

# Linux Kernel Development: Getting Started

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# Agenda

- Timetable: began life as a 3-hour tutorial
- Just hitting highlights today
- Full presentation URL later
  
- Abstract:
- Linux development is fast-paced and [as they say in Oregon] “things are different here.” This tutorial introduces some of the Linux culture and how to succeed when working with the Linux development community.

# Topics

- Open source development style, values, culture
- Linux rapid development cycle
- Testing
  
- Linux “maintainers” and hierarchy
- Communications methods
  
- Getting Involved
- Coding style
- How to submit Linux kernel patches
- Some best known practices
  
- **and OMITTED today:**
- Legal/Licenses
- Working in the kernel tree

# Major Goals

- Learn how to work successfully in the Linux kernel culture
- Learn how to contribute to Linux kernel development thru kernel testing and patches

# Development Style, Values, and Culture

- Learning curve, things are different
- Meritocracy – good ideas & good code are rewarded
- Chance to work on a real OS – any parts of it that interest you
- Massive amounts of open communication via email, IRC, etc. (i.e., not private)

# Linux Culture

- Work in open, not behind closed doors (in smoke-filled rooms) #
- Community allegiance is very high
- Do what is right for Linux
- Meritocracy: good ideas and good code are rewarded
- Often driven by ideals and pragmatism, bottom-up development
- Not driven by marketing requirements
- Don't just take, give back too: #
  - Modifications are & remain GPL (if distributed)
  - Payment in kind, self-interest
  - Improve software quality, features used/understood more

# Linux Culture (2)

- Committed to following and using standards (e.g., POSIX, IETF)
- Committed to compatibility with other system software
- Informal design/development: Not much external high-level project planning or design docs (maybe some internally at companies); can appear to be chaotic
- New ideas best presented as code, not specifications or requirements
- RERO: Release Early, Release Often -- for comments, help, testing, community acceptance #
- Possible downsides: flames, embarrassment

# Linux Culture (3)

- Development community is highly technical
- Motivated and committed, but since many are volunteers, treat them with respect and ask/influence them, don't tell
- Continuous code review (including security)
- Continuous improvement
- Have fun!! :)
- **Follow the culture**

# Linux Development Values

- Scratch your own itch
- Weekenders -> big business
- Code, not talk
- Pragmatism, not theory
- Thick skin
- Code producer makes [most] decisions
- Pride, principles, ethics, honesty
- Performance
- Hardware & software vendor neutral
- Technical merit, not politics, who, or money
- Maintainability & aesthetics: clean implementation, not ugly hacks (coding style)
- Peer review of patches (technical & style)
- Contributions earn respect

# Some Things to Avoid

- Patents, binary modules, NDA
- Proprietary benchmarks
- Huge patch files
- Adding more IOCTLs
- Marketing
- Design documents
- Mention of accomplishments outside of the open source world
- No patch rationale
- How do I intercept a system call (or replace a syscall table entry)?
- Making demands instead of requests
- This {driver / feature} must be merged, it's important to our company.
- Date or release version requirements

# Some Good Terms to Use

- Simpler
- Deletes N lines of code
- Faster (with data)
- Smaller (with data)
- Here's the code....
- Series of small patches....
- Tested... (how many configs)
- Builds on 8 architectures

# Development Cycle

- Moved from split “stable” (2.even) and “development” (2.odd) trees – caused delay and backport mania
- Now accepting development patches into the -mm patchset and moving them to the mainline kernel tree after a shakeout period (e.g., 2.6.11-mm3)
- 2.6.x kernel version cycle: make patches against Linus's tree (unless they only apply to some other tree or patchset)
- Time between 2.6.x releases, intermediate 2.6.x-rcN
- Nightly snapshots; automated builds of releases; commits mailing list
- 2.6.x.y stable kernel patches

