LINUX FOUNDATION
COLLABORATIVE PROJECTS

CIVIL
INFRASTRUCTURE
PLATFORM

Time is ready for the Civil Infrastructure Platform

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Definition

Civil Infrastructure Systems are technical systems responsible for supervision, control, and management of infrastructure supporting human activities, including, for example,

- Electric power generation
- Energy distribution
- Oil and gas
- Water and wastewater
- Healthcare
- Communications
- Transportation
- Collections of buildings that make up urban & rural communities.

These networks deliver essential services, provide shelter, and support social interactions and economic development. They are society's lifelines.[1)]

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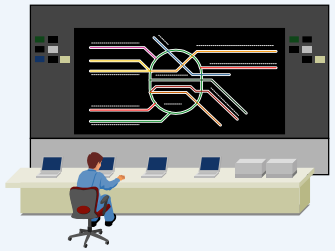
1) adapted from https://www.ce.udel.edu/current/graduate_program/civil.html

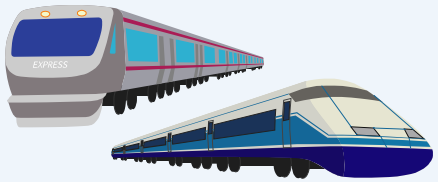
Linux is widely used in …

Transport



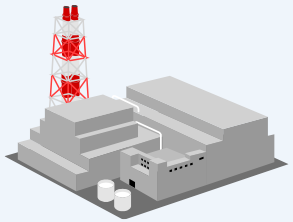
Rail automation

Automatic ticket gates

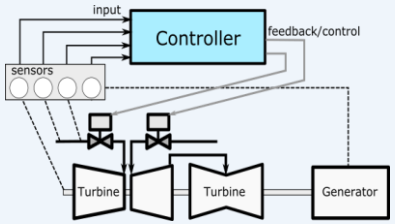


Vehicle control

Energy



Power Generation



Turbine Control

Industry

Industry automation

Industrial communication

CNC control

Others

Healthcare

Building automation

Broadcasting

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Civil infrastructure systems

Core characteristics

Industrial grade

- Reliability
- Functional Safety
- Security
- Real-time capabilities

Sustainability

- Product life-cycles of 10 – 60 years

Conservative update strategy

- Firmware updates only if industrial grade is jeopardized
- Minimize risk of regression
- Keeping regression test and certification efforts low

Business needs

Maintenance costs

- Low maintenance costs for commonly uses software components
- Low commissioning and update costs

Development costs

- Don‘t re-invent the wheel

Development time

- Shorter development times for more complex systems

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The evolution of civil infrastructure systems

Technology changes

Proprietary nature

- Systems are built from the ground up for each product
- little re-use of existing software building blocks
- Closed systems

Commoditization

- Increased utilization of commodity (open source) components, e.g., operating system, virtualization
- Extensibility, e.g., for analytics

Stand-alone systems

- Limited vulnerability
- Updates can only applied with physical access to the systems
- High commissioning efforts

Connected systems

- Interoperability due to advances in machine-to-machine connectivity
- Standardization of communication
- Plug and play based system designs

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Things to be done

- Join forces for commodity components
  - Ensure industrial grade for the operating system platform focusing on reliability, security, real-time capability and functional safety
  - Increase upstream work in order to increase quality and to avoid maintenance of patches
- Share maintenance costs
  - Long-term availability and long-term support are crucial
- Innovate for future technology
  - Support industrial IoT architectures and state-of-the art machine-to-machine connectivity

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Civil infrastructure systems require a super long-term maintained industrial-grade embedded Linux platform for a smart digital future

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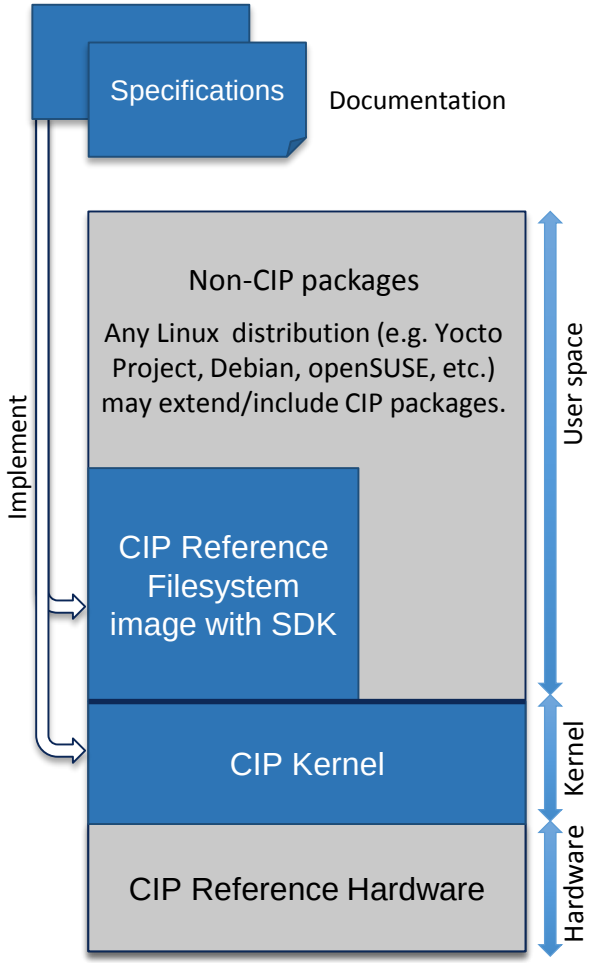
Civil Infrastructure Platform aims to provide industrial grade software

Establish an **open source "base layer" of industrial grade software** to enable the use and implementation in infrastructure projects of software building blocks that meet the **safety, reliability, security and maintainability requirements**.

