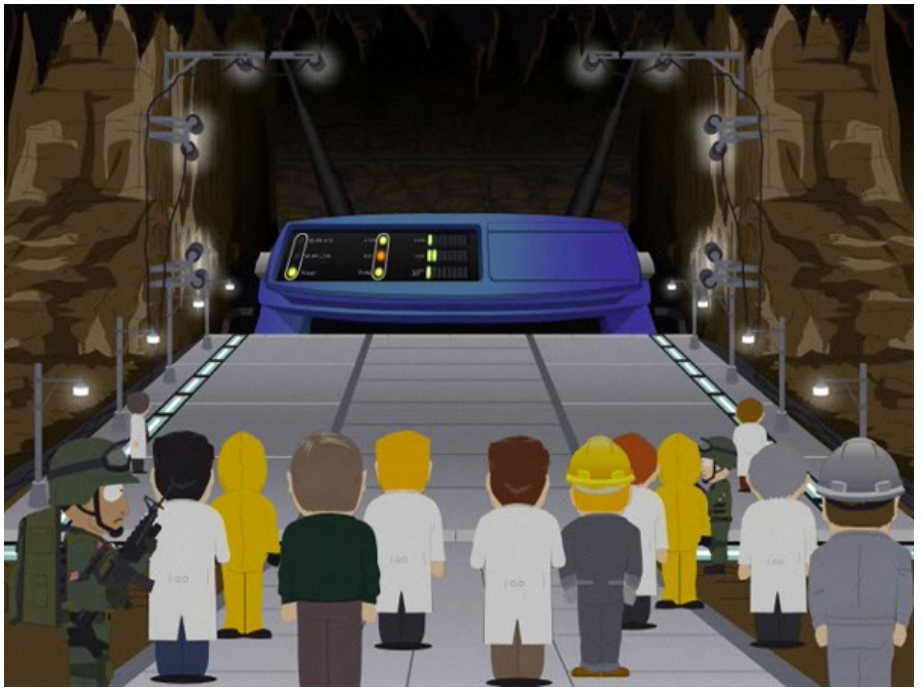
OpenWrt/LEDE: when two become one

Florian Fainelli



About Florian

- 2004: Bought a Linksys WRT54G
- 2006: Became an OpenWrt developer
- 2013: Joined Broadcom to work on Set-top Box and Cable Modem Linux kernel, toolchain, bootloader, root filesystem
- 2016: Joined the LEDE team...
- … while remaining in OpenWrt

Summary

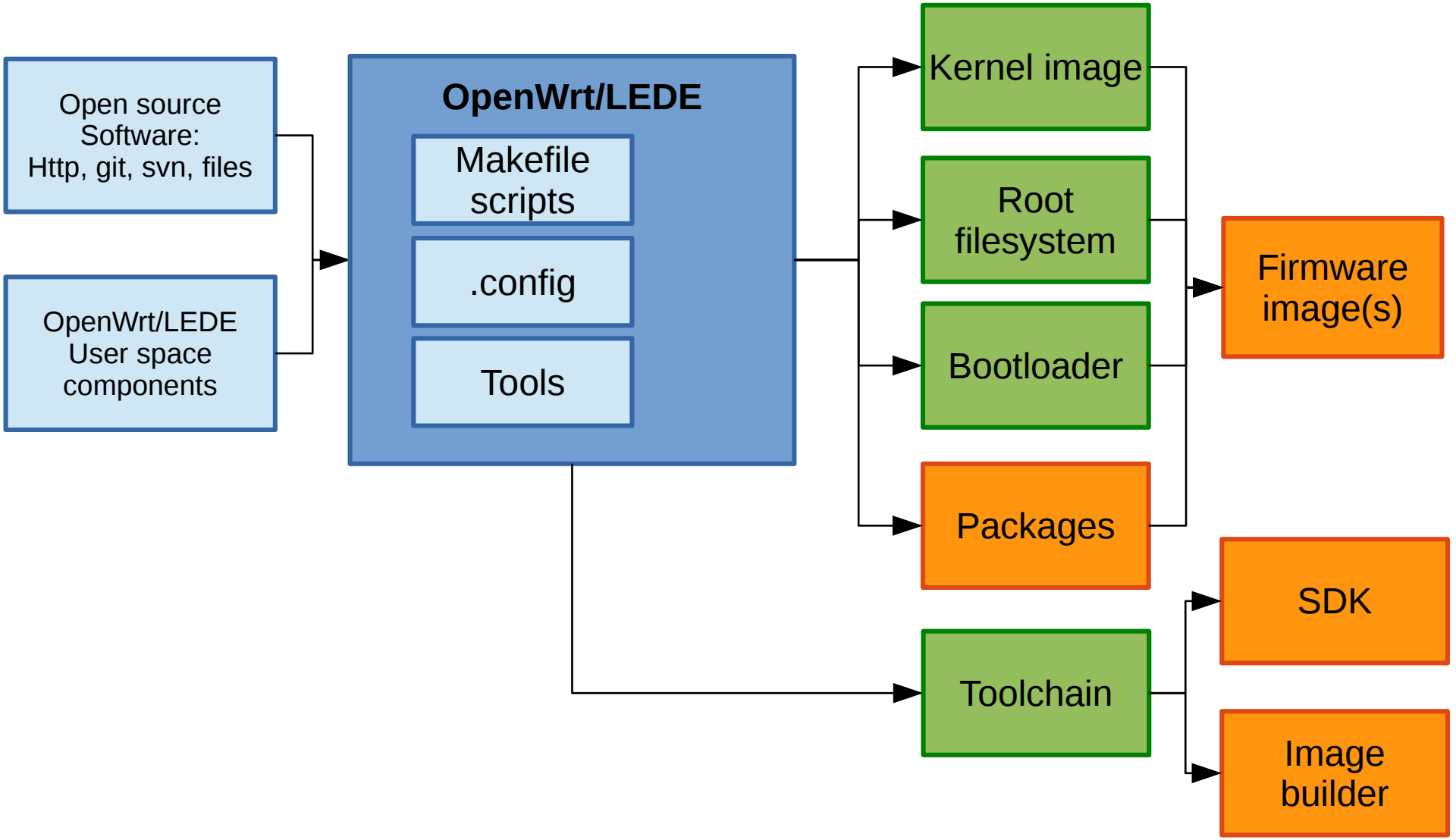
- Introduction to OpenWrt and LEDE
- Design, features and examples
- OpenWrt/LEDE reunification status

Introduction to OpenWrt/LEDE

What are OpenWrt and LEDE?