# Development Cycles

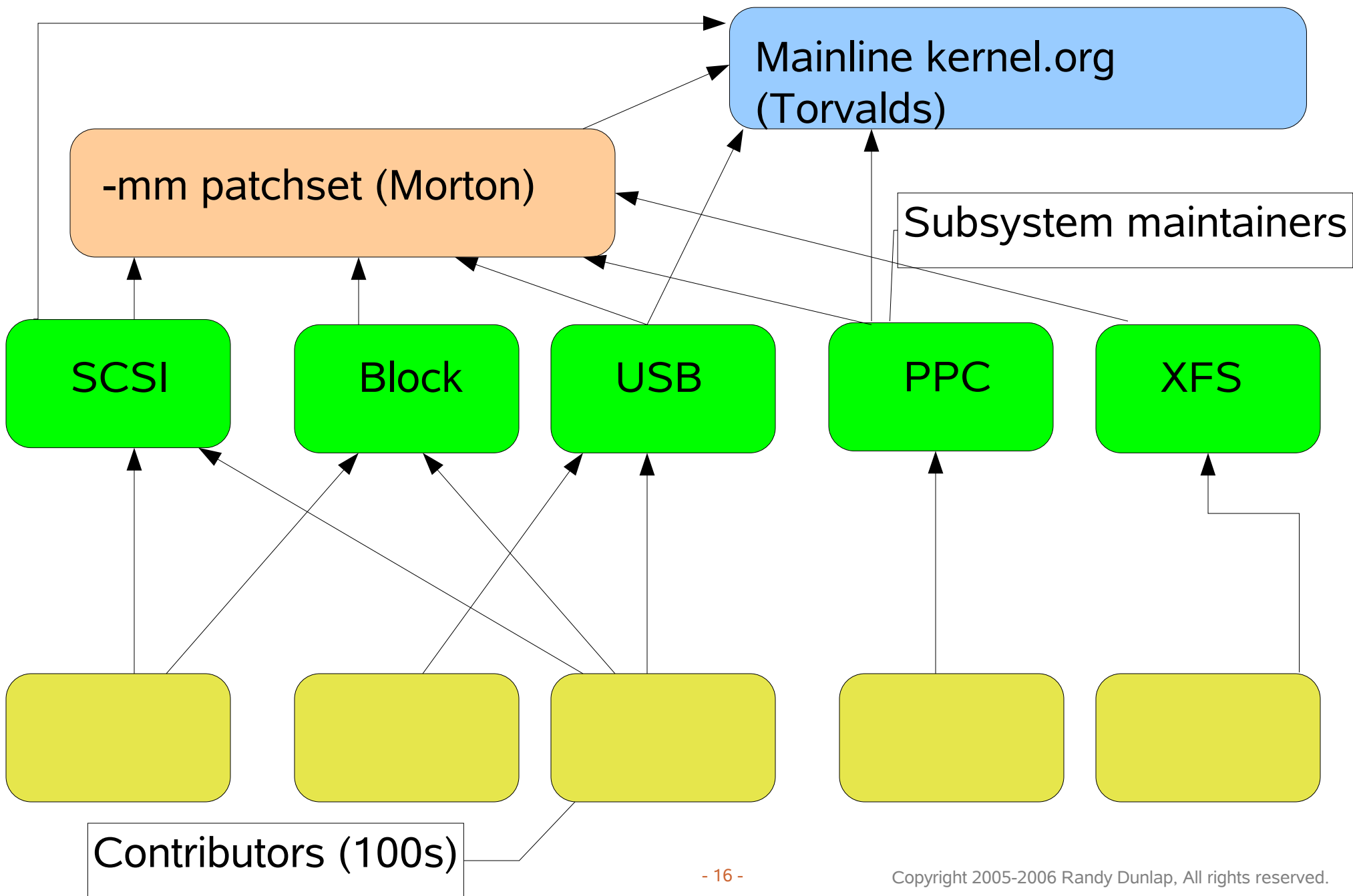
- Rapid development cycle, no timelines/schedules
- Only online documentation has a chance of being up-to-date
- Accommodate large changes and high rate of change without regressions
- Open discussion (mailing lists, archives, not private) #
- RERO, facilitates testing on a large variety of platforms #
- Maintainers available and accessible, don't disappear for long periods of time
- Test suites
- Bug tracking

# Rates of Kernel Change

- first six months of 2.4 devel: -220,000 lines, +600,000 lines
- first six months of 2.6 devel: -600,000 lines, +900,000 lines
  - 1.5M lines changed in a 6.2M line tree
  - 64 MB diff in six months - and that's the stable kernel
- Current 2.6.11 -> 2.6.12-rc4 (10 weeks): 729 K lines, 22 MB diff
- Current 2.6.12-rc4-mm1 patchset: 414 K lines, 13 MB diff



# Merges to Mainline (with exceptions)



# Kernel Testing

- Part of the RERO culture
- You can contribute to Linux kernel development just by testing new kernels (stable and development branches or other trees that you are interested in, such as USB, ATA, ACPI, filesystems)
- Report bugs to the linux-kernel mailing list or project mailing lists or on <http://bugzilla.kernel.org> or (same) <http://bugme.osdl.org>