- Fill the gap between capabilities of the existing OSS and industrial requirements.
- Provide reference implementation
- Trigger development of an emerging ecosystem including tools and domain specific extensions

➔**Initial focus on establishing long term maintenance infrastructure for selected Open Source components, funded by participating membership fees**



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Railway Example

3 – 5 years development time

2 – 4 years customer specific extensions

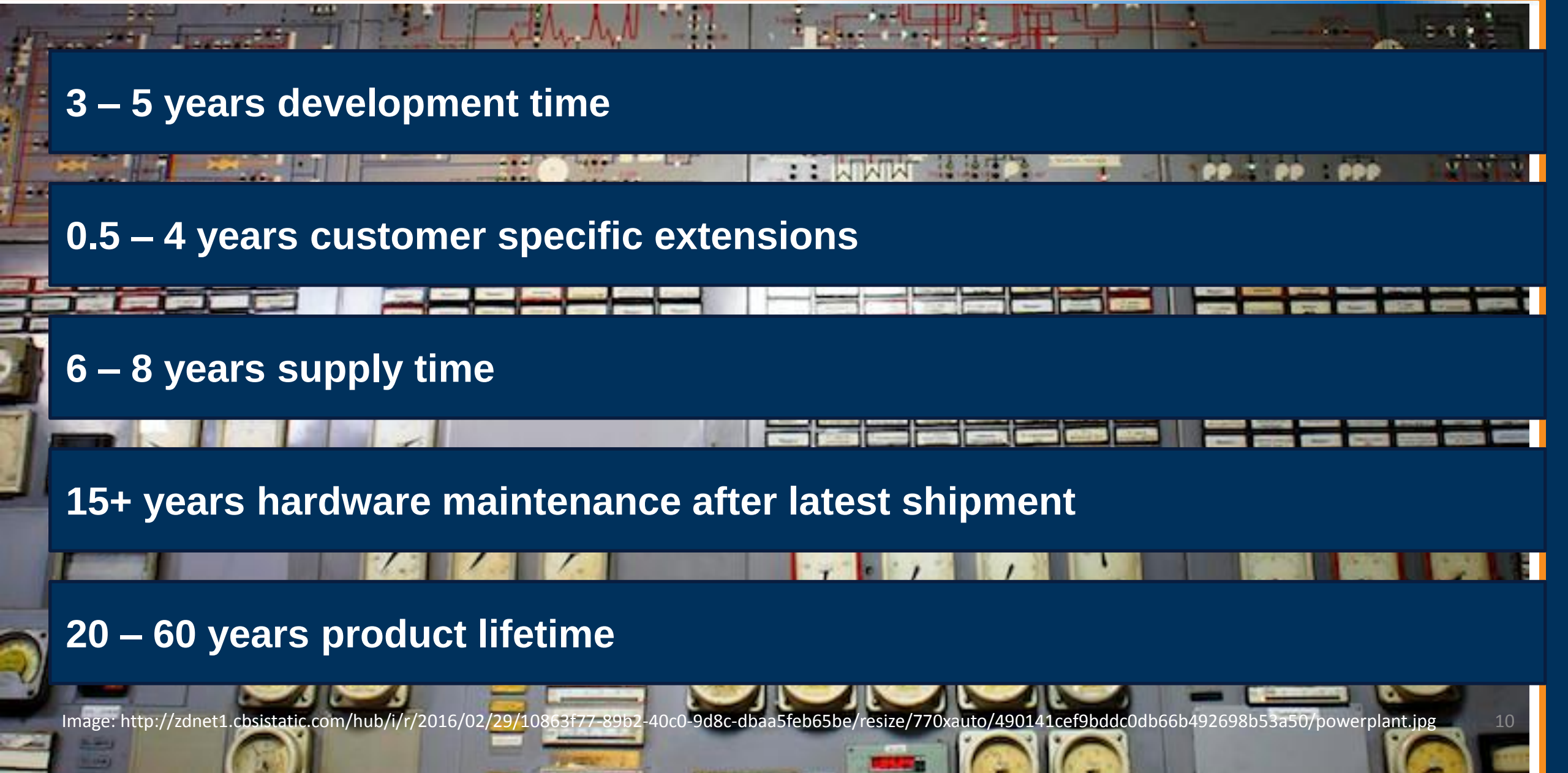
1 year initial safety certifications / authorization

3 – 6 months safety certifications / authorization for follow-up releases (depending on amount of changes)

25 – 50 years lifetime

Image: http://www.deutschebahn.com/contentblob/10862328/20160301+Stw+M%C3%BClheim+Innenansicht+1+(1)/data.jpg