- Build systems
- Linux distributions
- Communities:
  - Wiki, forums, mailing-lists and git repositories
  - Users, contributors, developers

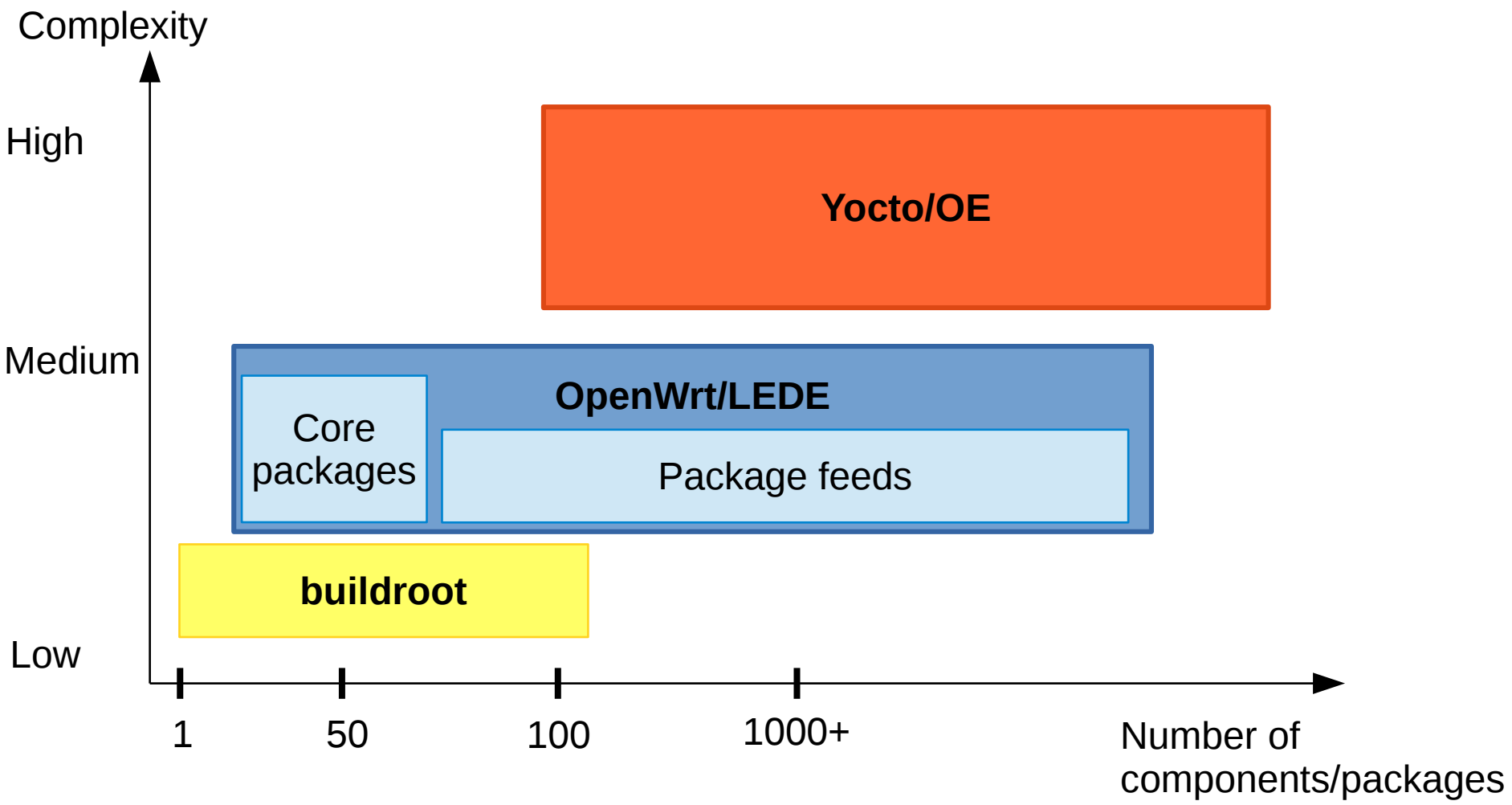
OpenWrt and LEDE in a nutshell



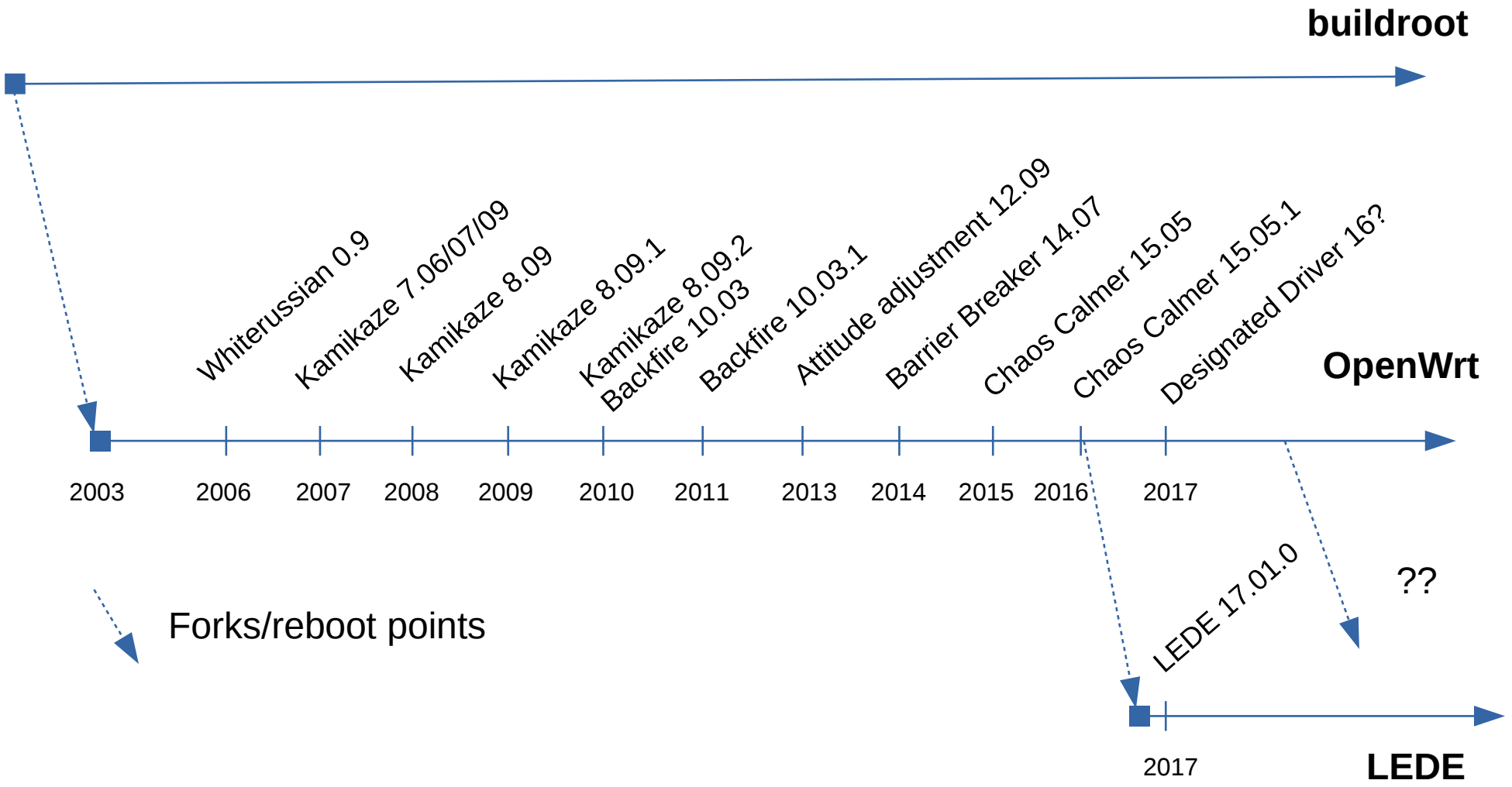
Design goals

- Maintainability
  - Working with latest technologies
  - Frequent updates to solve security flaws
- Ubiquity
  - Most off the shelf routers supported within weeks/months following public availability
  - With LEDE: extend scope beyond traditional network devices
  - Work with vendors to support OpenWrt/LEDE natively
- User empowerment
  - It’s open source!
  - Superior quality and control over vendor provided firmware
- Selected differentiation
  - Provide a state of the art network device experience
  - Turn-key solution to build real products

OpenWrt/LEDE in the landscape



Time line


buildroot
Whiterussian 0.9
Kamikaze 7.06/07/09
Kamikaze 8.09
Kamikaze 8.09.1
Kamikaze 8.09.2
Backfire 10.03
Backfire 10.03.1
Attitude adjustment 12.09
Barrier Breaker 14.07
Chaos Calmer 15.05
Chaos Calmer 15.05.1
Designated Driver 16?
OpenWrt
2003
2006
2007
2008
2009
2010
2011
2013
2014
2015
2016
2017
LEDE 17.01.0
??
Forks/reboot points
2017
LEDE

A word or two about router security

- Home routers are a great attack targets
  - Use vendor SDKs, old software, with custom NIH software
  - Millions of vulnerable devices out there running Linux