# Kernel Testing Software

- LTP: <http://ltp.sourceforge.net>
- Open POSIX test suite:  
<http://posixtest.sourceforge.net>
- OSDL PLM for building and cross-building patches:  
<http://www.osdl.org/plm-cgi/plm/>
- OSDL STP framework and servers:  
<http://www.osdl.org/stp/>
- <http://test.kernel.org> frequent tests & reports
- Virtualization for testing: UML, qemu, bochs, XEN:  
see the Linux virtualization summary:  
[http://www.linuxsymposium.org/proceedings/reprints/  
Reprint-Wright-OLS2004.pdf](http://www.linuxsymposium.org/proceedings/reprints/Reprint-Wright-OLS2004.pdf)

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- How to submit Linux kernel patches
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# Maintainers and Hierarchy

- Loose hierarchy with “benevolent dictator”
- Kernel series maintainers (2.6) – Linus and Andrew Morton
- Patch (“stable”) maintainers (2.6.x.y) – Greg Kroah-Hartman and Chris Wright
- Top-level maintainers are gatekeepers, integrators, tiebreakers or overrulers when needed
- Delegate to lieutenants and individual maintainers; share the load
- Strong trust system -> begin with small patches for credibility
- Lower-level maintainers don't have absolute authority

# Maintainers & Hierarchy (2)

- Kernel Janitors, security kernels, some embedded support
- Arch and subsystem maintainers: coordinate subsystems and maintain consistency
- Driver maintainers: cover all current mainline kernels and update to new kernel APIs, even development APIs
- See files: `linux/MAINTAINERS` and `linux/CREDITS`

# Communications

- Communicating is hard, let's go shopping
- Writing ideas/thoughts down is good (but too wordy may be ignored)
- Participate constructively
- Mailing lists & archives (newsgroups)
- Working in open/public (technical readers/writers) vs. embarrassment
- Discussion and decisions on lists, no meetings required
- Work through concensus (with exceptions)
- Project web pages, IRC channels (in References)
- Developer conferences

# Mailing List Etiquette

- Use Reply-to-All, threaded (Message-ID, References)
  - > > Try A or B.
  - > I prefer A, sound OK?
  - yes
- Be prompt with replies (being responsive is important)
- No encoded or zipped attachments (inline preferred, text/plain attachments OK); others are often ignored
- No HTML or commercial email, no auto-replies (OOO/vacation)
- ALL CAPS == SHOUTING; rude, don't do it
- Use < 80-column width lines (70-72 is good) for text (not for patches)

# Mailing List Etiquette (2)

- Keep it technical and professional. If attacked (flamed), stick with technical points, don't get involved with attacks, & move on.
- Trim replies (body) to relevant bits (don't modify To:/Cc: recipient list).
- Don't cross-post to closed mailing lists.
- Non-English speakers
- <http://www.arm.linux.org.uk/armlinux/mletiquette.php>
- RFC 1855: Netiquette Guidelines:  
<http://www.ietf.org/rfc/rfc1855.txt>

# Mailing List Etiquette: No top-posting

- A: [http://en.wikipedia.org/wiki/Top\\_post](http://en.wikipedia.org/wiki/Top_post)

Q: Where do I find info about this thing called top-posting?

A: Because it messes up the order in which people normally read text.

Q: Why is top-posting such a bad thing?

A: Top-posting.

Q: What is the most annoying thing in e-mail?

A: No.

Q: Should I include quotations after my reply?

# Development Conferences

- Linux Symposium (Ottawa, July)
- Linux Conference AU (LCA, usually March-April)
- LinuxTag (Germany, June)
- Linux Kongress (Germany, September)
- Kernel (July), GCC (June), Desktop (July) summits
- Focused mini-summits (networking, power management, storage management, filesystems, wireless, desktop)

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# Getting Involved in Kernel Development

- Testing, feedback/results
- Learn some basics at <http://kernelnewbies.org>
- Find some small tasks that are identified at <http://www.kerneljanitors.org>
- Focus on an area that you are interested in (many to choose from)
- Can just fix compile/build/sparse problems as an introduction
- Fix bugs in the bugzilla database at <http://bugzilla.kernel.org>
- Add to kernel documentation

# Coding Style

- **Clean code, not for other OS-es or for other Linux versions**
- **Keep it looking like Linux code for readability, maintainability, debugging, etc.**
- Documentation/: CodingStyle, SubmittingPatches, SubmittingDrivers, SubmitChecklist, & web pages