Power Plant Control Example



3 – 5 years development time

0.5 – 4 years customer specific extensions

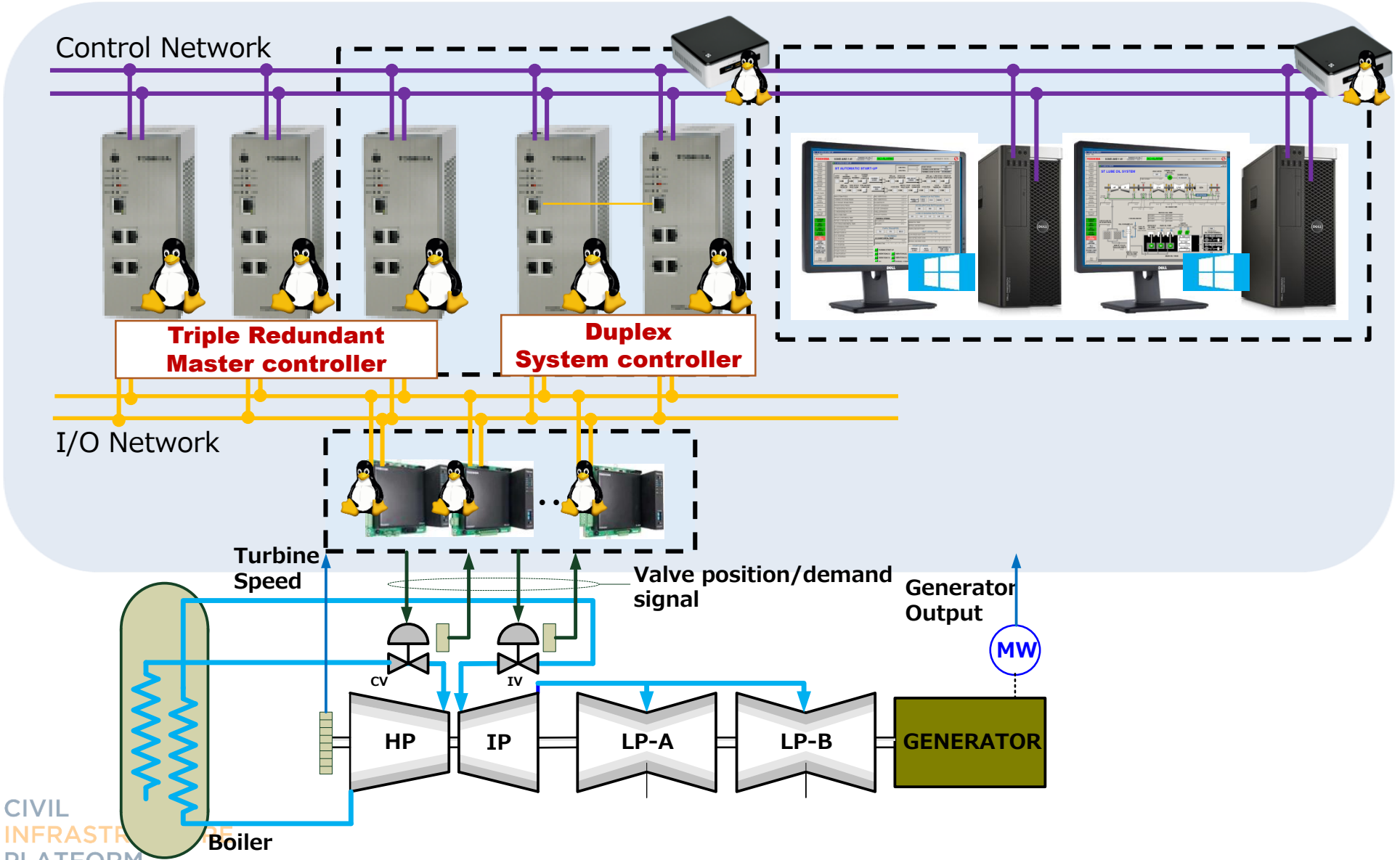
6 – 8 years supply time

15+ years hardware maintenance after latest shipment

20 – 60 years product lifetime

Image: http://zdnet1.cbsistatic.com/hub/i/r/2016/02/29/10863f77-89b2-40c0-9d8c-dbaa5feb65be/resize/770xauto/490141cef9bddc0db66b492698b53a50/powerplant.jpg

Power plant runs on the Linux (please visit our booth)



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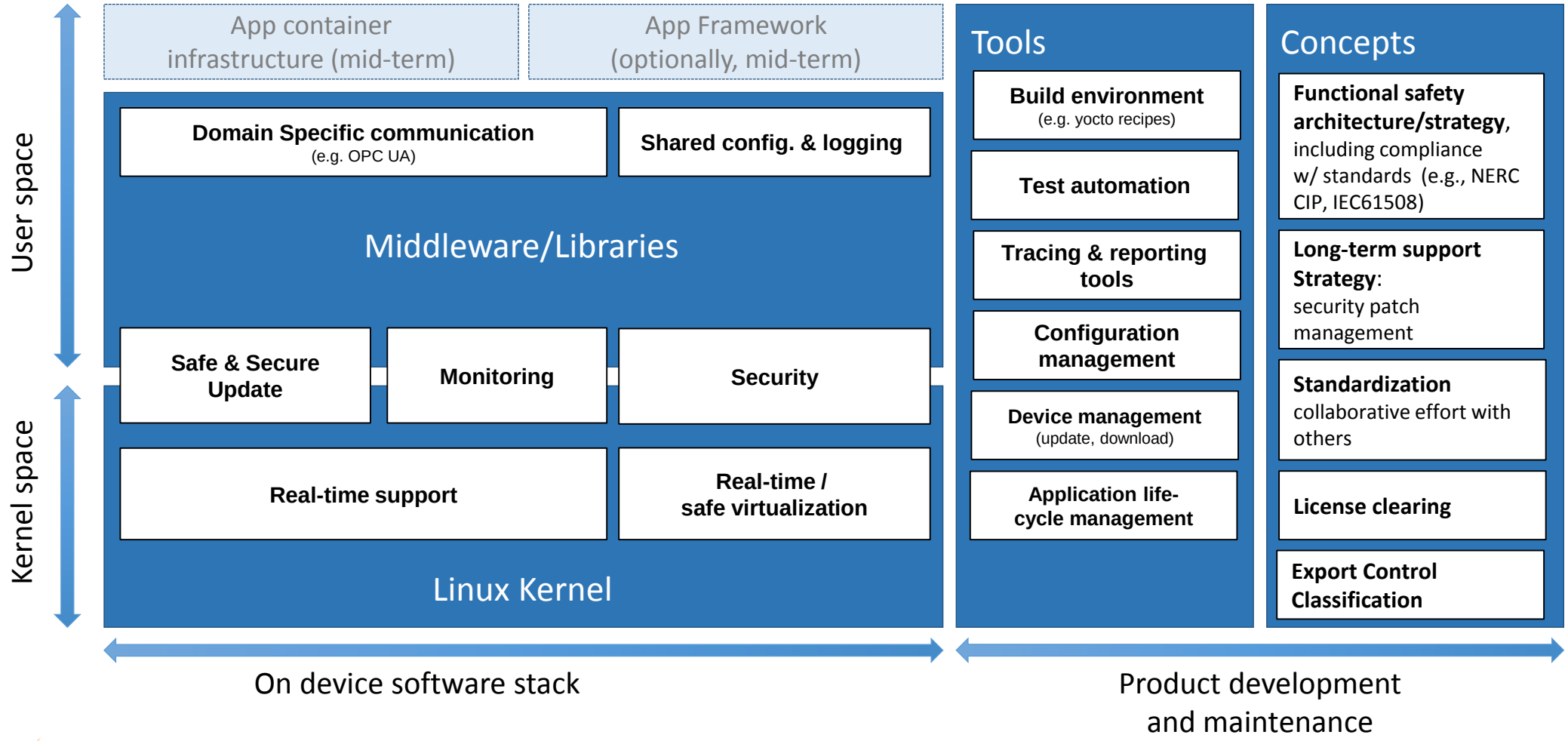
Why maintaining old kernels?

