# Lisp as a Business Work Horse

Espen J. Vestre
Netfonds ASA
Oslo, Norway
ev@netfonds.no

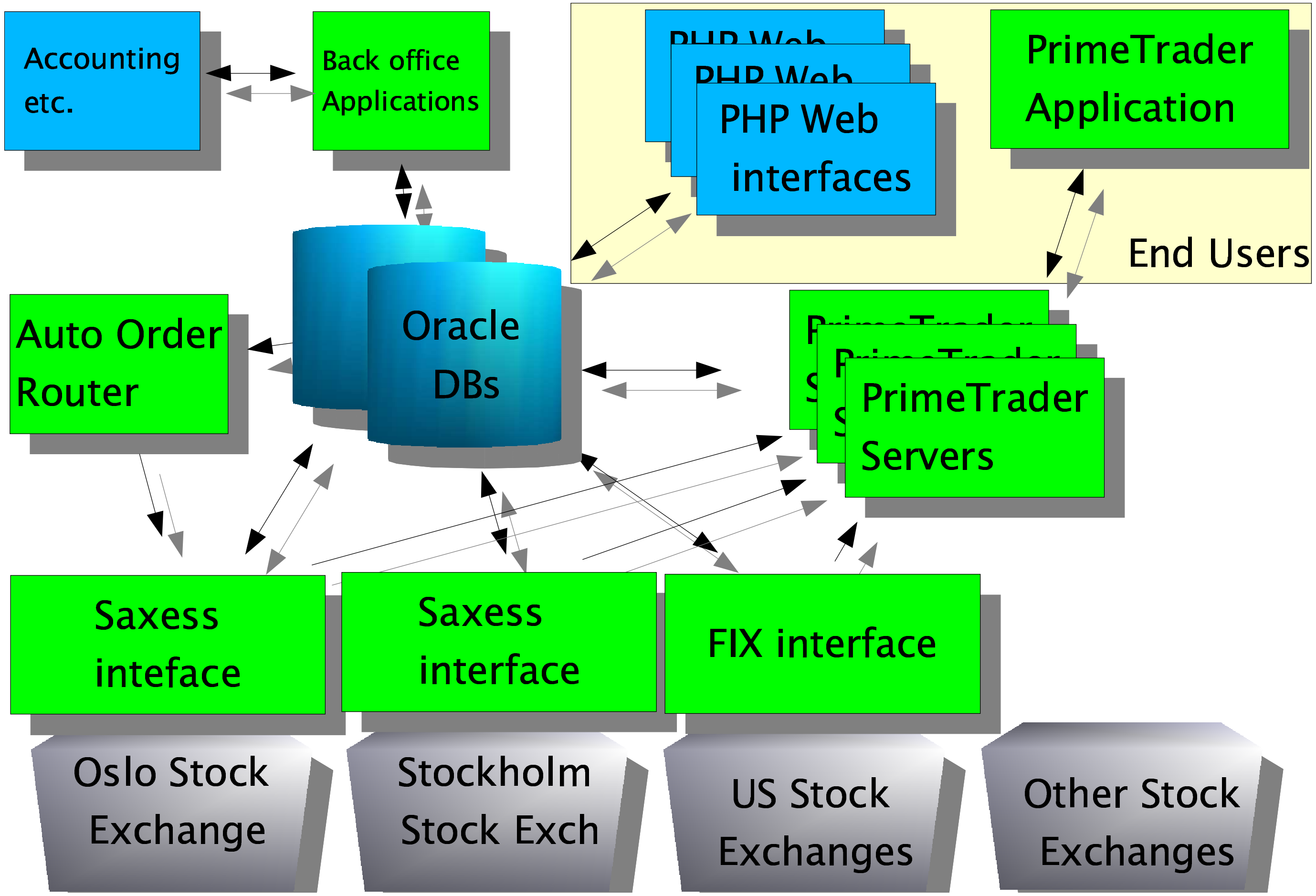
# Net Fonds

- Established 1997
- Offers Internet-based (“self serve”) stock trading
- Appr. 10% of Oslo Stock Exchange trades
- Other exchanges (e.g. Stockholm, New York)
- 11 employees
- 4 Common Lisp Developers / linux sysadmins

# Talk Overview

- Overview of systems
- “The Lisp-based Company”
- Some details from our systems and some lessons learned
- System Demo

# Simplified Systems Overview



Accounting etc.

