Linux PCI-HOWTO

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Information on what works with Linux and PCI-boards and what does not.

Contents

1 Introduction

Because I plan to get me a PCI-Board and because the situation is not very clear at all whether it works or not, and which configuration, I made a survery and took some hours to compile the information gathered therein.

If you have information to add, please mail me, if you have questions, feel free to ask.

Help on my style/language is welcome as well - I am no native-speaker so I expect to do occasional mistakes :-) (Speaking of "onboard-chip" in the following I mean a on-motherboard-chip instead of expansion-card.

Someone pointed out to me that this might not be that obvious)

2 Why PCI

2.1 General overview

The PC-architecture has several BUS-Systems to choose from:

ISA
: cheap, slow (usualy 8Mhz), standard, many cards available¿

EISA
: expensive, fast, some cards available¿

MCA
: ex-ibm-proprietary, fast but not very wide-spread

VESA-Local-Bus
: based on ISA, cheap, fast, some cards available, not very standard¿

PCI-Local-Bus
: expensive, fast, some cards available, the up-coming standard¿

ISA/VESA-Local-Bus had some problems with high-frequenzy, and was not very relyable, but due to its low price and higher performance sold very well.

EISA was reliable, but rather expensive, more for power-users, and servers, not for the average user.

PCI now has the advantage, that it is like EISA not proprietary, fast as EISA (or even faster), 64bit-wide. This will be important with the i586 (they would rather like to read as Pentium).

PCI is not like ISA/Local-Bus prozessor-dependend. This means you can use the winner-1000-PCI in an Alpha-driven-PCI-board as well as in a i486/i586-driven PCI-Board).

PCI allows cheaper production of onboard-components, no glue-logic needed.

2.2 Performance

taken from Craig Sutphin's Pro-PCI-Propaganda

> Unlike some local buses, which are aimed at speeding up graphics alone, the PCI Local Bus is a total system solution, providing increased performance for networks, disk drives, full-motion video, graphics and the full range of high-speed peripherals. At 33 MHz, the synchronous PCI Local Bus transfers 32 bits of data at up to 132 Mbytes/sec. A transparent 64-bit extension of the 32-bit data and address buses can double the bus bandwidth (264 Mbytes/sec) and offer forward and backwards compatibility for 32 and 64-bit PCI Local Bus peripherals. Because it's

processor-independent, the PCI Local Bus is optimized for I/O functions, enabling the local bus to operate concurrent with the processor/memory subsystem. For users of high-end desktop PCs, PCI makes high reliability, high performance and ease of use more affordable than ever, no trivial task at 33 MHz bus-clock rates. Variable length linear or toggle mode bursting for both reads and writes improves write dependent graphics performance. By comprehending the loading and frequency requirements of the local bus at the component level, buffers and glue logic are eliminated.

2.3 The onboard-SCSI-II-chip NCR53c810

One very nice feature of the PCI-Boards is the onboard-SCSI-II-chip, which is said to be as fast as the EISA-Adaptec-1742, but much cheaper. Drivers for DOS/OS2 are available. Linux does not have the driver yet, but Drew Eckard is working on it, the iX Multiuser Multitasking Magazine is supporting the driver development. It seems to be not yet stable-enough for release but people are already testing it... It is not easy to write the driver, because it is radicaly different from the normal NCR-Chip.

Until it is finished Linux-users have to disable the chip and use a cheap ISA-Card...

Drew said about the SCSI on PCI:

> Currently, your only PCI SCSI option that stands a chance of working is the Buslogic 946. It purports to be Adaptec 1540 compatable, like the EISA/VESA/ISA boards in the series. I'm working on getting the Linux NCR53c810 driver stable, some one else is doing the same thing for one of the BSD flavors. Fast busmaster, often included on motherboard implementations, supposedly available for \$ 100 in card for sans BIOS (many of the PCI boards that don't include the NCR onboard still have the NCR BIOS).
>
> This covers the majority of PCI SCSI adapters on the market (Nexstor, Chaintech, Gigabyte, FIC, etc). Adaptec is shipping (see below) a FAST WIDE version of the AIC-7770 with a PCI interface, AIR is using it on their Pentium boards, but I haven't seen any board level product with it.
>
> Scott Ferris is working on the AIC-7770 driver under Linux, but I don't know of anyone doing the same thing under one of the BSDs.
>
> Emulux has a propriety FAST+WIDE PCI controller, it's unlikely that it will show up as supported under one of the BSDs or Linux anytime soon since the NCR based controllers are cheaper and more prevalant (even included on many mainboards which don't have a real price difference versus non SCSI equipped boards) and the Buslogic controllers are compatable with the 1540 so I doubt anyone will buy them.
>
> Forex is shipping a PCI SCSI adapter, I don't have details.