1. Fear of regressions in newer kernels
   (performance and system stability)
2. Reducing re-certification costs and time by minimizing changes
3. Reduced number of kernel versions to be provided by SoC vendors
   (like LSK or LTSI)
4. Serving as a common base for vendor-specific kernel forks
   and out-of-tree code
   (yes, we prefer upstreaming…)

see also http://lwn.net/Articles/700530/

Scope of activities



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Target Systems

Target systems

	Networked Node [1]	Embedded Control Unit [2]	Embedded Computer [3]	Embedded Server [4]
ARM offerings[1)]	M0/M0+/M3/M4	M4/7, A9, R4/5/7	ARM A9/A35, R7	ARM A53/A72
Intel offerings[1)]	Quark MCU	Quark SoC	Atom	Core, Xeon
Architecture, clock	8/16/32-bit, < 100 MHz	32-bit, <1 GHz	32/64-bit, <2 GHz	64-bit, >2 GHz
non-volatile storage	n MiB flash	n GiB flash	n GiB flash	n TiB flash/HDD
RAM	< 1 MiB	< 1 GiB	< 4 GiB	> 4 GiB
HW ref. platform	Arduino class board	Raspberry Pi class board	SoC-FPGA, e.g.Zync	industrial PC
application examples	Sensor, field device	control systems	special purpose & server based controllers	
	PLC		gateways	multi-purpose controllers

Out of scope:

- Enterprise IT and cloud system platforms.

Reference hardware for common software platform:

- Start from working the common HW platform (PC)
- Later extend it to small/low power devices

1) Typical configurations Q1/2016 [1] … [4] Device class no.

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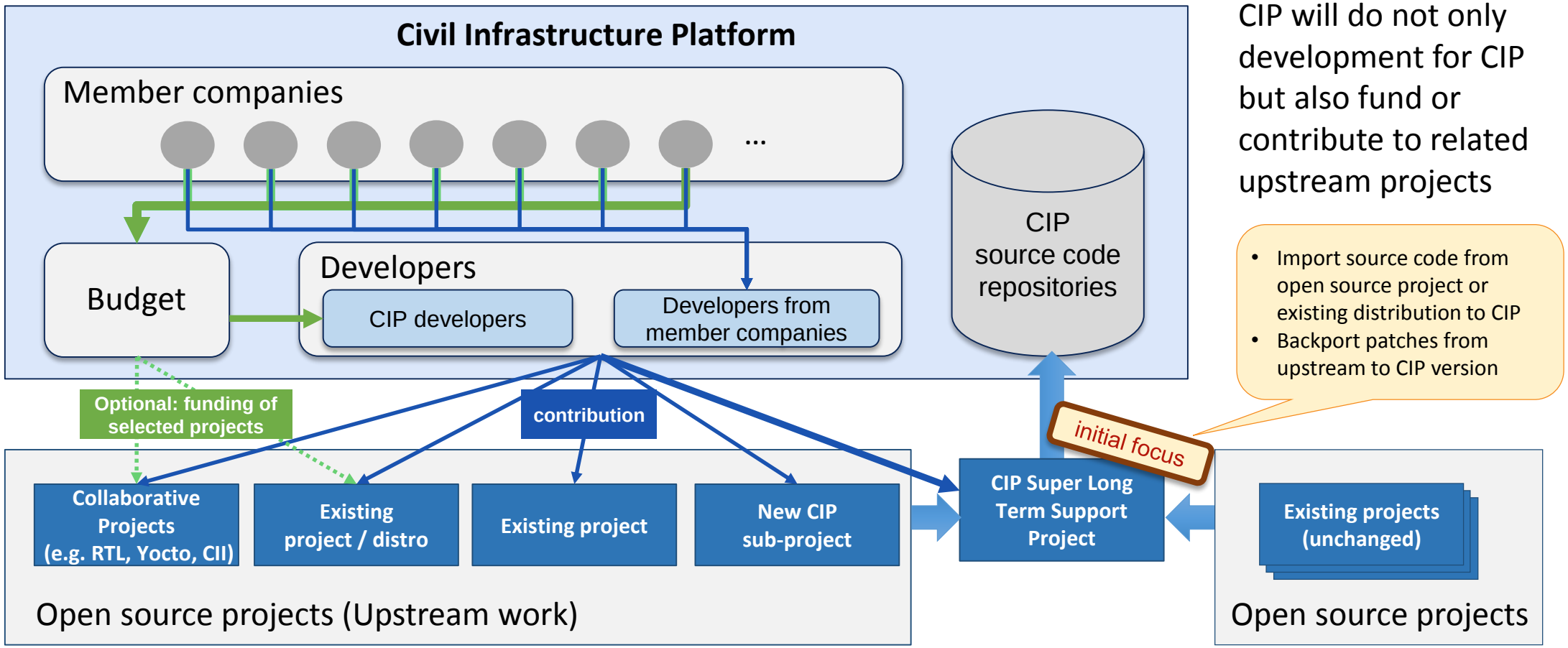
Relationship between CIP and other projects



CIP will do not only development for CIP but also fund or contribute to related upstream projects

- Import source code from open source project or existing distribution to CIP
- Backport patches from upstream to CIP version

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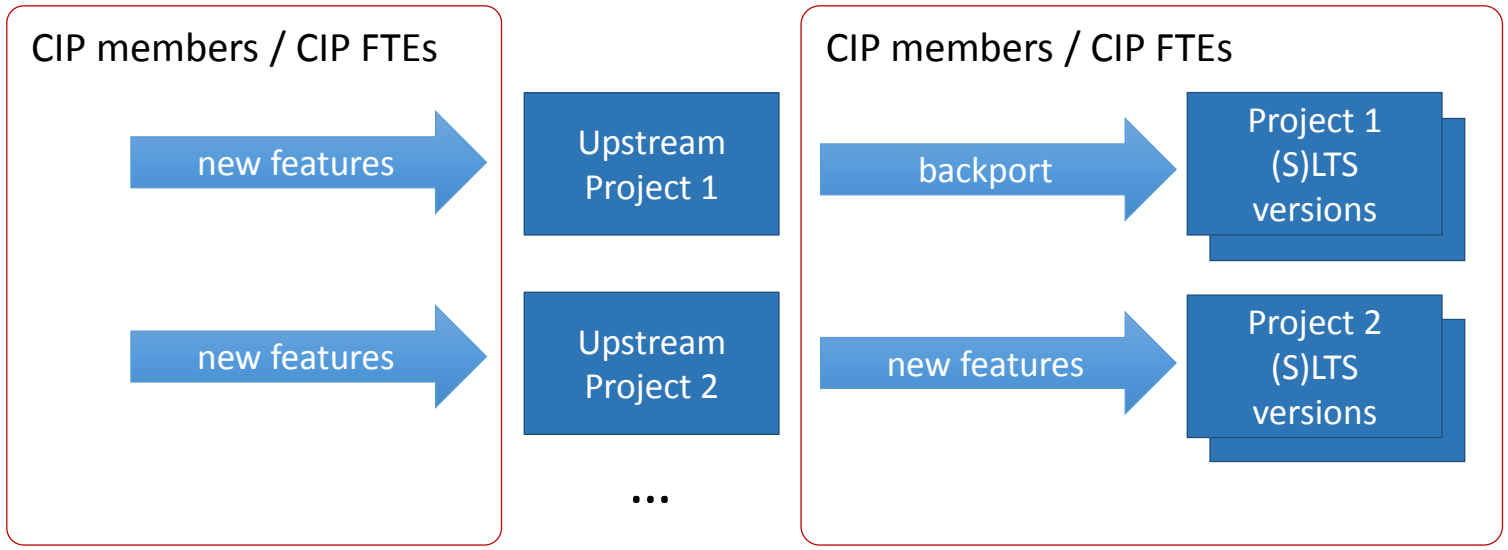
Upstream first policy for implementation of new features