Design, features and examples

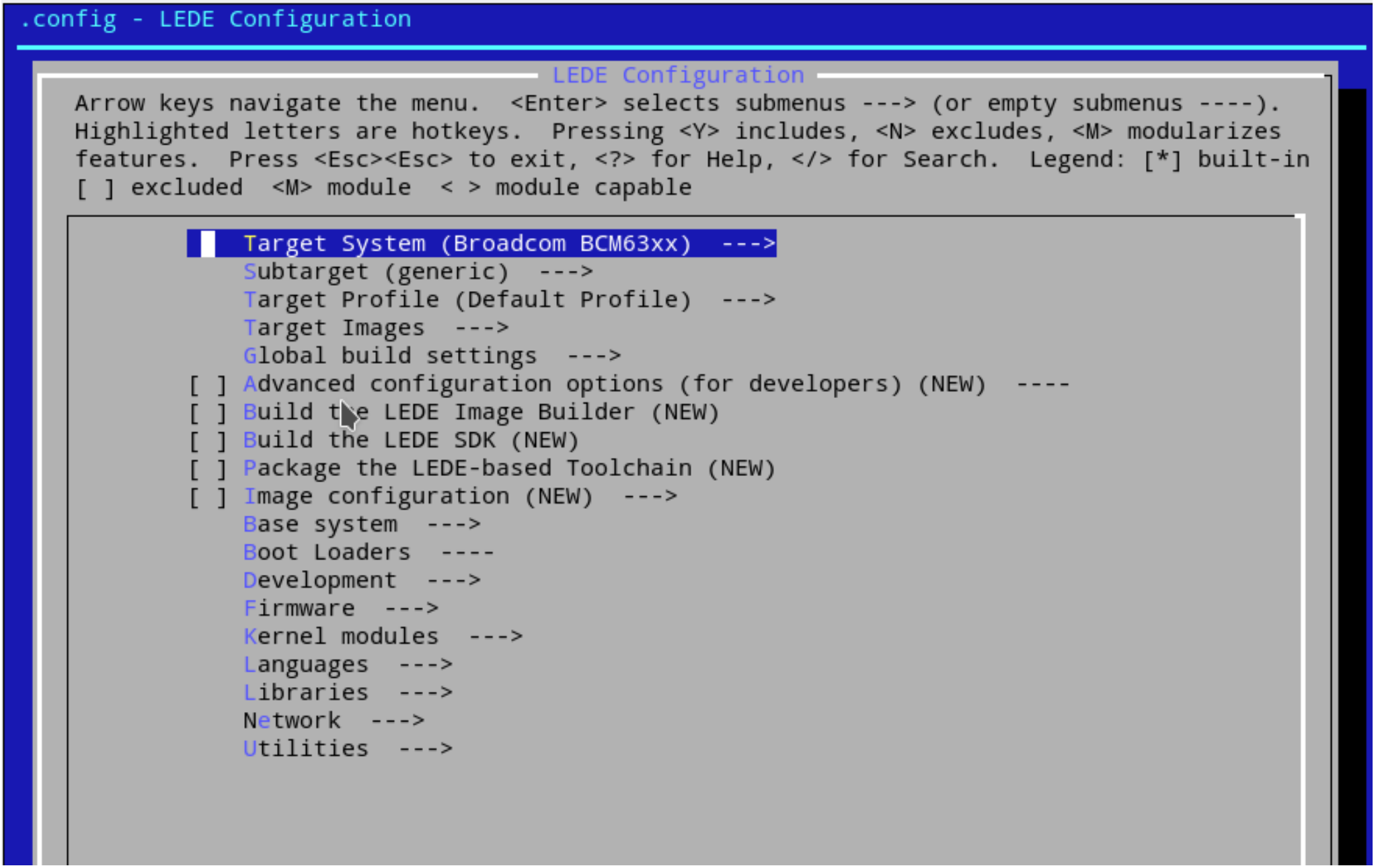
Build system

- Written in GNU Makefile
- Produces *.ipk files for software packages and kernel modules
- Abstracts autotools, cmake, bare-Makefile, libtool
- Make menuconfig based user interface
- Dependencies resolution and configuration validation
- Partial rebuild of everything (packages, toolchain, kernel)
- Supports building for different targets within the same source tree
- Parallel whenever possible

Why not use buildroot or Yocto?

- Buildroot
  - Does not support packages
  - But was a great basis to work from!
- Yocto/OE
  - Too slow, too complex

Menuconfig based interface



Toolchain & kernel

- Toolchain
  - Internal build (default)
  - External (crosstool-ng, custom…)
  - Supports glibc, uClibc-ng and musl-libc
- Kernel