James Soutter (J.K.Soutter1@lut.ac.uk) asked me to add the following information on Fast-Wide-SCSI-2:

> Fast Wide SCSI-2 is sometimes incorrectly called SCSI-3. It differs from the normal Fast SCSI-2 (like the Adapted 1542B?) because it uses a 16 bit data bus rather than the more usual 8 bit bus. This improves the maximum transfer rate from 10 MB/s to 20 MB/s but requires the use of special Fast Wide SCSI-2 drives. The added performance of Fast Wide SCSI-2 will not

> necessarily improve the speed of your system. Most hard disk drives have a maximum internal transfer rate of less than 10 MB/s and so one drive alone can not flood a FAST SCSI-2 bus. In Segate's Oct 1993 product overview, only one Fast Wide SCSI-2 drive has an internal transfer rate of more than 10 MB/s (the ST12450W). Most of the drives have a maximum internal transfer rate of 6 MB/s or less, although the ST12450W is not the only exception to the rule. In conclusion, Fast Wide SCSI is designed for the file server market and will not necessarily benefit a single user workstation style system. Rather than buying a PCI system with a SCSI interface on the motherboard, or rather than waiting for the NCR driver, you could purchase a separate PCI based SCSI card. According to Drew, the only PCI SCSI option that stands a chance of working is the Buslogic 946. It purports to be Adaptec 1540 compatible, like the EISA/VESA/ISA boards in the series.
>
> Drew commented that other PCI based SCSI controllers are unlikely to be supported under Linux or the BSDs because the NCR based controllers are cheaper and more prevalent.

Ernst Kloecker (ernst@cs.tu-berlin.de) wrote:

> Talus Corporation has finished a NS/FIP driver for PCI boards with NCR SCSI. It will be shipping very soon, might even be fee because a third party might buy it of them and donate the driver to NeXT.

Not every PCI-Board has got the chip. ASUS does, and one of the J-Bond-boards does, too. Some vendors provide an alternative as you can read in Drews text...

The NCR-Chip is clever enough to work with drives formatted by other controllers, and should be no problem.

3 ASUS-Board

detailed information from heinrich@zsv.gmd.de:

- 3 PCI, 4 ISA Slots (3x16, 1x8 Bit)
- ZIF Sockel for the CPU
- room for 4 72pin-Simms (max. 128M)
- Award BIOS in Flash-Eprom
- Onboard: NCR-SCSI, 1par, 2ser (with FIFO), AT-Bus, Floppy

The board does like most in that price-class only write-through cache, no write-back. (which should not be grave, maybe 3% of performance?).

The BIOS supports scsi-drives under DOS/Windows without additional drivers, but with the board come addtitional drivers which are said to give better performance, for DOS/Windows(ASPI), OS2, Windows-NT, SCO-Unix, Netware (3.11 and 4, if interpreted correctly)

Gert Doering (gert@greenie.muc.de) was saying the SCO-Unix-driver for the onboard-SCSI-Chip was not working properly. After two or three times doing: "time dd if=/dev/rhd20 of=/dev/null bs=100k count=500" it kernel-panicked...

The trouble some people experienced with it might be due to them using an Adaptec-SCSI-Controller with "sync negotiation" turned on. Please check that in the BIOS-Setup of the Adaptec-1542C if you use one and have problems with occasional hangups!

4 Video-Cards

People have successfully used # 9 XGE Level 12, ELSA Winner 1000 boards, and others with the S3928P under Linux.

tldraben@eos.ncsu.edu said about the following cards:

- Diamond Stealth W32 – Text mode works, X11 sufferered from "pixel dust"
- ET4000/W32 – unbearable
- # 9GXEL13 – Works, virtual consoles corrupted when switched. Had to buy card from Dell.

Genoa Phantom 8900PCI card seems to work well Genoa Phantom/W32 2MB does not work in an ASUS-Board. Tseng 3000/W32i chipset seems to work well Spea-v7 mecury-lite works perfect since XFree86-2.1

ATI Graphics Ultra Pro for PCI with 2MB VRAM and an ATI68875C DAC runs great as far as dem@skyline.dayton.oh.us tells us: "It's humming right along at 1280x1024 w/256 colors @74Hz non-interlaced. Looks great."