All deltas to mainline to be treated as technical debt

- Avoid parallel source trees, directly discuss features in upstream projects
- Upstream first for fixes and features, just like for stable kernels
- Afterwards back-port to super long-term versions driven by CIP



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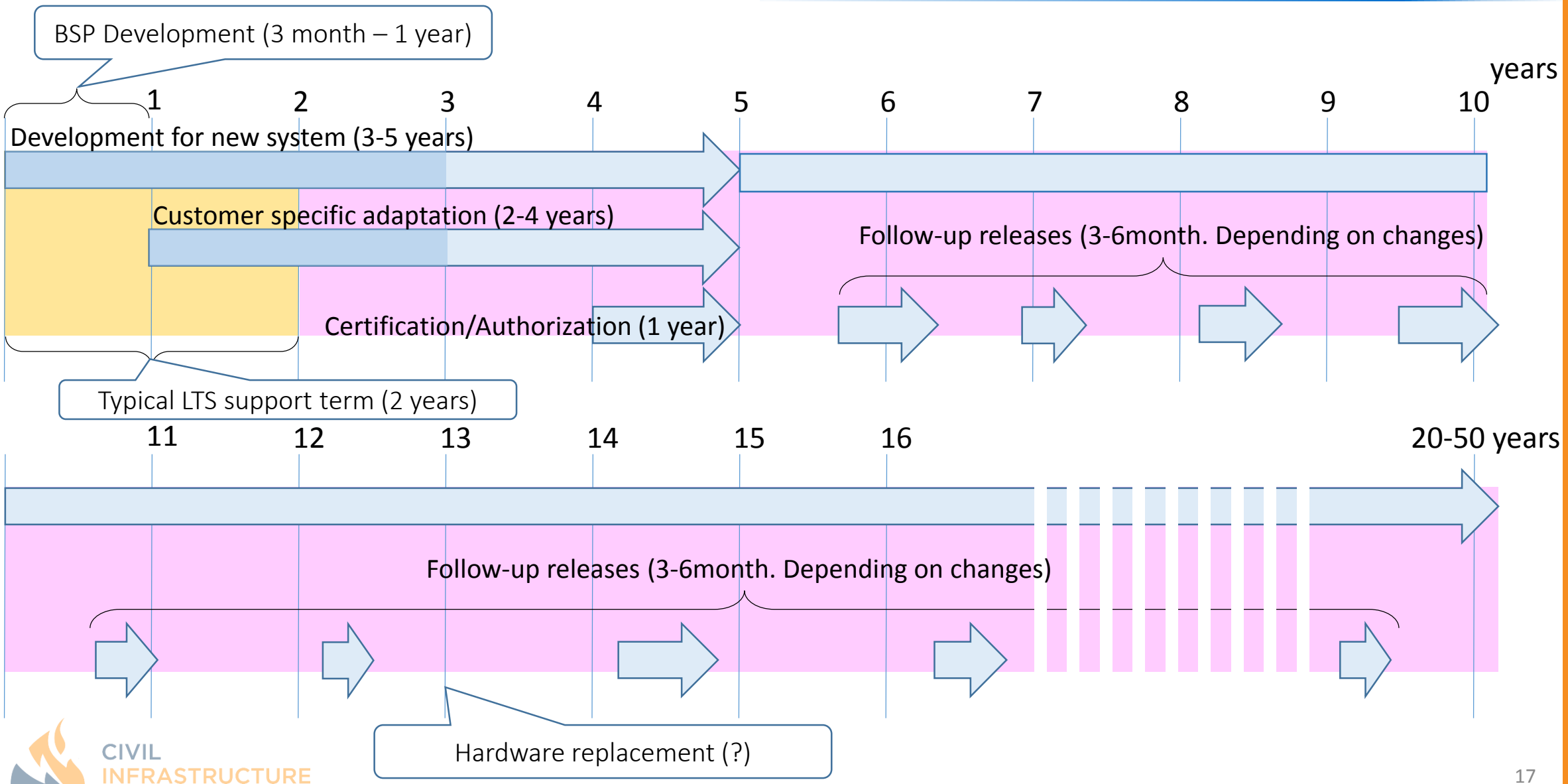
Why super long term support? (Let's look a typical development process)