Back office Applications

PHP Web

PHP Web

PHP Web interfaces

PrimeTrader Application

End Users

Auto Order Router

Oracle DBs

PrimeTrader S

PrimeTrader S

PrimeTrader Servers

Saxess inteface

Saxess interface

FIX interface

Oslo Stock Exchange

Stockholm Stock Exch

US Stock Exchanges

Other Stock Exchanges

# Main CL-based Components

- Feeders (provide “real time” stock quotes to internal systems)
- Auto Router (order examination and forwarding)
- Stock Exchange Interfaces (order entry, trade notifications etc.)
- “PrimeTrader” and its server (trading application)
- Back Office Applications

# Feeders / Interfaces

- Several processes talk different protocols to different stock exchanges
- Stock Quotes propagated to DB and trading application servers
- Automatic order entry, order matching
- Complex protocols with frequent protocol revisions

# End User Interfaces

- Web interfaces (Apache, PHP, Oracle)
- Prime Trader (Trading Application)
  - LispWorks CAPI application
  - Developed on linux
  - Built on
    - Linux
    - Windows
    - Mac OS X
  - Server-part also in Lisp

# The Lisp-based Company

- Net Fonds does no “rocket science”
- Lisp is our “Work Horse”
- Scripting and application development
- What's special about Net Fonds is that we use lisp for even the most trivial tasks (where others use perl)

# Net Fonds lisp background

- Emacs (gnus) developer Lars Ingebrigtsen was initially the one-man it department
- Initially, most things were done in php a little tcl, and quite a lot of emacs lisp
- Internal Broker interface is still running on emacs (with a common lisp back end).

# Flexible System Administration

- Dynamic features ideal for server applications
- All servers have lisp listeners:
  - Some servers are started from inside emacs which again runs under the control of “screen”
  - Other servers include their own eval server and accept local socket connections
- “Hot” upgrades (load fasl files into running images)
- “Hot” fixes (inspect errors in running images)

# Writing Parsers

- “Traditional” lisp stuff
- Complex, ever-changing protocols
- Auto-generation of parsers from specs (C header files or more formal specs)

# High Reliability

- Very reliable programs with less programming effort
- Servers run for months non-stop
- Upgraded and bug-fixed while they run