  - Vanilla kernel + OpenWrt/LEDE patches + platform specific patches
  - External kernel: directory or git repository

Package makefile

- Define name, revision
- Git URL, git commit, date
- Distribution metadata
- Include cmake macros
- Define package metadata (dependencies, location in menuconfig)
- How to create the package
- Add to the build system

Example work flow

- Clean, build and install jsonfilter into rootfs:

```
make package/jsonfilter/{clean,compile,install}
```

- Force ethtool selection and download sources:

```
CONFIG_PACKAGE_ethtool=m make
package/ethtool/download
```

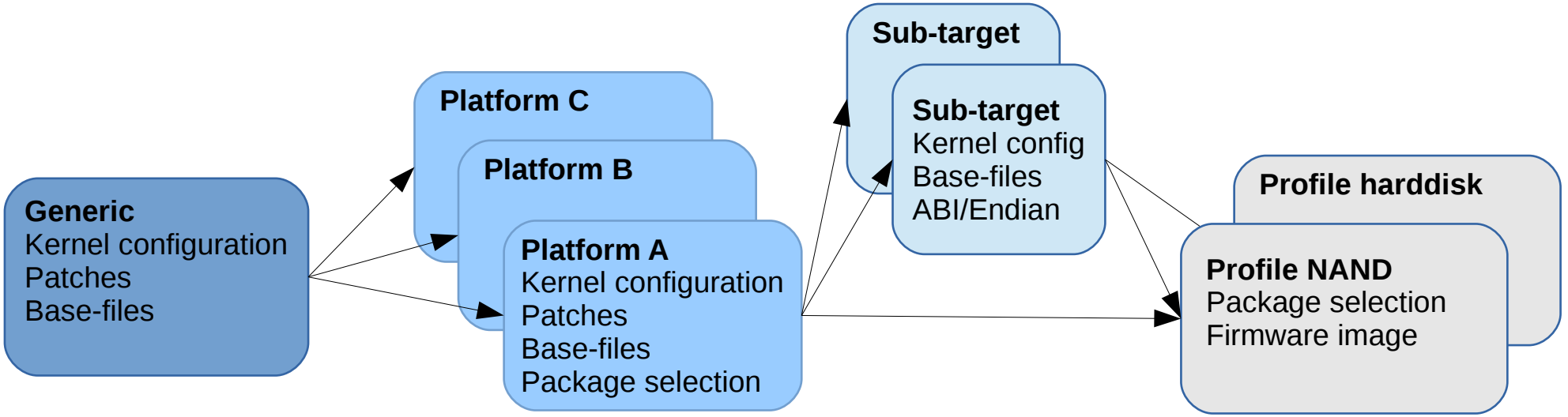
- Manage package patches with quilt:

```
make package/ethtool/prepare QUILT=1
```

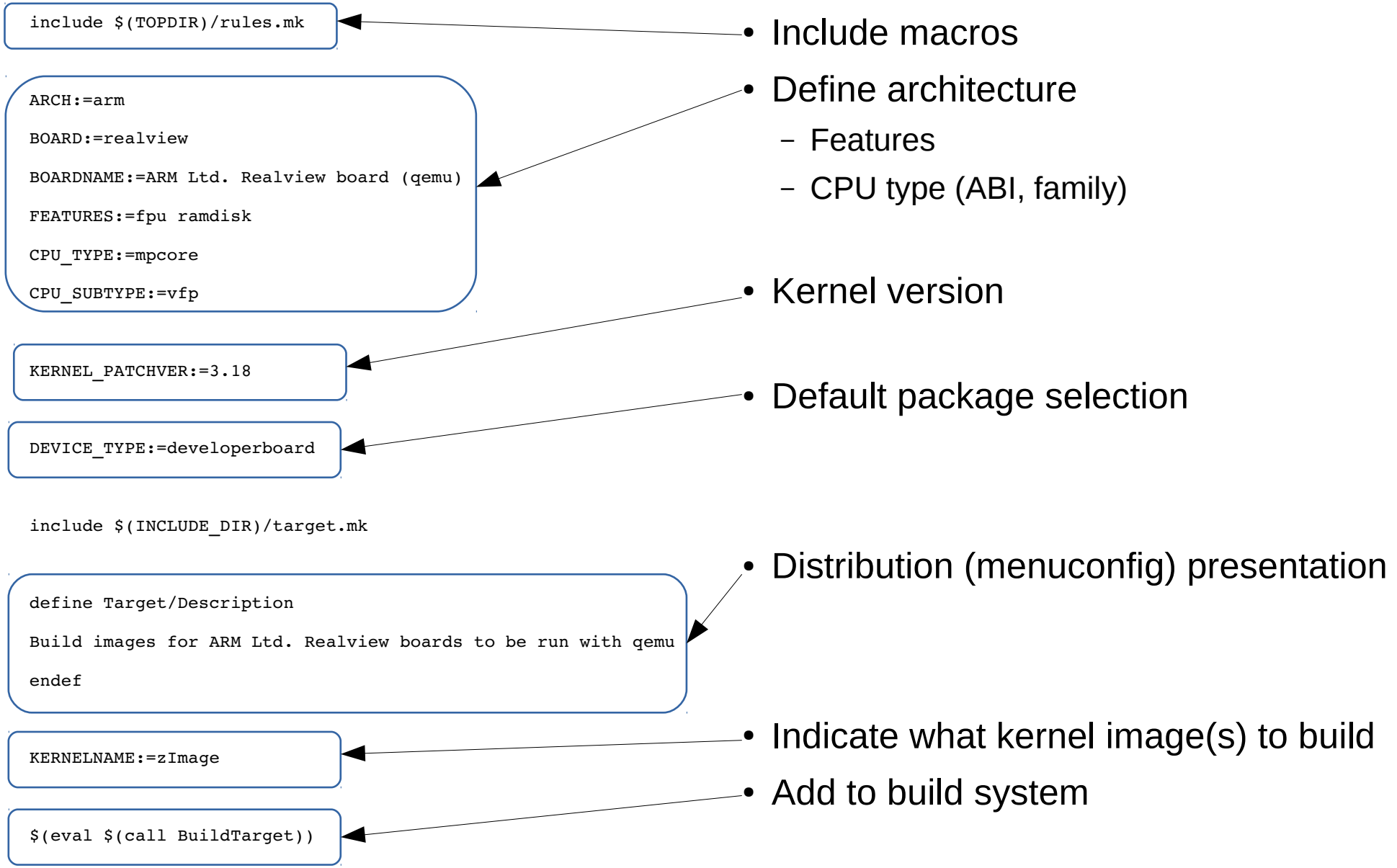
```
cd build_dir/*/*/ethtool-*/
```

```
quilt push/pop/delete/add
```