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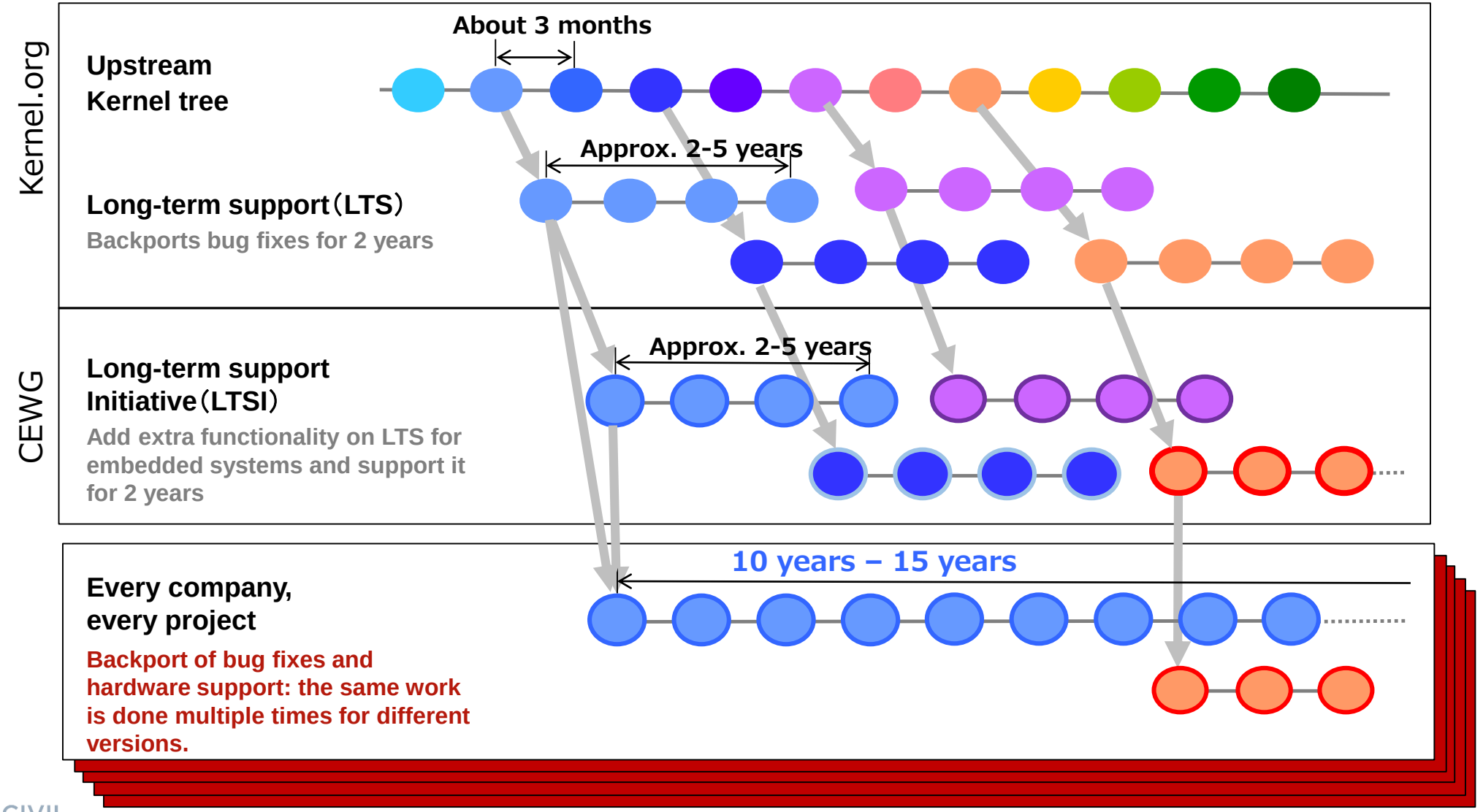
Super Long Term Support - Motivation



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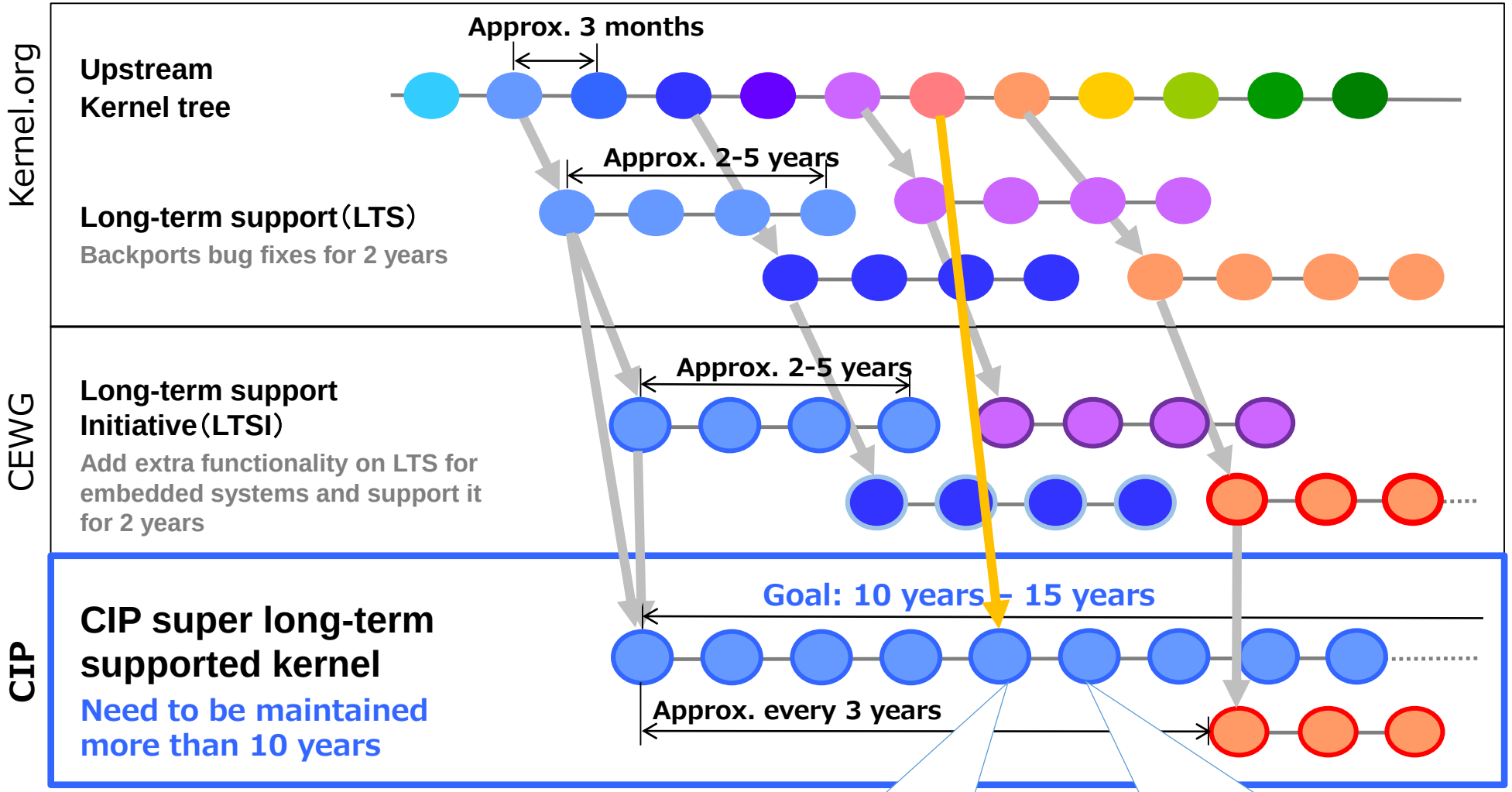
Release / Maintenance release