# Some Samples

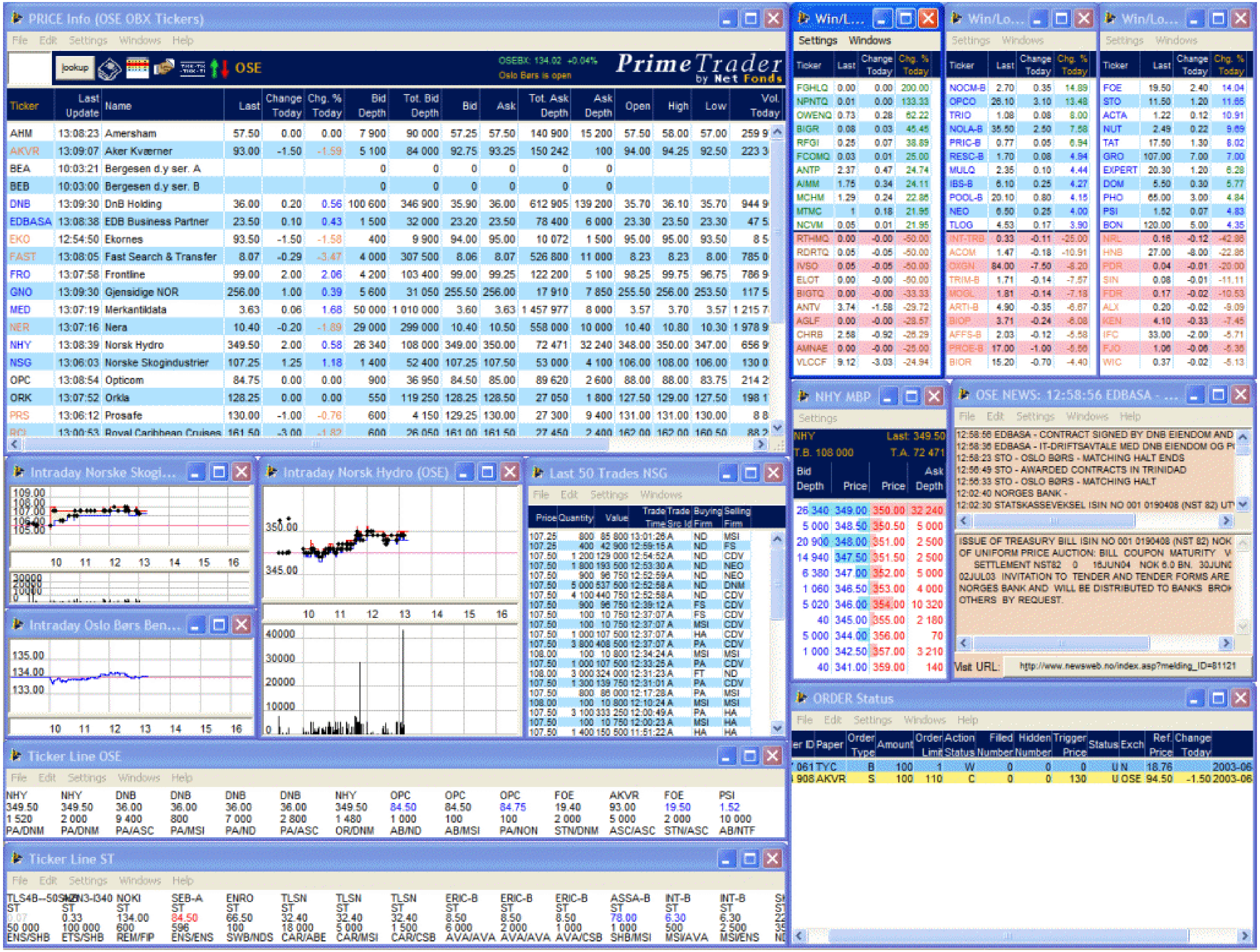
- A “taste” of what we do with CL
- Rest of talk:
  - PrimeTrader application and its server
  - Automatic patch downloads
  - Some useful server tools
  - GC considerations
  - Slave subprocesses
  - Demonstration

# PrimeTrader

- “Real-time” stock quotes
- Fast order-entry
- Order status
- Written in LispWorks with CAPI
- Windows, linux (+ bsd) and Mac OS X
- Self-contained (even its own crypto code)

# Prime Trader tech. Highlights

- Uses RSA encryption for handshaking and key transmission (all in lisp)
- Uses on-demand blowfish encryption (when transferring sensitive (personal) data)
- Automatic patch downloads
- Patches are created automatically from sexp-level diffs of CVS tagged versions
- Protocol on top of a subset of http to avoid firewall problems
- “Subscription-model” ensures low bandwidth. If your setup has only a small number of shares, you can stream stock quotes over gsm (9600bps)