# Coding Style (2)

- Use comments, but not for obvious code
- Drivers, filesystems, etc., are not arch-specific (must be arch-portable)
- Follow style in surrounding code
- Very minimal use of typedefs (only for basic types)
- Minimize use of `#ifdef` in C source files, use stubs in header files instead (as much as possible/feasible)
- Don't use `#ifdefs` to support multiple kernel versions
- Linux kernel is written in C, not C++
- Use `/* ... */` for comments (not `//`)
- Function comments in “kernel-doc” style

# Coding Style (3)

- Use C99-style struct initializers
- Use tabs for indentation, not spaces (Tab size is 8)
- Don't disable or ignore compiler/build warnings
- Use 'sparse' static checker for even more warnings
  - `$ make C=1 ...`
- Use 'make checkstack', 'make namespacecheck' to check for details; and watch for/fix build warnings
- Don't make functions or data global unless needed (mostly 'static')
- Don't use deprecated kernel APIs

# Coding Style (5) (Policies)

- Don't abuse the kernel stack (it's small)
- Don't use recursion (sometimes OK if it has a low bound)
- Push data conversions (like graphics) to userspace
- Don't use or depend on BIOS calls or data except during kernel init, and then as little as possible

# How to Submit Linux Kernel Patches

- Patch -current mainline from kernel.org or -mm patchset
- Send patches to subsystem maintainer, driver maintainer, & mailing list #
- Each patch (re-)submission should include feature justification and explanation, not just the patch #
- Use the DCO (“Signed-off-by: Your Name [your.name@example.com](mailto:your.name@example.com)”) #
- Patches should be encapsulated (self-contained) as much as possible, not touching other code (when that makes sense) #

# Submitting Patches (2)

- ONE patch per email, logical progression of patches, not mega-patches, not attached and not zipped (cannot review/reply) #
- Don't do multiple things in one patch (like fix a bug and do some cleanup)
- Check your email client: send a patch to yourself and see that it still applies (doesn't damage whitespace, line breaks, content changed) before going public with it
- Patch must apply with 'patch -p1'; i.e., use expected directory levels
- Don't use PGP or GPG with patches, they mess up patch scripts

## Some Best-Known Practices #

- Send patches directly to their intended maintainer for merging (they don't troll mailing lists looking for patches to merge)
- Copy patches to the appropriate mailing list(s), not private (don't work in isolation)
- Subscribe to relevant mailing lists (or use one representative for this)
- Listen to review feedback and promptly respond to it

## Best Known Practices (2) #

- Some maintainers do not acknowledge when they merge a patch; you just have to keep watching
- Use correct 'diff' directory level (linux/ top-level directory) and options (-up)
- Use source code to convey ideas
- Generate patch files against the latest development tree branch (-rcN) or mainline kernel if there is no current development branch
- Make focused patches or a series of patches, not large patches that cover many areas or that just synchronize a (CVS) repository with the kernel source tree

## Best Known Practices (3) #

- Include Copyright and license:  
`MODULE_LICENSE("GPL");`
- Use an email client that supports inserting patches inline (not as attachments)
- Begin with small patches: use kernel-janitor m-list
- For larger patches or complete drivers or features, use the kernel-mentors m-list (for beginner feedback/comments/corrections)
- Don't post private email replies to a public m-list (without permission)
- Don't introduce gratuitous whitespace changes in patches

# Best Known Practices (4) #

- Back up your patch with performance data (if applicable)
- Don't add binary IOCTLs unless there are no other acceptable options; use sysfs (/sys) or private-fs or debug-fs or relayfs or netlink if possible
- Make Linux drivers that are native Linux drivers, not a shim from another OS
- Don't introduce kernel drivers if the same functionality can be done reasonably in userspace
- Try to be processor- and distro-agnostic (except for CPU-specific code)
- Don't be afraid to accept patches from others

# Best Known Practices (5) #

- Keep your patch(es) updated for the current kernel version
- Resubmit patches if they are not receiving comments
- Release early, release often
- Open, public discussion on mailing lists
- One patch per email
- Large patches should be split into logical pieces and mailed as a patch series
- Make testing tools available & easy to use; your device(s) will get better testing