Paradise WD90C33 PCI does lock up on screensaver/X says jbauer@badlands.NoDak.edu (John Edward Bauer)

miroChrystal 8S/PCI (1MB) S3 - no problem.

5 Motherboards

The people which answered where using the following boards:

5.1 ASUS

- Ruediger.Funck@Physik.TU-Muenchen.DE - successful, but...
- strauss@dagoba.escape.de - half-successful, works, but...
- ut@informatik.uni-kiel.d400.de - successful.
- heinrich@zsv.gmd.de - successful

- CARSTEN@AWORLD.aworld.de - successful
- egooch@mc.com - successfull - but trouble with the serialport
- archie@CS.Berkeley.EDU and his friend - successful after solving IDE-puzzle
- Lars Heinemann (lars@uni-paderborn.de) successful

5.2 Sirius SPACE

ub9x@rz.uni-karlsruhe.de - successful

5.3 Gateway-2000

kenf@clark.net - no problems except the soundcard he tries to swap dmarples@comms.eee.strathclyde.ac.uk - successful, but... robert logan (rl@de-montfort.ac.uk) - flawless. James D. Levine (jdl@netcom.com) - flawless.

5.4 Intel-Premier

grif@cs.ucr.edu - successful

5.5 Comtrade Best Buy PCI / PCI48X MB Rev 1.0

tldraben@eos.ncsu.edu - "Works, I believe it has buggy Saturn chipset"

5.6 IDeal PCI / PCI48X MB Rev 1.0

tldraben@eos.ncsu.edu - "Did not work with PCI48X motherboard"

5.7 CMD Tech. PCI IDE / CSA-6400C

tldraben@eos.ncsu.edu - "Works"

5.8 GA-486iS (Gigabyte)

Stefan.Dalibor@informatik.uni-erlangen.de - success with problems.

5.9 ESCOM 486dx2/66 - which board?

Works perfect except the ftape-streamer (archive)

5.10 J-Bond with i486dx2/66

Drew Eckhardt (drew@kinglear.cs.Colorado.EDU) - The NCR53c810 doesn't work too hot (yet), but I'm working on fixing that.

6 reports on success

6.1 zenon@resonex.com about Gateway2000 P-66

Gateway2000's P5-66 system with Intel's PCI motherboard, with 5 ISA slots and 3 PCI slots. The only PCI card I am using is the # 9 GXe level 12 PCI card (2 MB VRAM and 1 MB DRAM). This card was bought from Dell. Under Linux I am using the graphics in the 80x25 mode only (I am waiting for some XFree86 refinements before using it in 1280x1024 resolution), but under DOS/Windows I have used the card in 1280x1024x256 mode without problems. Etherlink 3C509 Ethernet card, Mitsumi bus-interface card, Adaptec 1542C SCSI interface card and additional serial/parallel ports card (which makes the total of serial ports 3).

I have total of 32 MB RAM (recognized and used by both Linux and DOS). There is also a bus mouse (Microsoft in the PS2 mode).

No problems so far.

6.2 James D. Levine (jdl@netcom.com) with Gateway2000

Gateway 2000 P5-60 with an Intel Mercury motherboard, AMI-Flash-BIOS, (1.00.03.AF1, (c)'92) 16M RAM, on-board IDE controller and an ATI AX0 (Mach32 Ultra XLR) PCI display adapter. He had absolutely no problems with the hardware so far but has not tried anything fancy, such as accelerated IDE drivers or SCSI support.

6.3 ub9x@rz.uni-karlsruhe.de with SPACE

SPACE-board, 8MB RAM, S3 805 1MB DRAM PCI 260MB Seagate IDE-Harddiskdrive because of lack of NCR53c810-Driver, 0.99pl15d, does seem to work well.

6.4 grif@cs.ucr.edu with INTEL

17 machines running a 60Mhz-i586 on Intel-Premier-PCI-Board

6.5 heinrich@zsv.gmd.de with ASUS

ASUS-PCI-Board (SP3) having:

- – Asus PCI-Board with AMD 486/dx2-66 and 16M RAM

- – Fujitsu 2196ESA 1G SCSI-II
- – Future Domain 850MEX Controller (cheap-SCSI-Controller, almost a clone to Seagates ST01... soon there should be a driver for the onboard-NCR53c810 -Controller.
- – ATI Graphics Ultra (the older one with Mach-8 Chip, ISA-Bus)
- – Slackware 1.1.1

He just exchanged the boards, plugged his cards in, connected the cables, and it worked perfect. He does not use any PCI-Cards yet, though.