| Ticker | Last Update | Name | Last | Change Today | Chg. % Today | Bid Depth | Tot. Bid Depth | Bid | Ask | Tot. Ask Depth | Ask Depth | Open | High | Low | Vol. Today |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AHM | 13:08:23 | Amersham | 57.50 | 0.00 | 0.00 | 7 900 | 90 000 | 57.25 | 57.50 | 140 900 | 15 200 | 57.50 | 58.00 | 57.00 | 259 9 |
| AKVR | 13:09:07 | Aker Kværner | 93.00 | -1.50 | -1.59 | 5 100 | 84 000 | 92.75 | 93.25 | 150 242 | 100 | 94.00 | 94.25 | 92.50 | 223 3 |
| BEA | 10:03:21 | Bergesen d.y ser. A | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | | |
| BEB | 10:03:00 | Bergesen d.y ser. B | | | | 0 | 0 | 0 | 0 | 0 | 0 | | | | |
| DNB | 13:09:30 | DnB Holding | 36.00 | 0.20 | 0.56 | 100 600 | 346 900 | 35.90 | 36.00 | 612 905 | 139 200 | 35.70 | 36.10 | 35.70 | 944 9 |
| EDBASA | 13:08:38 | EDB Business Partner | 23.50 | 0.10 | 0.43 | 1 500 | 32 000 | 23.20 | 23.50 | 78 400 | 6 000 | 23.30 | 23.50 | 23.30 | 47 5 |
| EKO | 12:54:50 | Ekornes | 93.50 | -1.50 | -1.58 | 400 | 9 900 | 94.00 | 95.00 | 10 072 | 1 500 | 95.00 | 95.00 | 93.50 | 8 5 |
| FAST | 13:08:05 | Fast Search & Transfer | 8.07 | -0.29 | -3.47 | 4 000 | 307 500 | 8.06 | 8.07 | 526 800 | 11 000 | 8.23 | 8.23 | 8.00 | 785 0 |
| FRO | 13:07:58 | Frontline | 99.00 | 2.00 | 2.06 | 4 200 | 103 400 | 99.00 | 99.25 | 122 200 | 5 100 | 98.25 | 99.75 | 96.75 | 786 9 |
| GNO | 13:09:30 | Gjensidige NOR | 256.00 | 1.00 | 0.39 | 5 600 | 31 050 | 255.50 | 256.00 | 17 910 | 7 850 | 255.50 | 256.00 | 253.50 | 117 5 |
| MED | 13:07:19 | Merkantildata | 3.63 | 0.06 | 1.68 | 50 000 | 1 010 000 | 3.60 | 3.63 | 1 457 977 | 8 000 | 3.57 | 3.70 | 3.57 | 1 215 7 |
| NER | 13:07:16 | Nera | 10.40 | -0.20 | -1.89 | 29 000 | 299 000 | 10.40 | 10.50 | 558 000 | 10 000 | 10.40 | 10.80 | 10.30 | 1 978 9 |
| NHY | 13:08:39 | Norsk Hydro | 349.50 | 2.00 | 0.58 | 26 340 | 108 000 | 349.00 | 350.00 | 72 471 | 32 240 | 348.00 | 350.00 | 347.00 | 656 9 |
| NSG | 13:06:03 | Norske Skogindustrier | 107.25 | 1.25 | 1.18 | 1 400 | 52 400 | 107.25 | 107.50 | 53 000 | 4 100 | 106.00 | 108.00 | 106.00 | 130 0 |
| OPC | 13:08:54 | Opticom | 84.75 | 0.00 | 0.00 | 900 | 36 950 | 84.50 | 85.00 | 89 620 | 2 600 | 88.00 | 88.00 | 83.75 | 214 2 |
| ORK | 13:07:52 | Orkla | 128.25 | 0.00 | 0.00 | 550 | 119 250 | 128.25 | 128.50 | 27 050 | 1 800 | 127.50 | 129.00 | 127.50 | 198 1 |
| PRS | 13:06:12 | Prosafe | 130.00 | -1.00 | -0.76 | 600 | 4 150 | 129.25 | 130.00 | 27 300 | 9 400 | 131.00 | 131.00 | 130.00 | 8 8 |
| RCI | 13:00:53 | Royal Caribbean Cruises | 161.50 | -3.00 | -1.82 | 600 | 26 050 | 161.00 | 161.50 | 27 450 | 2 400 | 162.00 | 162.00 | 160.50 | 88 2 |