# References

- Mailing lists
- Web pages

# Related Documentation

- lwn.net articles: <http://lwn.net/Articles/driver-porting/>
- LDD3 book: <http://lwn.net/Kernel/LDD3/>
- Driver “DOs and DON'Ts”: at the KJ web site
- Arjan: How Not to Write a Driver (OLS 2002 proceedings or <http://www.fenrus.org/how-to-not-write-a-device-driver-{paper,slides}.pdf> )
- Greg (PCI, USB maintainer): Coding Style, Writing Portable Code, et al (<http://www.kroah.com/linux/>)

# References

- <http://www.linuxsymposium.org/2005/> - OLS proceedings
- This full presentation:  
<http://www.xenotime.net/mentor/linux-mentoring-2006.pc>
- Andrew (top kernel maintainer): TPP: The Perfect Patch:  
<http://www.zip.com.au/~akpm/linux/patches/stuff/tpp.txt>  
#
- Jeff (net drivers maintainer):  
<http://linux.yyz.us/patch-format.html> #

# Mailing Lists for Linux Starters

- <http://kernelnewbies.org> - [kernelnewbies@nl.linux.org](mailto:kernelnewbies@nl.linux.org)
- <http://janitor.kernelnewbies.org> -  
[kernel-janitors@lists.osdl.org](mailto:kernel-janitors@lists.osdl.org)
- [os\\_drivers@lists.osdl.org](mailto:os_drivers@lists.osdl.org)
- [kernel-mentors@selenic.com](mailto:kernel-mentors@selenic.com)
- Trivial patch monkey: [trivial@kernel.org](mailto:trivial@kernel.org) and  
<http://www.kernel.org/pub/linux/kernel/people/bunk/trivial>
- <http://vger.kernel.org/majordomo-info.html> - has list info  
and taboos
- Kernel announcements:  
[linux-kernel-announce@vger.kernel.org](mailto:linux-kernel-announce@vger.kernel.org)

# Mailing Lists

- Most lists have spam filters [to get past]; you probably need to use them also
- LKML a.k.a linux-kernel (@vger.kernel.org)
- LKML FAQ at <http://www.tux.org/lkml/>
- Index: <http://vger.kernel.org/vger-lists.html> and their archives
- Kernel patch commits mailing list:  
[git-commits-head@vger.kernel.org](mailto:git-commits-head@vger.kernel.org)

# More Kernel Project Mailing Lists

- Networking development: [netdev@vger.kernel.org](mailto:netdev@vger.kernel.org)
- Index: <http://oss.sgi.com/ecartis/>
- Subsystems: arches, filesystems, MM/VM (<http://www.linux-mm.org>), security, drivers (ACPI [SF.net], I2C, IDE, video, PCI, PCMCIA, IEEE 1394 [SF.net], USB [SF.net], SCSI, Infiniband, Bluetooth)
- More mailing lists in MAINTAINERS file and at <http://kernelnewbies.org>

# Mailing List Archives

- Archives for almost all
  - <http://gmane.org> has interface
  - <http://marc.theaimsgroup.com/> has many, with Search
  - <http://lkml.org> -- kernel list only
  - Google groups
- <http://lwn.net/> -- summaries

# Project Web Pages

- SourceForge.net (<http://sf.net>): web pages, mailing lists, CVS, bug tracking, etc.
- OSDL: <http://lists.osdl.org> - <http://developer.osdl.org>
- Hardware vendors: IBM, HP, Dell
- Distro vendors (Red Hat, SUSE, Debian)

# Open Source Licenses

- FSF on licenses:  
[http://www.fsf.org/licensing/licenses/index\\_html](http://www.fsf.org/licensing/licenses/index_html)
- <http://www.opensource.org> - Open Source Initiative, many open source licenses listed, but desire is to significantly reduce to number of licenses that are used

# Linux kernel source tree References

- linux/ MAINTAINERS, CREDITS
- linux/Documentation/
  - CodingStyle
  - SubmittingPatches
  - SubmittingDrivers
  - feature-removal-schedule.txt (deprecated)
  - stable\_api\_nonsense.txt
  - SubmitChecklist (currently only in -mm patchset)
  - HOWTO (do kernel development)

# Credits

- Hugh Blemings
- James Bottomley
- Matt Domsch
- Jeff Garzik
- Clyde Griffin
- Christoph Hellwig
- Gerritt Huizenga
- Greg Kroah-Hartman
- Pat Mochel
- Andrew Morton
- Arjan van de Ven
- Ric Wheeler
- Cliff White
- Chris Wright
- Top-posting A&Q from a .sig on the old crackmonkey m-l