6.6 CARSTEN@AWORLD.aworld.de with ASUS

ASUS-PCI-Board with 486DX66/2, miro-crystal 8s PCI driven by the S3-drivers of XFree86-2.0, not using the onboard SCSI-Chip yet because of lack of driver, but tried it on DOS, it was very fast. No problems with compatibility at all.

6.7 Lars Heinemann (lars@uni-paderborn.de) with ASUS

ASUS PCI/I-486SP3 Motherboard w/ 486DX2/66 and 16M RAM (2x8), miroChrystal 8S/PCI (1MB) S3, Soundblaster PRO, Adaptec 1542b (3.20 ROM) SCSI-Hostadapter with two harddiskdrives (Fujitsu M2694ESA u. Quantum LPS52) and a QIC-150 Streamer attached. No problems at all!

6.8 Ruediger.Funck@Physik.TU-Muenchen.DE with ASUS

ASUS PCI/I-486SP3 / i486DX2-66 / 8 MB PS/2 70 ns BIOS: Award v 4.50 CPU TO DRAM write buffer: enabled CPU TO PCI write buffer: enabled PCI TO DRAM write buffer: disabled, unchangeable CPU TO PCI burst write: enabled Miro Crystal 8s PCI - S3 P86C805 - 1MB DRAM

To use X-window he has to do restorefont -r /usr/lib/X11/savefont and restorefont -w /usr/lib/X11/savefont to get the fonts restored properly after getting to textmode from X-window-mode. I believe this has changed with XFree86(tm)-2.1

6.9 robert logan (rl@de-montfort.ac.uk with GW/2000

Gateway 2000 4DX2-66P 16 Megs RAM, PCI ATI AX0 2MB DRAM (ATI GUP). WD 2540 Hard Disk (528 Megs) CrystalScan 1776LE 17inch. (Runs up to 1280x1024) Slackware 1.1.2 (0.99pl15f)

It is giving no problems. He uses SLIP for networking and an Orchid-Soundwave-32 for niceties, awaiting the NCR-Driver. The only problem he has is that the IDE-Drive could be much faster on the PCI-IDE because it is one of the new Western Digital fast drives and in DOS/WfW it absolutely screams - on Linux it is just as slow as a good IDE-Drive.

6.10 archie@CS.Berkeley.EDU and his friend use ASUS

Archie and his friend have rather similar configurations:

- ASUS PCI-SP3 board (4 ISA, 3 PCI)
- Intel 486DX2/66
- Genoa Phantom 8900PCI card (friend: Tseng 3000/W32i chipset)
- Maxtor 345 MB IDE hard drive
- Supra 14.4 internal modem
- ViewSonic 6e monitor (Archie)
- NEC Multisync 4fge (friend)
- Slackware 1.2.0

The onboard-scsi is disabled. First there where problems with the IDE-drive: "The thing is that on the board there's a jumper which selects whether IRQ14 comes from the ISA bus or the PCI bus. The manual has an example where they show connecting it to PCI INTA. Well, we did that just like the example... but then later our IDE drive would not work (the IDE controller is on board). Had to take it back, they guys at NCA were puzzled, then traced it back to this jumper. I guess the IDE controller uses IRQ14 or something? That's not documented anywhere in the manual. Other than that, seems to be kicking ass nicely now. Running X, modeming, etc. (for the Supra you have to explicitly tell the kernel that the COM port has a 16550A using setserial (in Slackware /etc/rc.d/rc.serial))".

6.11 kenf@clark.net with G/W 2000

He uses a Gateway 2000 with no problems, except the soundcard (which one?) he now trades in for a genuine soundblaster and hopes it helps.

6.12 Joerg Wedeck (jw@peanuts.informatik.uni-tuebingen.de) / ESCOM

486 DX2/66 from ESCOM (which board?) with onboard IDE and without (!) onboard NCR-SCSI-chip. ISA-adaptec 1542cf scsi-controller instead spea v7 mercury lite (s3, PCI, 1MB), ISA-Soundblaster-16, mitsumi-cdrom (the slower one). Anything except the archive-streamer works with no problems. The spea-v7 works perfect since XFree86-2.1

6.13 ut@informatik.uni-kiel.d400.de / ASUS

ASUS-PCI board with AMD486dx40 (but actualy running at 33Mhz?!) His ISA-ET3000 Optima 1024A ISA works nice.