| Ticker | Last | Change Today | Chg. % Today |
|---|---|---|---|
| FGHLQ | 0.00 | 0.00 | 200.00 |
| NPNTQ | 0.01 | 0.00 | 133.33 |
| OWENQ | 0.73 | 0.28 | 62.22 |
| BIGR | 0.08 | 0.03 | 45.45 |
| RFGI | 0.25 | 0.07 | 38.89 |
| FCOMQ | 0.03 | 0.01 | 25.00 |
| ANTP | 2.37 | 0.47 | 24.74 |
| AIMM | 1.75 | 0.34 | 24.11 |
| MCHM | 1.29 | 0.24 | 22.86 |
| MTMC | 1 | 0.18 | 21.95 |
| NCVM | 0.05 | 0.01 | 21.95 |
| RTHMQ | 0.00 | -0.00 | -50.00 |
| RDRTQ | 0.05 | -0.05 | -50.00 |
| IVSO | 0.05 | -0.05 | -50.00 |
| ELOT | 0.00 | -0.00 | -50.00 |
| BIGTQ | 0.00 | -0.00 | -33.33 |
| ANTV | 3.74 | -1.58 | -29.72 |
| AGLF | 0.00 | -0.00 | -28.57 |
| CHRB | 2.58 | -0.92 | -26.29 |
| AMNAE | 0.00 | -0.00 | -25.00 |
| VLCCF | 9.12 | -3.03 | -24.94 |

| Ticker | Last | Change Today | Chg. % Today |
|---|---|---|---|
| NOCM-B | 2.70 | 0.35 | 14.89 |
| OPCO | 26.10 | 3.10 | 13.48 |
| TRIO | 1.08 | 0.08 | 8.00 |
| NOLA-B | 35.50 | 2.50 | 7.58 |
| PRIC-B | 0.77 | 0.05 | 6.94 |
| RESC-B | 1.70 | 0.08 | 4.94 |
| MULQ | 2.35 | 0.10 | 4.44 |
| IBS-B | 6.10 | 0.25 | 4.27 |
| POOL-B | 20.10 | 0.80 | 4.15 |
| NEO | 6.50 | 0.25 | 4.00 |
| TLOG | 4.53 | 0.17 | 3.90 |
| INT-TRB | 0.33 | -0.11 | -25.00 |
| ACOM | 1.47 | -0.18 | -10.91 |
| OXGN | 84.00 | -7.50 | -8.20 |
| TRIM-B | 1.71 | -0.14 | -7.57 |
| MOGL | 1.81 | -0.14 | -7.18 |
| ARTI-B | 4.90 | -0.35 | -6.67 |
| BIOP | 3.71 | -0.24 | -6.08 |
| AFFS-B | 2.03 | -0.12 | -5.58 |
| PROE-B | 17.00 | -1.00 | -5.56 |
| BIOR | 15.20 | -0.70 | -4.40 |

| Ticker | Last | Change Today | Chg. % Today |
|---|---|---|---|
| FOE | 19.50 | 2.40 | 14.04 |
| STO | 11.50 | 1.20 | 11.65 |
| ACTA | 1.22 | 0.12 | 10.91 |
| NUT | 2.49 | 0.22 | 9.69 |
| TAT | 17.50 | 1.30 | 8.02 |
| GRO | 107.00 | 7.00 | 7.00 |
| EXPERT | 20.30 | 1.20 | 6.28 |
| DOM | 5.50 | 0.30 | 5.77 |
| PHO | 65.00 | 3.00 | 4.84 |
| PSI | 1.52 | 0.07 | 4.83 |
| BON | 120.00 | 5.00 | 4.35 |
| NRL | 0.16 | -0.12 | -42.86 |
| HNB | 27.00 | -8.00 | -22.86 |
| PDR | 0.04 | -0.01 | -20.00 |
| SIN | 0.08 | -0.01 | -11.11 |
| FDR | 0.17 | -0.02 | -10.53 |
| ALX | 0.20 | -0.02 | -9.09 |
| KEN | 4.10 | -0.33 | -7.45 |
| IFC | 33.00 | -2.00 | -5.71 |
| FJO | 1.06 | -0.06 | -5.36 |
| WIC | 0.37 | -0.02 | -5.13 |