Platform layer



Platform definition



Kernel example work flow

- Build kernel modules

```
make target/linux/compile
```

- Build kernel image and firmware

```
make target/linux/install
```

- Manage kernel patches with quilt

```
make target/linux/prepare QUILT=1
cd build_dir/target*/linux*/linux-x.y/
quilt push/pop/add/delete
```

- Switching between environments

```
./scripts/env/new arm-platform
./scripts/env/switch arm-platform
make -j42
./scripts/env/switch mips-platform
```

Even kernel modules are packages!

```
define KernelPackage/tg3
  TITLE:=Broadcom Tigon3 Gigabit Ethernet
  KCONFIG:=CONFIG_TIGON3
  DEPENDS:=+!TARGET_brcm47xx:kmod-libphy
+kmod-hwmon-core +kmod-ptp
  SUBMENU:=$(NETWORK_DEVICES_MENU)
  FILES:=$
(LINUX_DIR)/drivers/net/ethernet/broadcom/tg3
.ko
  AUTOLOAD:=$(call AutoLoad,19,tg3,1)
endef

define KernelPackage/tg3/description

Kernel modules for Broadcom Tigon3 Gigabit
Ethernet adapters

endef

$(eval $(call KernelPackage,tg3))
```

- Kernel package name
- Kconfig option to enable
- Dependencies
- File to install
- Insmod loading hints
- Add to build system

Feeds

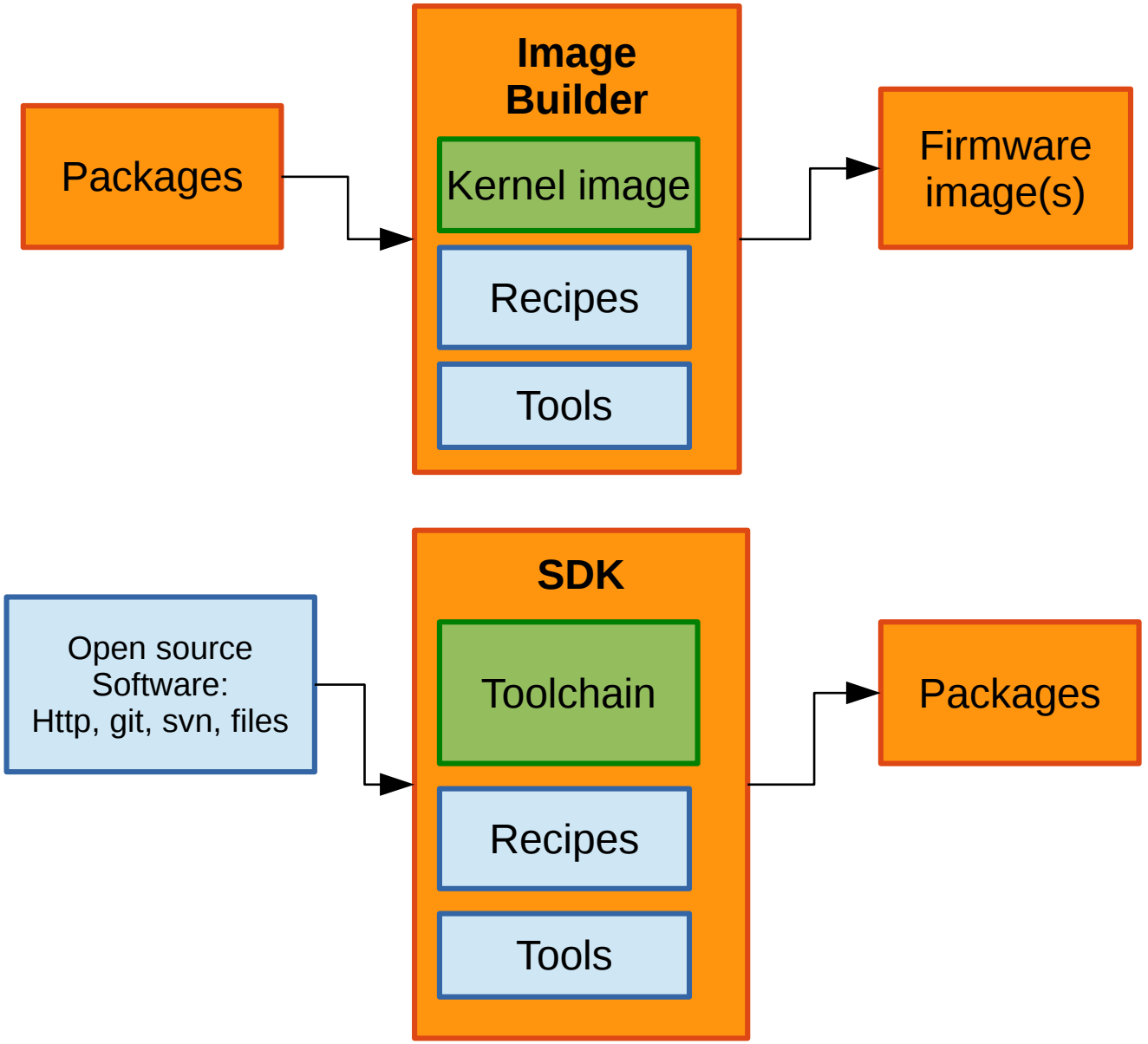
- Locations to package recipes

```
src-git packages https://git.lede-project.org/feed/packages.git
src-link custom /usr/src/openwrt/custom-feed
```