CIP kernel super long term support (SLTS) overview



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Announcement: The first CIP SLTS kernel version

4.4

Announcement: The first CIP SLTS kernel version

- CIP will maintain the Linux kernel 4.4 for more than 10 years

- Selection Criteria for the first SLTS kernel version
  - LTS version, ideally synchronized with LTSI
  - Broadly used for civil infrastructure systems
    - Currently deployed products
    - **Upcoming products**

- Next SLTS kernel version?
  - Will be announced in 2-3years
  - **Synchronize with LTSI kernel version at this timing**

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Super Long-Term Stable Team

- Ben Hutchings is first super long-term kernel maintainer
  - Well-known Debian contributor and package maintainer
  - Currently LTS maintainer for 3.2 and 3.16
- Ben will be supported by one additional developer
- Work started in September 2016
  - Setup of SLTS development and validation process
  - Prepare and perform first SLTS kernel release
  - Support CIP in extending SLTS model to further core packages

Plans for CIP SLTS kernel development

- Development Process
  - Development process will be similar to LTSI
    - Accept feature backports from upstream kernel
    - CIP will have merge windows and validation periods for feature backporting
  - Important NOTE: If the backport changes the kernel API, it will not be accepted

- Validation
  - Establishing kernel test infrastructure
  - Enhance on-target testing beyond boot-tests
  - Share the results for open spec boards

CIP Testing Considerations

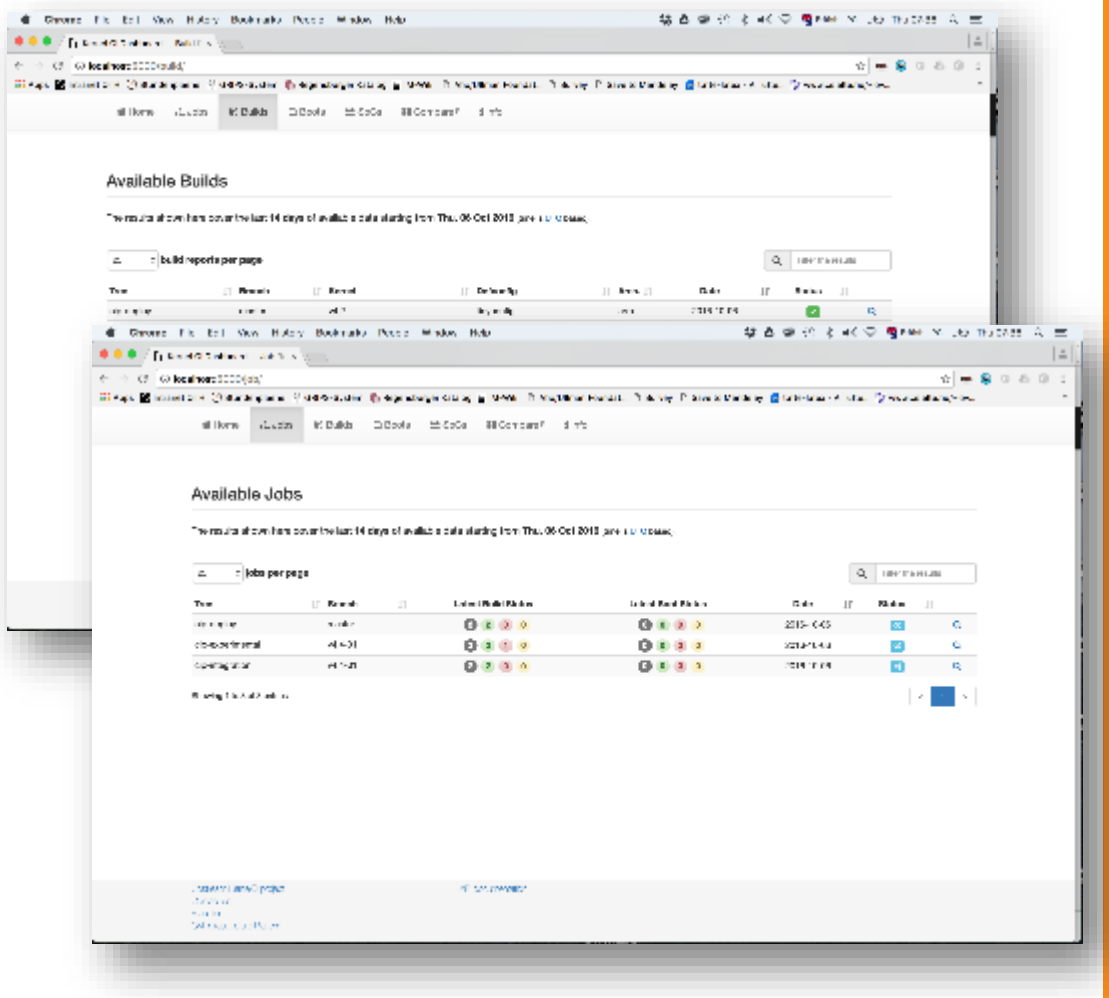
Testing goals

- Perform testing on real HW (VM: no detail quirks and real-world issues)
- Focus on CIP reference platforms
- Critical Fixes: Build & test within hours on all machines
- No continuous functional testing (for instance, latencies)
- Super-Long-Term result preservation
- Align approach with established community best practices

CIP Testing Considerations (cont'd)

Current Status

- Initial CIP-private instance of Kernel CI (vagrant based)
  - Member companies can run local labs
  - HW rack standard (standardized physical and electrical setup) under consideration
- Purely local operation; results via central public web server once fully operational
- Job + Build scheduling: To be defined (likely Fuego and friends)
- Feed results back to Kernel CI?