| Price | Quantity | Value | Trade Time | Trade Src Id | Buying Firm | Selling Firm |
|---|---|---|---|---|---|---|
| 107.25 | 800 | 85 800 | 13:01:26 | A | ND | MSI |
| 107.25 | 400 | 42 900 | 12:59:15 | A | ND | FS |
| 107.50 | 1 200 | 129 000 | 12:54:52 | A | ND | CDV |
| 107.50 | 1 800 | 193 500 | 12:53:30 | A | ND | NEO |
| 107.50 | 900 | 96 750 | 12:52:59 | A | ND | NEO |
| 107.50 | 5 000 | 537 500 | 12:52:58 | A | ND | DNM |
| 107.50 | 4 100 | 440 750 | 12:52:58 | A | ND | CDV |
| 107.50 | 900 | 96 750 | 12:39:12 | A | FS | CDV |
| 107.50 | 100 | 10 750 | 12:37:07 | A | FS | CDV |
| 107.50 | 100 | 10 750 | 12:37:07 | A | MSI | CDV |
| 107.50 | 1 000 | 107 500 | 12:37:07 | A | HA | CDV |
| 107.50 | 3 800 | 408 500 | 12:37:07 | A | PA | CDV |
| 108.00 | 100 | 10 800 | 12:34:24 | A | MSI | MSI |
| 107.50 | 1 000 | 107 500 | 12:33:25 | A | PA | CDV |
| 108.00 | 3 000 | 324 000 | 12:31:23 | A | FT | ND |
| 107.50 | 1 300 | 139 750 | 12:31:01 | A | PA | CDV |
| 107.50 | 800 | 86 000 | 12:17:28 | A | PA | MSI |
| 108.00 | 100 | 10 800 | 12:10:24 | A | MSI | MSI |
| 107.50 | 3 100 | 333 250 | 12:00:49 | A | PA | HA |
| 107.50 | 100 | 10 750 | 12:00:23 | A | MSI | HA |
| 107.50 | 1 400 | 150 500 | 11:51:22 | A | HA | HA |

NHY Last: 349.50
T.B. 108 000 T.A. 72 471

| Bid Depth | Price | Price | Ask Depth |
|---|---|---|---|
| 26 340 | 349.00 | 350.00 | 32 240 |
| 5 000 | 348.50 | 350.50 | 5 000 |
| 20 900 | 348.00 | 351.00 | 2 500 |
| 14 940 | 347.50 | 351.50 | 2 500 |
| 6 380 | 347.00 | 352.00 | 5 000 |
| 1 060 | 346.50 | 353.00 | 4 000 |
| 5 020 | 346.00 | 354.00 | 10 320 |
| 40 | 345.00 | 355.00 | 2 180 |
| 5 000 | 344.00 | 356.00 | 70 |
| 1 000 | 342.50 | 357.00 | 3 210 |
| 40 | 341.00 | 359.00 | 140 |