- Search, install and update additional packages

```
scripts/feeds update packages
scripts/feeds search “snmp”
scripts/feeds/install snmpd
```

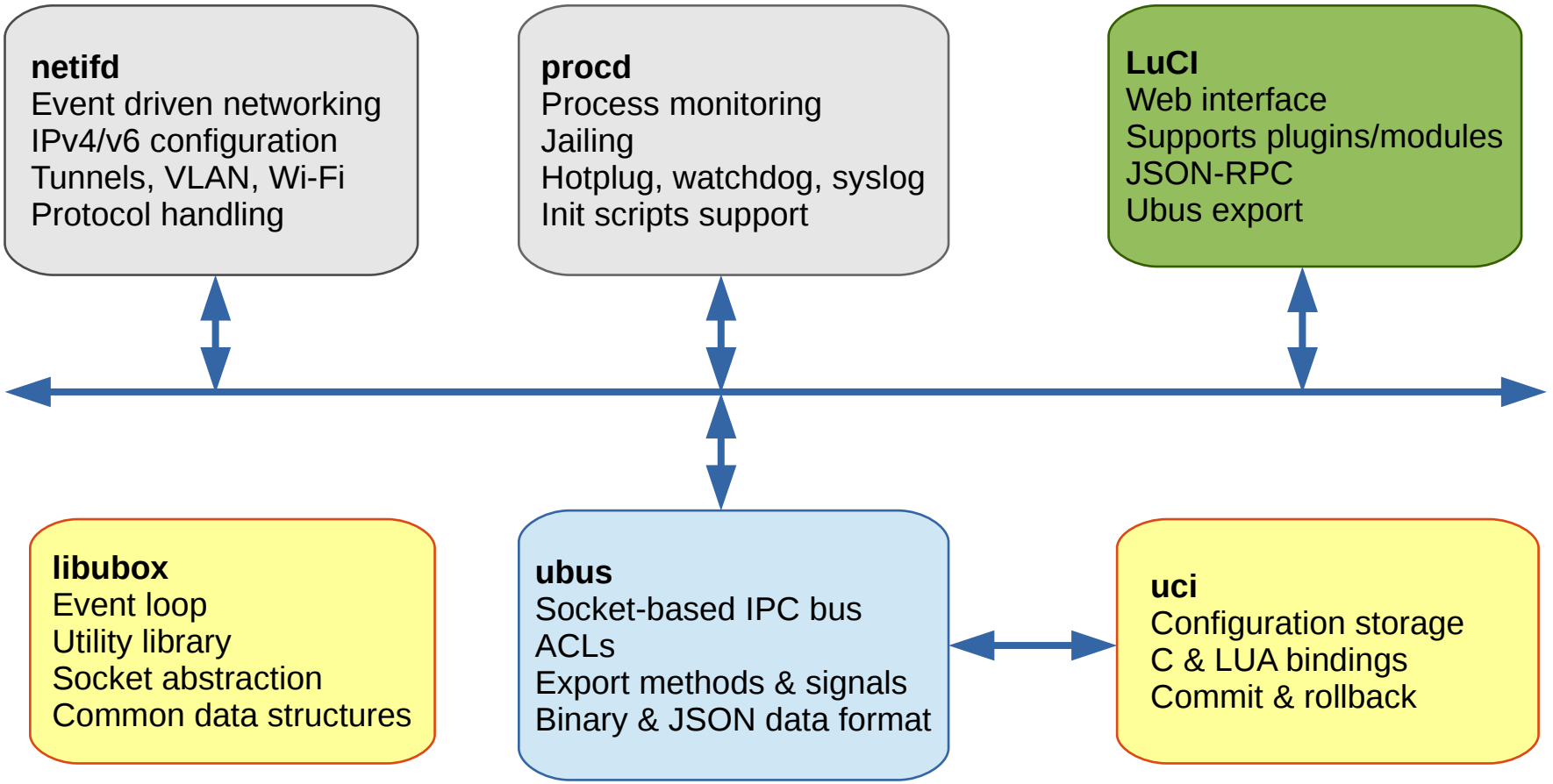
Development and deployment



Custom user-space, why?

- Modern systems require coordination between heterogeneous and discrete components
- User interfaces (CLI, web, GUI) change system configuration
- Networking devices are incredibly more complex (tunnels, provisioning etc.)
- Requirement for a proven, solid and consistent update mechanism