Kernel-CI: https://kernelci.org/
Fuego: http://elinux.org/Fuego

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Selection Criteria for Userspace Packages

- Essential for booting and basic functionality
- Commonly used in civil infrastructure systems
- Security sensitive
- Likely maintainable over 10 years+ period
- **We are open for proposals!**

Further Candidates for Super Long-term Maintenance

An Example minimal set of “CIP kernel” and “CIP core” packages for initial scope

Super Long-term support

Kernel (SLTS)

- Kernel
  - Linux kernel (cooperation with LTSI)
  - PREEMPT_RT patch
- Bootloader
  - U-boot
- Shells / Utilities
  - Busybox
- Base libraries
  - Glibc
- Tool Chain
  - Binutils
  - GCC
- Security
  - Openssl
  - Openssh

Core Packages (SLTS)

Maintain for Reproducible build

Dev packages

- Flex
- Bison
- autoconf
- automake
- bc
- bison
- Bzip2
- Curl
- Db
- Dbus
- Expat
- Flex
- gawk
- Gdb
- Git
- Glib
- Gmp
- Gzip
- gettext
- Kbd
- Libibverbs
- Libtool
- Libxml2
- Mpclib
- Mpfr4
- Ncurses
- Make
- M4
- pax-utils
- Pciutils
- Perl
- pkg-config
- Popt
- Procps
- Quilt
- Readline
- sysfsutils
- Tar
- Unifdef
- Zlib

NOTE: The maintenance effort varies considerably for different packages.

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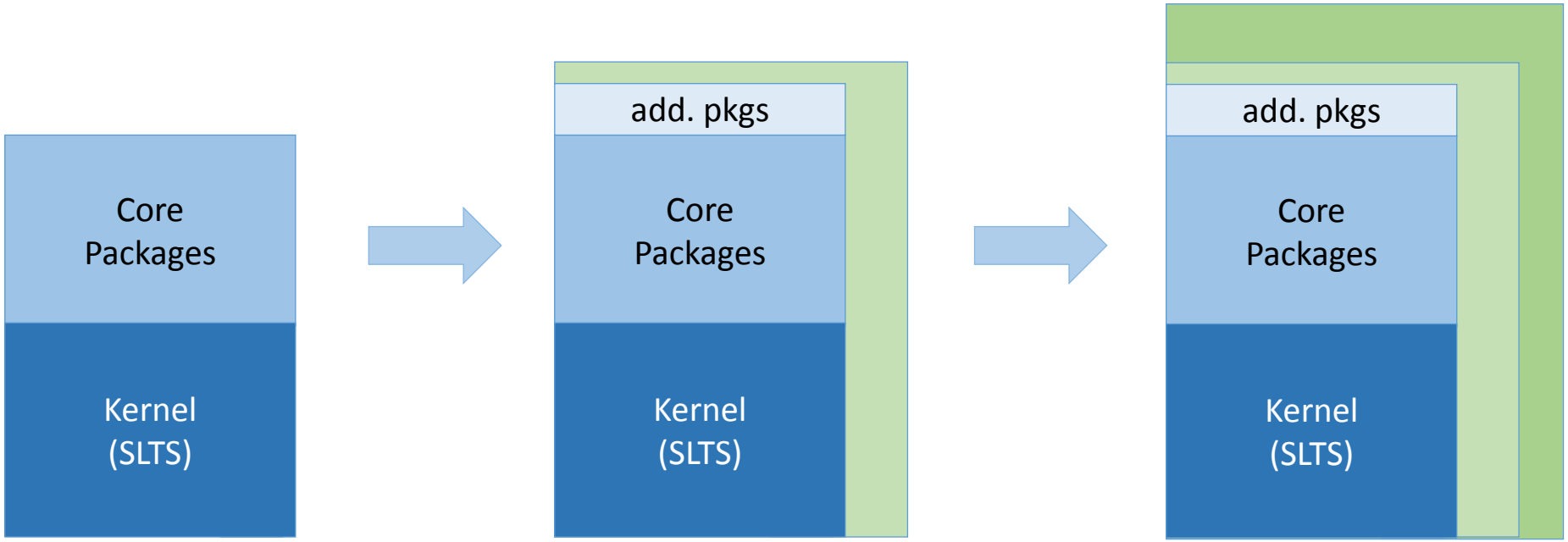
Development plan

CIP will increase the development effort to create industrial grade common base-layer



Phase 1:

- Define supported kernel subsystems, arch.
- Initial SLTS component selection
- Select SLTS versions
- Set-up maintenance infrastructure (build, test)

Phase 2:

- Patch collection, stabilization, back port of patches for CIP kernel packages
- Support more subsystems
- Additional core packages

Phase 3:

- Domain specific enhancements, e.g. communication protocols, industrial IoT middleware
- Optionally: more subystems
- Optionally: more core packages

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Currently under discussion

- CIP should collaborate with other similar efforts
  - LSK (Linaro Stable Kernel)
  - Other distributor or SoC vendors
- Selection of features for backporting
  - PREEMPT_RT
    - PREEMPT_RT might be merged into separate branch
  - KSPP (Kernel Self Protection Project)
- Testing infrastructure (KernelCI + Fuego)
- Kernel maintenance policy
- Userland package selection

Milestones

- 2016:
  - Project launched announcement at Embedded Linux Conference 2016
  - Requirements defined, base use cases defined, technical & non-technical processes established (license clearing, long-term support), maintenance plan
  - Common software stack defined, related core projects agreed (e.g. PREEMT_RT, Xenomai), maintenance infrastructure set up
  - Domain specific extensions defined, tool chain defined, test strategy defined
  - Maintenance to be operational and running
- 2017:
  - Realization phase of selected components
- 2018:
  - Advancement, improvements, new features

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Please join!

Provide a super long-term maintained industrial-grade embedded Linux platform.

Current members

Platinum Members

HITACHI
Inspire the Next

SIEMENS

TOSHIBA

Silver Members

CodeThink

Plat' Home
There, we are. Internet of Things

Why join CIP?

- Participate in **project decisions** through the governing board and/or committees; leverage an ecosystem of like-minded participants to help drive project priorities as a community.
- Provide **technical direction** through a TSC representative enabling fast engagement and input into the technical direction of the project
- Demonstrate support for CIP.
- Priority access to any events, sponsorship and marketing opportunities. Potential events include:
  - Embedded Linux Conference
  - LinuxCon
  - Collaboration summits
  - Other community events
- Visibility on the CIP website and in membership collateral

Contact Information and Resources

To get the latest information, please contact:

- Noriaki Fukuyasu fukuyasu@linuxfoundation.org
- Urs Gleim urs.gleim@siemens.com
- Yoshitake Kobayashi yoshitake.kobayashi@toshiba.co.jp
- Hiroshi Mine hiroshi.mine.vd@hitachi.com

Other resources

- CIP Web site https://www.cip-project.org
- CIP Mailing list cip-dev@lists.cip-project.org
- CIP Wiki https://wiki.linuxfoundation.org/civilinfrastructureplatform/

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Questions?

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Thank you!

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