- Daemon which stops, reconnects, sends the new IP address to the application server, and restart the database server every 23 hours.
Availability: about 99.98%



- Daemon which pings specific addresses to keep alive the connection.
- Tool which simulates keystrokes to eliminate troubleshootings with dial-up connections, e.g. MCL.
- Daemon which kills the dial-up connection if it hangs.



High availability of Windows XP Home

- Disable automatic shutdown.
- Disable the "Indexing Service."
- Disable the service "Messenger."
- Log on automatically at system startup and restart all daemons if for example an electrical power outage occurred. Tools like "Tweak UI" can be used.
- Using automatically updating AntiVirus and Firewall tools.
- Install OS security patches manually.



Agenda

1	Overview
2	Examples
3	Technical Details
4	Security & Privacy
5	ZetaGrid Directions



Security functions

- Authentication
- Access control / authorization
- Confidentiality
- Data integrity
- Privacy
- Nonrepudiation



Authentication

- Definition:
Authentication is the process of verifying the identity of a participant to an operation or request.

- Solution in ZetaGrid:
 - Using the user name, e-mail address, and hostname for the client-server authentication.

 - Using hostname, IP address patterns, and encryption (448-bit key Blowfish).



Access control / authorization

- Definition:
Authorization is the process through which it is determined whether a particular operation is allowed.

- Solution in ZetaGrid:
 - Proprietary solution (trust factor, active, etc.)

 - Database access control (user, administrator, monitor)



Confidentiality

- Definition:
The degree to which the sensitive data have not been made available or disclosed to unauthorized individuals, processes, or other entities.

- Solution in ZetaGrid:
 - ElGamal public-key encryption; the keys have a length of 1024 Bits

 - Key establishment protocols (half-certified Diffie-Hellmann and ElGamal key agreement)



Data integrity

- Definition:
The data integrity condition existing when data is unchanged from its source and has not been accidentally or maliciously modified, altered, or destroyed.

- Solution in ZetaGrid:
 - Digital signatures

 - ElGamal public-key encryption; the keys have a length of 1024 Bits



Privacy

- Definition:
The protection given to prevent unauthorized disclosure of the information in the system.

- Solution in ZetaGrid:
 - The client is written in Java only so that Java2 Security concepts, i.e. the Java Sandbox

 - Open Source



Nonrepudiation

- Definition:
A sender and a receiver should not be able to falsely deny later that he sent a message.

- Solution in ZetaGrid:
 - Access list of the web server

 - Logs of the application server

 - Only insert and select statements are permitted in the database (no delete or update)