7 Reports of problems

7.1 hschmal@informatik.uni-rostock.de and SCSI-PCI-SC200

He reports that after plugging that card into his Pentium-board Linux does no longer boot. My first guess is that it is not supported.

7.2 dmarples@comms.eee.strathclyde.ac.uk G/W 2000

Gateway 2000 G/W 2000 4DX2/66 PCI ATI-Graphics-Ultra-Pro IDE of indetermiate make

It works nice - only the IDE-Card runs in ISA-compatibility-mode, and works a lot faster when switched into PCI-Mode by a DOS-program... thus not that fast in Linux, patch would be nice.

7.3 cip574@wpax01.physik.uni-wuerzburg.de (Frank Hofmann) / ASUS

he uses the ASUS-Board with 16MB-RAM, ISA-based S3/928, and the onboard-IDE-controller with a Seagate ST4550A harddisk, and had never any trouble with the newer Linux-kernels.

His problem is:

```
using X, my mouse is not responding the way I was used to before, it's sometimes behind
movement and making jumps if moved fast.  I think this was discussed In a Linux
newsgroup before (I don't know wich one) and is due to the use of 16550 serial chips for
the onboard serial interfaces.  After two weeks, I got used to it :-)
```

Reducing the threshold of the 16550 should help. There should be some patch to setserial available somewhere, but I do not know where.

7.4 axel@avalanche.cs.tu-berlin.de (Axel Mahler) / ASUS

ASUS PCI/I-486SP3 Motherboard (Award BIOS 4.50), 16 MB RAM on-Board NCR Chip is disabled, he had the Genoa Phantom/W32 2MB for PCI and a Adaptec AHA-1542CF (BIOS v2.01) connected to:

- an IBM 1.05 GB Harddisk
- a Toshiba CD-ROM (XM4101-B)
- a HP DAT-Streamer (2GB)

when creating the filesystems mke2fs (0.4, v. 1.11.93) did hang and installing was impossible. After replacing the Genoa Phantom/W32 2MB PCI with an ELSA Winner 1000 2MB PCI it works perfectly. He tested it with an old Eizo VGA-ISA and it worked as well, so the problem was in the Genoa-PCI-card.

7.5 Frank Strauss (strauss@dagoba.escape.de) / ASUS

ASUS SP3 Board i486DX2/66 NCR53c810 disabled Adaptec 1542B in ISA Slot with 2 Harddiskdrives (200MB Maxtor, 420MB Fijutsu), SyQuest 88MB and Tandberg Streamer ELSA Winner 1000 PCI, 1MB-VRAM Soundblaster Pro in ISA Slot at IRQ 5 Onboard IDE disabled Onboard serial, parallel, FD enabled

after a reset, the machine sometimes 'hangs' (soft and hard-reset the same) - this is probably not related to the Adaptec and the Soundcard, because even without these the system sometimes fails to come up. But if it runs, (and the ELSA-WINNER-1000-PCI-message appears) it runs ok.

the two serial ports are detected as 16550 as they should, but at some mailbox-sessions there was heavy data-loss at V42bis... The problem seems to be in the hardware...

CPU>-PCI-Burst seems to work well with DOS/MS-Windows

CPU->PCI-Burst does not work properly with linux0.99p15, Messing up when switching the virtual-consoles, crashing completely when calling big apps like ghostview, or xdvi, leaving the SCSI-LED on (!).

(I suspect these apps would be using a lot of CPU->PCI-burst because of the big heap of data to transmit to the PCI-Winner-1000)

After disabling CPU->PCI-Burst, it works well, the Winner-1000 at 1152x846 (not much fontcache with 1MB) does 93k xstones. OpaqueMove with twm is more than just endureable :-)

He has got a SATURN.EXE which he loads under DOS before starting Linux, helping to turn on burst without hangs...

Someone stated that these problems might go away when turning off "sync negotiation" on the Adaptec - I do not know if this is possible with the adaptec1542B too? But I guess so.