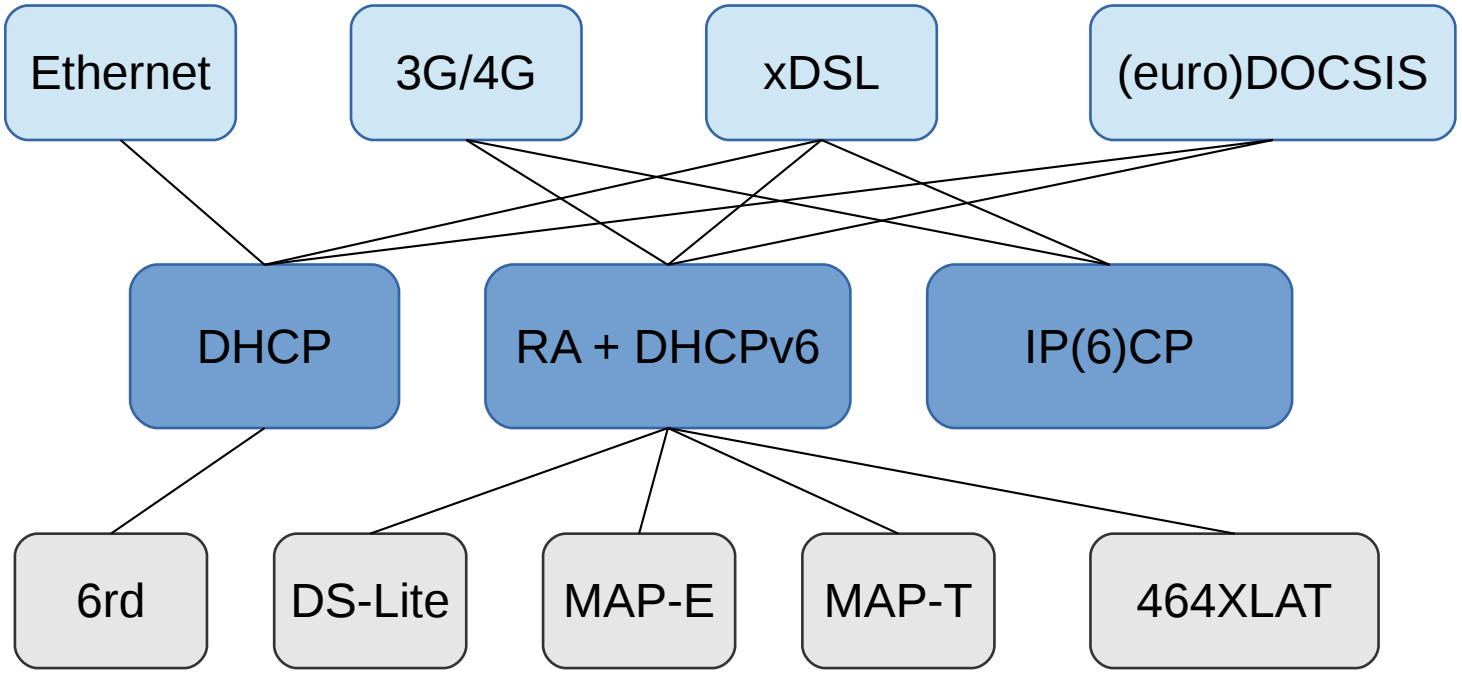
OpenWrt/LEDE software stack



System upgrades and failsafe

- System upgrades work consistently across devices:
  - Independent of the boot medium (SPI, NAND, eMMC)
  - Platform layer provides how to identify firmware image and where to flash kernel and root filesystem (partitions, mangling)
  - Scripts freeze system, preserve configuration files, and pivot_root to /tmp
  - Reboot into new version!
- Overlay FS allows marking the base system as read-only
  - But still allow read/write partition(s) for installable packages
  - Avoids wiping your entire system by accident
- Failsafe allows recovery of devices using device-specific buttons
  - Provides a recovery mechanism in case configuration is botched

Networking today



Configure only the minimum

Ethernet
```
config interface wan
        option ifname eth1
        option proto dhcp

config interface wan6
        option ifname eth1
        option proto dhcpv6
```

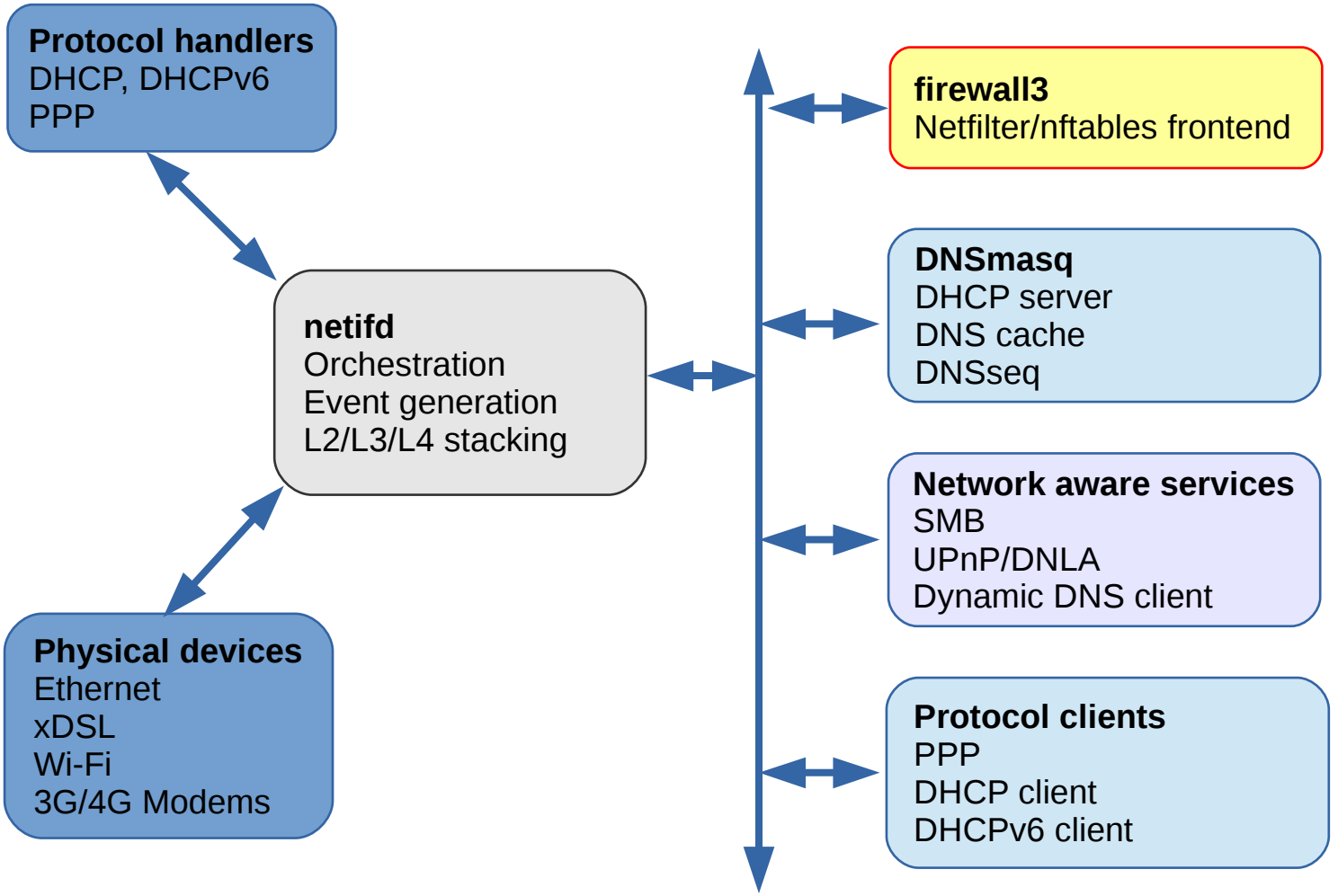
3G/4G
```
config interface wan
        option ifname wwan
        option pincode 1234
        option apn #apn#
```