OSE NEWS: 12:58:56 EDBASA - ...
File Edit Settings Windows Help

```
12:58:56 EDBASA - CONTRACT SIGNED BY DNB EIENDOM AND
12:58:36 EDBASA - IT-DRIFTSAVTALE MED DNB EIENDOM OG P
12:58:23 STO - OSLO BØRS - MATCHING HALT ENDS
12:56:49 STO - AWARDED CONTRACTS IN TRINIDAD
12:56:33 STO - OSLO BØRS - MATCHING HALT
12:02:40 NORGES BANK -
12:02:30 STATSKASSEVEKSEL ISIN NO 001 0190408 (NST 82) UT
```

```
ISSUE OF TREASURY BILL ISIN NO 001 0190408 (NST 82) NOK
OF UNIFORM PRICE AUCTION: BILL  COUPON  MATURITY  V
    SETTLEMENT NST82   0    16JUN04   NOK 6.0 BN.  30JUN
02JUL03  INVITATION TO  TENDER AND TENDER FORMS ARE
NORGES BANK AND  WILL BE DISTRIBUTED TO BANKS  BRO
OTHERS  BY REQUEST.
```

Visit URL: http://www.newsweb.no/index.asp?melding_ID=81121

| er ID | Paper | Order Type | Amount | Order Limit | Action Status | Filled Number | Hidden Number | Trigger Price | Status | Exch | Ref. Price | Change Today | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 061 | TYC | B | 100 | 1 | W | 0 | 0 | 0 | U | N | 18.76 | | 2003-06 |
| 4 908 | AKVR | S | 100 | 110 | C | 0 | 0 | 130 | U | OSE | 94.50 | -1.50 | 2003-06 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NHY | NHY | DNB | DNB | DNB | DNB | NHY | OPC | OPC | OPC | FOE | AKVR | FOE | PSI |
| 349.50 | 349.50 | 36.00 | 36.00 | 36.00 | 36.00 | 349.50 | 84.50 | 84.50 | 84.75 | 19.40 | 93.00 | 19.50 | 1.52 |
| 1 520 | 2 000 | 9 400 | 800 | 7 000 | 2 800 | 1 480 | 1 000 | 100 | 100 | 2 000 | 5 000 | 2 000 | 10 000 |
| PA/DNM | PA/DNM | PA/ASC | PA/MSI | PA/ND | PA/ASC | OR/DNM | AB/ND | AB/MSI | PA/NON | STN/DNM | ASC/ASC | STN/ASC | AB/NTF |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TLS4B--50S | HZN3-I340 | NOKI | SEB-A | ENRO | TLSN | TLSN | TLSN | ERIC-B | ERIC-B | ERIC-B | ASSA-B | INT-B | INT-B | SI |
| ST | ST | ST | ST | ST | ST | ST | ST | ST | ST | ST | ST | ST | ST | ST |
| 0.07 | 0.33 | 134.00 | 84.50 | 66.50 | 32.40 | 32.40 | 32.40 | 8.50 | 8.50 | 8.50 | 78.00 | 6.30 | 6.30 | 22 |
| 50 000 | 100 000 | 600 | 596 | 100 | 18 000 | 5 000 | 1 500 | 6 000 | 2 000 | 1 000 | 1 000 | 500 | 2 500 | 35 |
| ENS/SHB | ETS/SHB | REM/FIP | ENS/ENS | SWB/NDS | CAR/ABE | CAR/MSI | CAR/CSB | AVA/AVA | AVA/AVA | AVA/CSB | SHB/MSI | MSI/AVA | MSI/ENS | NI |

# Automatic patching

```
(defmethod install-patch ((patch nftp:patch))
  (unless (find patch *installed-patches*)
    (set-status "Downloading ~a" (nftp:patch-name-of patch))
    (handler-case (download-patch patch)
      (error (cond) (error "Error during patch download: ~a" cond)))
    (set-status "Verifying ~a" (nftp:patch-name-of patch))
    (verify-sha1 patch)
    (set-status "Loading ~a" (nftp:patch-name-of patch))
    (load-patch patch)
    (set-status "Updating patch info")
    (push patch *installed-patches*)
    (recompute-active)
    (save-patch-file)))

(defmethod download-patch ((patch nftp:patch))
  (http:get-url (nftp:url-of patch)
                (patch-local-pathname patch)))
```