With CPU->PCI-Burst it yielded 95k xstones, so he considers it as not too grave to do without. His only problem is that he would like to run his Winner-1000 at 1152x900 which fails because it seems to take any x-resolution higher than 1024pixels as a 1280pixel-resolution, thus wasting a lot end resulting in a y-resolution of 816pixels... but this is probably no PCI-related problem. It should have gone away with XFree86-2.1

7.6 egooch@mc.com / ASUS

- BOARD ASUS PCI/I-486 SP3 RAM: 16MB (4x4M-SIMM)
- CPU 486DX33 CPU
- BIOS Ver. 4.50 (12/30/93)
- Floppy Two floppy drives (1.2 and 1.44), using ASUS on-board floppy controller
- SCSI tried both WD7000 SCSI controller and Adaptec 1542CF and worked.
- Two SCSI 320M hard drives
- SCSI NEC84 CDROM drive
- SCSI QIC150 Archive tape drive

- Video Tseng ET4000 ISA graphics card
- Sound PAS16 sound card
- Printer attached to on-board ASUS parallel port

He has nothing in the PCI-Slots yet, but wants to buy a PCI-Video-Card, currently uses WD7000 SCSI controller but will switch to the NCR-Chip onboard as soon as the driver is out.

Everything works perfect - only the first serial port which has a 14.4K-Modem attached does hang occasianly after reconnecting with the modem after having used it previously. He says that would not be unique to ASUS but rather a bug in the SMC-LSI device with its 16550UART. The logitech-serial-mouse on the second port works fine. Setting down the threshhold of the 16550 for the mouseport would definitly help, one does seem to need a special patched setserial for that? I have not got the information yet, please contact me if you know more!

7.7 Stefan.Dalibor@informatik.uni-erlangen.de / GigaByte

- Board GA-486iS from Gigabyte w/ 256Kb 2L-Cache, i486-DX2
- Bios AMI, 93/8
- SCSI no scsi-NCR-chip on-board, using Adaptec 1542C,
- Video ELSA Winner 1000
- Linux 0.99pl14 + SCSI-Clustering-Patches / Slackware 1.1.1

All seems to go well, but he has not tried neither networking, printing or a streamer yet. Before applying the Clustering- patches he had some problems with hangs triggered by "find", but this no longer is the case - perhaps it was an older kernel-bug.

The ELSA-Winner-1000 sometimes hangs. very strange patterns on the screen resolved only by booting... The dealer has told him it was a bug in the ELSA-Card, but the manufacturer claims it had solved the problem. The bug is not reproducable so he does not take any action at the moment.

All in all the machine seems to work very well using it a lot for textprocessing (emacs, LaTeX, xfig, ghostview). Interaction is surprisingly responsive, few difference from the 3 to 4-times as expensive sun he works on...

CPU->PCI-Burst is still disabled because the bios does not support the PCI-things well?

7.8 Tom Drabenstott (tldraben@eos.ncsu.edu) with Comtrade / PCI48IX

PCI48IX Motherboard Rev. 1.0. Made by ??? documentation copyrighted by "TMC". The BIOS says not very much about PCI.

His E-315E Super IDE UMC (863+865) ISA-Controller-card does make trouble. (it is a multifunction controller-card). It seems to work well under DOS/OS2 but not under Linux.

8 Conclusion

Not a clear one, yet... *sigh*... Most people seem to have set their heart on the ASUS-Board, some sucessful, some with Problems. It seems to be due to the bug in the Saturn-Chipset which does not do write-back and posting properly, ASUS seems to use that buggy version 2.0. Intel claimed that version 3 would be bugfixed and available since end of feburary. Someone stated that most of the problems would disappar when disabling "sync negotiation" on the adaptec-scsi-controller.

9 Thanks

I gathered my Information mostly by mail and by three news-postings by the following people:

CARSTEN@AWORLD.aworld.de, dmarples@comms.eee.strathclyde.ac.uk, drew@kinglear.cs.Colorado.EDU (Working at the PCI-NCR53c810-Driver), duncan@spd.eee.strathclyde.ac.uk, fm3@irz.inf.tu-dresden.de, grif@ucrengr.ucr.edu, heinrich@zsv.gmd.de, hm@ix.de (iX-Magazine), hm@seneca.ix.de, kebsch.pad@sni.de, kenf@clark.net, matthias@penthouse.boerde.de, ortloff@omega.informatik.uni-dortmund.de, preberle@cip.informatik.uni-erlangen.de, rob@me62.lbl.gov, rsi@netcom.com, sk001sp@unidui.uni-duisburg.de, strauss@dagoba.escape.de, strauss@dagoba.priconet.de, ub9x@rz.uni-karlsruhe.de, ut@informatik.uni-kiel.d400.de, Stefan.Dalibor@informatik.uni-erlangen.de, tldraben@eos.ncsu.edu, mundkur@eagle.ece.uci.edu, ooch@jericho.mc.com, Gert Doering (gert@greenie.muc.de), James D. Levine (jdl@netcom.com), archie@CS.Berkeley.EDU and his friend kenf@clark.net.

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