PPPoX
```
config interface wan
        option ifname eth1
        option proto pppoe
        option username john
        option password doe
```

Ethernet
```
config interface lan
        option ifname eth0
        option type bridge
        option proto static
        option ipaddr 192.168.1.1
        option netmask 255.255.255.0
```

Wi-Fi
```
config wifi-iface
        option device radio0
        option mode ap
        option encryption psk-mixed
        option key ...
        option ssid ELC
        option network lan
```

And let netifd do the magic



Build-time security features

- Full/partial RelRO (configurable)
- Format-security checking (-Werror=format-security)
- Source fortification (-D_FORTIFY_SOURCE)
- Stack-smashing protector (user & kernel)
- Packages (*.ipk) are signed

Run-time security features

- Jails through procd to restrict filesystem access:

```
procd_add_jail dnsmasq ubus log
procd_add_jail_mount $CONFIGFILE $TRUSTANCHORSFILE $HOSTFILE /etc/passwd
/etc/group /etc/TZ /dev/null /dev/urandom $dnsmasqconffile $dnsmasqconfdir
$resolvfile $dhcpscript /etc/hosts /etc/ethers $EXTRA_MOUNT
procd_add_jail_mount_rw /var/run/dnsmasq/ $leasefile
```

- Flexible seccomp definitions to white list system calls:

```
procd_set_param seccomp /etc/seccomp/mdns.json
{
   “whitelist”: [
      “read”
      “write”
      ..
      “brk”
}
```

And many more!

- Has existing ARM, MIPS and x86 targets that run in QEMU
- Packages with separate debug info
- Ex/inclusion of patented/specifically licensed packages
- Local package mirror, alternate download directory (corporate/development environments)
- Default IP, init-scripts, banner customization

Areas of improvements

- More continuous testing
  - Harder because of the wide variety of hardware
  - Leverage community and provide clear reporting guidelines
- Send more patches upstream
  - About 170 patches against Linux 4.9!
  - Migrate Qualcomm/Atheros AR71xx towards Device Tree (ath79)
- Opt-in security updates
- Documentation
  - Wiki
  - Table of hardware
  - Recommended, best supported, ranking of models

Conclusions

- It works great on your router, but equally well anywhere else!
- Fast, versatile, and flexible
- Turn-key user-space solution for products…
- … that you can ignore for development only
- Extremely active communities

OpenWrt/LEDE reunification status

What happened?

- On March 5th 2016, a group of OpenWrt developers announced the formation of LEDE
- Two types of reaction:
  - Most people immediately welcomed LEDE and switched to it
  - A smaller group did not acknowledge the problem, and a flurry of emails ensued
- But essentially, it did signal there was a problem to be fixed with OpenWrt

Why LEDE?

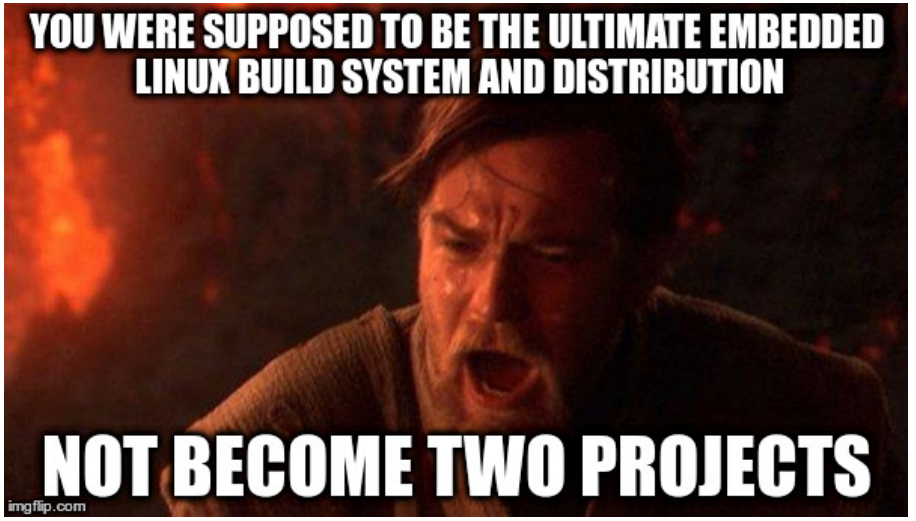
- More transparency
  - All decisions made public
  - Give equal decisions rights to all project members
  - Establish clear processes and guidelines to operate the project (conflicts, external communication, release decisions..)
- Less centralization
  - Do not rely on single person owned infrastructure (DNS, servers, repositories…)
  - Freedom to move code and services based on newer requirements (CI, capacity etc.)
- Predictability
  - Make frequent releases
  - Leverage community testing
  - Easier integration process from contributor to developer

Meanwhile in OpenWrt

- Surprise,
-
-

Where are we today?

- Reunification terms:
  - LEDE code base to be used moving forward
  - OpenWrt team given LEDE repository access
  - Discussions on whether OpenWrt should stick as a name (trademark, larger popularity...)
- But right now, it’s a stalled discussion...



What next?

- Release 17.01.0
  - So we can focus energy again on bringing the two projects together again
  - We critically need open source, recent and better software for our routers, users should have control and freedom!
- Meet, discuss and agree
  - In person
  - More frequently
  - On the the reunification terms
- And move forward together from there

http://lists.infradead.org/pipermail/lede-adm/2017-February/000380.html

References

- Websites

  http://lede-project.org

  http://openwrt.org

- Mailing-lists

  lede-dev@lists.infradead.org

  openwrt-devel@lists.openwrt.org

- IRC

  #lede-dev @ freenode

  #openwrt @ freenode

Questions!

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