# Some Useful Tools for Servers

- eval-srv.lisp: Connect to a lisp listener to do system maintenance on live server
- cron.lisp: Similar to unix *cron* – run scheduled reoccuring tasks
- at.lisp: Similar to unix *at* – run tasks once at given time
- logger.lisp: Log important events, rotate and compress log files

# cron.lisp

- Possibly do a global GC (every hour)
- Idle Job Killer: Remove state of aborted/inactive sessions (every minute)
- Refresh stock exchange info (every morning)
- Regenerate stock “watch lists” (every hour)
- Log the number of logged-in users (every minute)
- Rotate and compress logs (every midnight)
- Regenerate eval-server password (every hour)

# GC considerations

- Lots of data live long enough to be moved to LispWorks generation 2
- Gen. 2 GC a little too time consuming (3-4 seconds) for a time-critical application (*)
- Solution: Manual gen. 2 GC. Let image grow to (up to) 300MB – Full GC usually only once a day, early morning before stock trading starts

(*) on a linux server (~2Ghz, 1GB) with up to 100 simultanous LispWorks threads and more than 100MB allocated

# Slave Subprocesses

- Problem: Oracle calls block the lisp process
- Consequences in PrimeTrader: Unacceptable halts of the stock quote streaming threads, inpredictable delays in stock order entry.
- Solution: Use a pool of sub-processes (each a simple, standalone lisp application), communicate with them through pipes and with one “master thread” per “slave” sub process

# The lispslave program

```
(defun lispslave ()
  (let ((*error-output* system::*null-stream*))
    (ignore-errors
      (loop for error = nil
            for form = (handler-case (read)
                         (stream-error (cond)
                                       (error cond))
                         (error (cond) (setf error cond)))
            while (not (eq form :exit))
            do
            (let ((id (first form)))
              (unless error
                (let ((result (handler-case (eval `(multiple-value-list
,(rest form)))
                                (error (cond) (setf error cond)))))
                  (when (and result (not error))
                    (print-result id result))))
              (when error (print-error id error)))))))

(defun print-result (id reslist &optional (stream t))
  (let ((*print-readbly* t))
    (format stream "~&~s~%" `(,id NIL ,reslist))
    (force-output stream)))

(defun print-error (id cond &optional (stream t))
  (format stream "~&~s~%" `(,id ERR ,(type-of cond),(format nil "~a"
cond)))
  (force-output stream))
```

# Lispmaster

```
(defmacro with-slave-evaluation (&rest forms)
  `(slave-eval '(progn ,@forms)))

(defun slave-eval (form)
  (let ((pair (list form)))
    (lq:enqueue pair *eval-queue*)
    (unless
        (mp:process-wait-with-timeout "waiting for result"
                                      *slave-timeout*
                                      #'rest pair)
      (error "No response from slave subprocess"))
    (let ((result (rest pair)))
      (if (first result)
          (error (format nil "~a error in lispslave: ~a"
                         (second result)
                         (third result)))
        (values-list (second result))))))
```

# Lispmaster

```
(defun master-loop ()
  (push mp:*current-process* *slaves*)
  (let ((*id* 0))
    (loop
     (with-open-stream (s (open-slave))
       (ignore-errors
         (loop
          (mp:process-wait "Waiting for Queue"
                           #'lq:non-empty-queue-p
                           *eval-queue*)
          (let ((q-ent (lq:pop-queue *eval-queue*)))
            (when q-ent
              (process-job q-ent s))))))
     (sleep 5.0))))

(defun process-job (x s)
  (setf (rest x)(eval-in-slave (first x) s)))
```

# Conclusion

HAVING MORE FUN
WHILE DOING LESS WORK!

# System Demo

- Just a moment...

Starting up...

Trying (localhost 8001 )