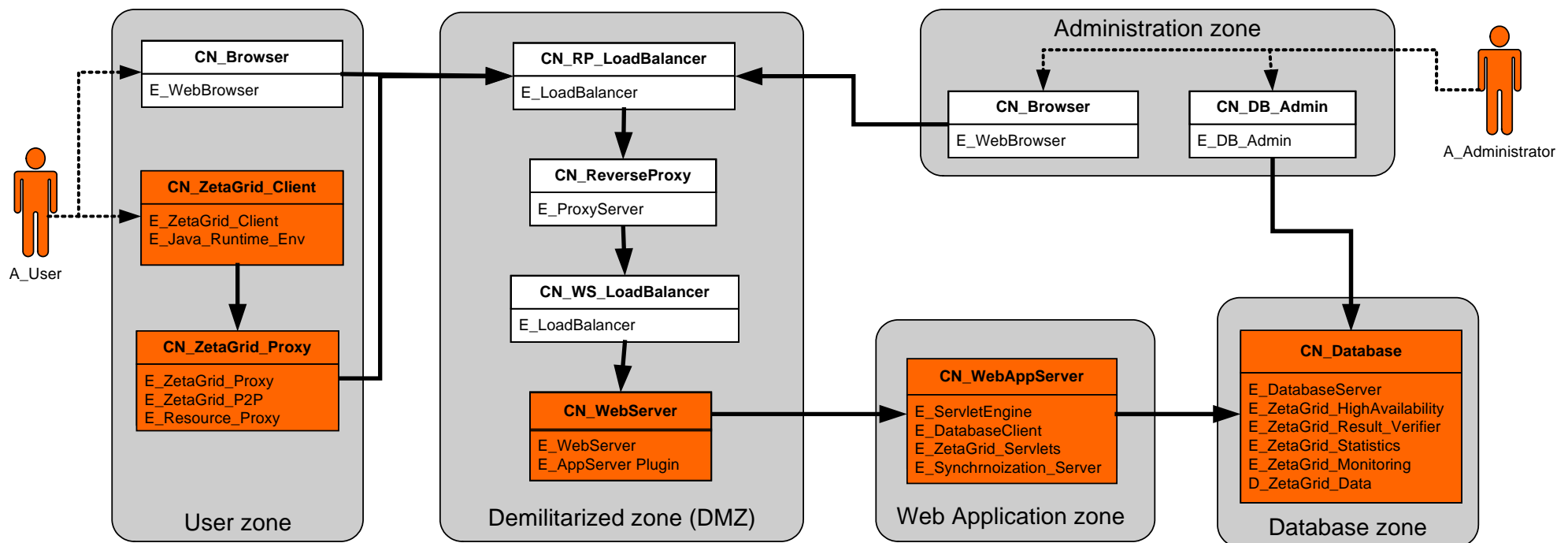
Agenda

1	Overview
2	Examples
3	Technical Details
4	Security & Privacy
5	ZetaGrid Directions



Operational model conceptual level

- OGSA
- Using forward proxies





Questions





Heterogeneity

operating system	processor	computers	percentage	zeros	percentage
AIX	ppc	434	6.50%	5,098,103,500	1.32%
Linux	alpha	6	0.09%	103,100,000	0.03%
Linux	i386	1,523	22.80%	64,756,490,000	16.78%
Linux	ppc	9	0.13%	42,800,000	0.01%
Linux	s390	4	0.06%	451,700,000	0.12%
Linux	sparc	5	0.07%	20,100,000	0.01%
Linux	x86	175	2.62%	24,790,297,900	6.42%
Mac OS X	ppc	30	0.45%	107,000,000	0.03%
SunOS	sparc	39	0.58%	624,400,000	0.16%
SunOS	sparcv9	1	0.01%	9,200,000	0.00%
Windows 2000	x86	2,529	37.86%	164,865,208,500	42.72%
Windows 95	x86	31	0.46%	247,900,000	0.06%
Windows 98	x86	262	3.92%	6,001,500,000	1.56%
Windows Me	x86	84	1.26%	1,941,300,000	0.50%
Windows NT	x86	472	7.07%	72,831,058,100	18.87%
Windows XP	x86	1,075	16.10%	44,016,774,000	11.41%
Σ 16		6,679		385,906,932,000	



Version control (2003/11/11)

version	starting	ending	#WU	%
0100	2001-08-28	2001-09-07	123	0.04
0101	2001-08-30	2001-09-18	1,092	0.12
0102	2001-09-02	2001-09-11	157	0.02
0103	2001-09-04	2001-09-30	3,454	0.32
0107	2001-09-14	2001-10-16	2,444	0.19
0108	2001-09-21	2001-11-19	2,309	0.14
0109	2001-09-25	2001-10-17	1,228	0.10
0110	2001-10-01	2001-12-11	2,374	0.21
0111	2001-10-15	2001-11-04	1,127	0.09
0112	2001-10-22	2001-11-12	703	0.05
0113	2001-10-26	2001-11-20	1,445	0.12
0114	2001-11-02	2001-11-16	1,715	0.14
0115	2001-11-11	2001-11-26	1,777	0.15
0116	2001-11-15	2001-11-21	879	0.07
0117	2001-11-18	2002-01-08	2,293	0.20
0118	2001-11-25	2001-12-16	1,558	0.13
0119	2001-11-30	2002-01-07	4,371	0.38
0120	2001-12-14	2002-02-01	8,433	0.73

version	starting	ending	#WU	%
0121	2001-12-30	2002-02-25	436	0.04
0122	2002-01-04	2002-02-08	6,781	0.57
0123	2002-01-17	2002-06-05	8,654	0.83
0124	2002-01-24	2002-07-24	5,560	0.49
0125	2002-01-26	2002-06-25	9,037	0.82
0126	2002-02-02	2002-08-05	24,916	2.34
0127	2002-02-13	2002-12-10	33,553	3.19
0128	2002-04-17	2002-11-22	32,089	2.96
0129	2002-06-03	2002-08-19	6,106	0.55
0130	2002-06-13	2002-11-29	3,173	0.30
0131	2002-06-18	2003-09-09	182,020	16.20
0132	2002-09-23	2003-10-17	81,614	6.91
0133	2002-12-13	2003-11-10	30,690	2.71
0134	2002-12-26	2003-11-11	36,300	3.38
0135	2002-12-14	2003-11-11	333,759	28.79
0136	2003-02-24	2003-11-11	272,376	25.91
0137	2003-05-05	2003-11-11	5,155	0.48
0138	2003-10-23	2003-11-11	1,836	0.14