LINUX FOUNDATION
COLLABORATIVE PROJECTS

CIVIL
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PLATFORM

Towards Sustainable Systems with 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,

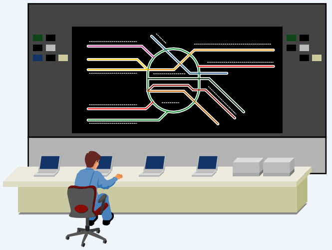
- Electric power generation
- Energy distribution
- Oil and gas
- Water and wastewater
- Healthcare
- Communications
- Transportation
- Collections of buildings that make up urban & rural communities.

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

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

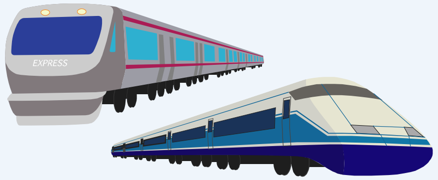
Linux is widely used in …

Transport



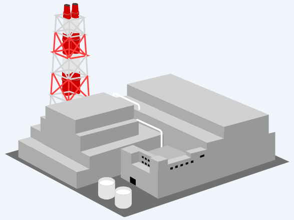
Rail automation

Automatic ticket gates

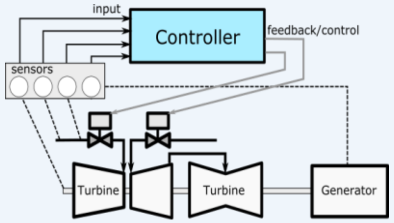


Vehicle control

Energy



Power Generation



Turbine Control

Industry

Industry automation

Industrial communication

CNC control

Others

Healthcare

Building automation

Broadcasting

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

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

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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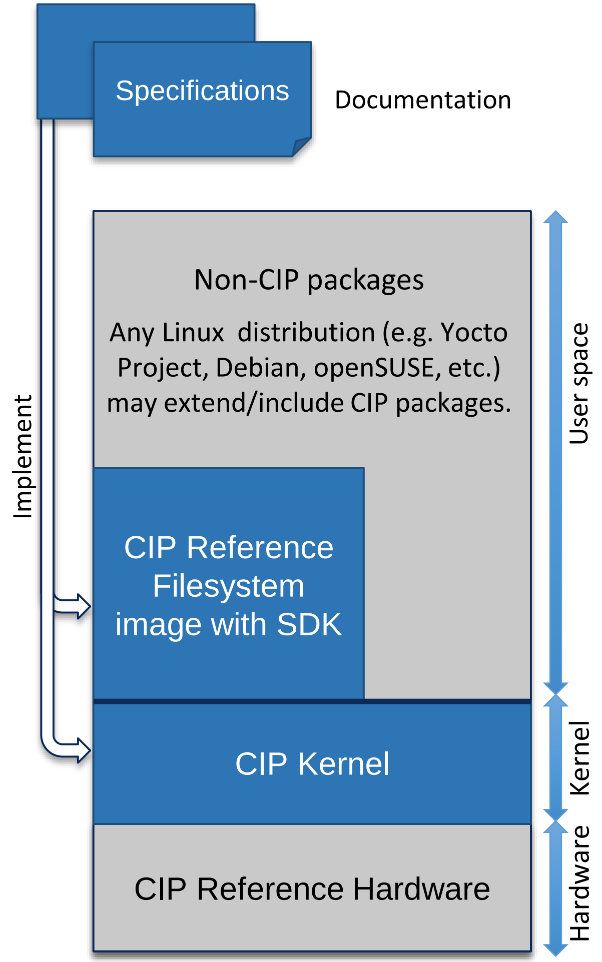
Civil Infrastructure Platform aims to provide industrial grade software

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

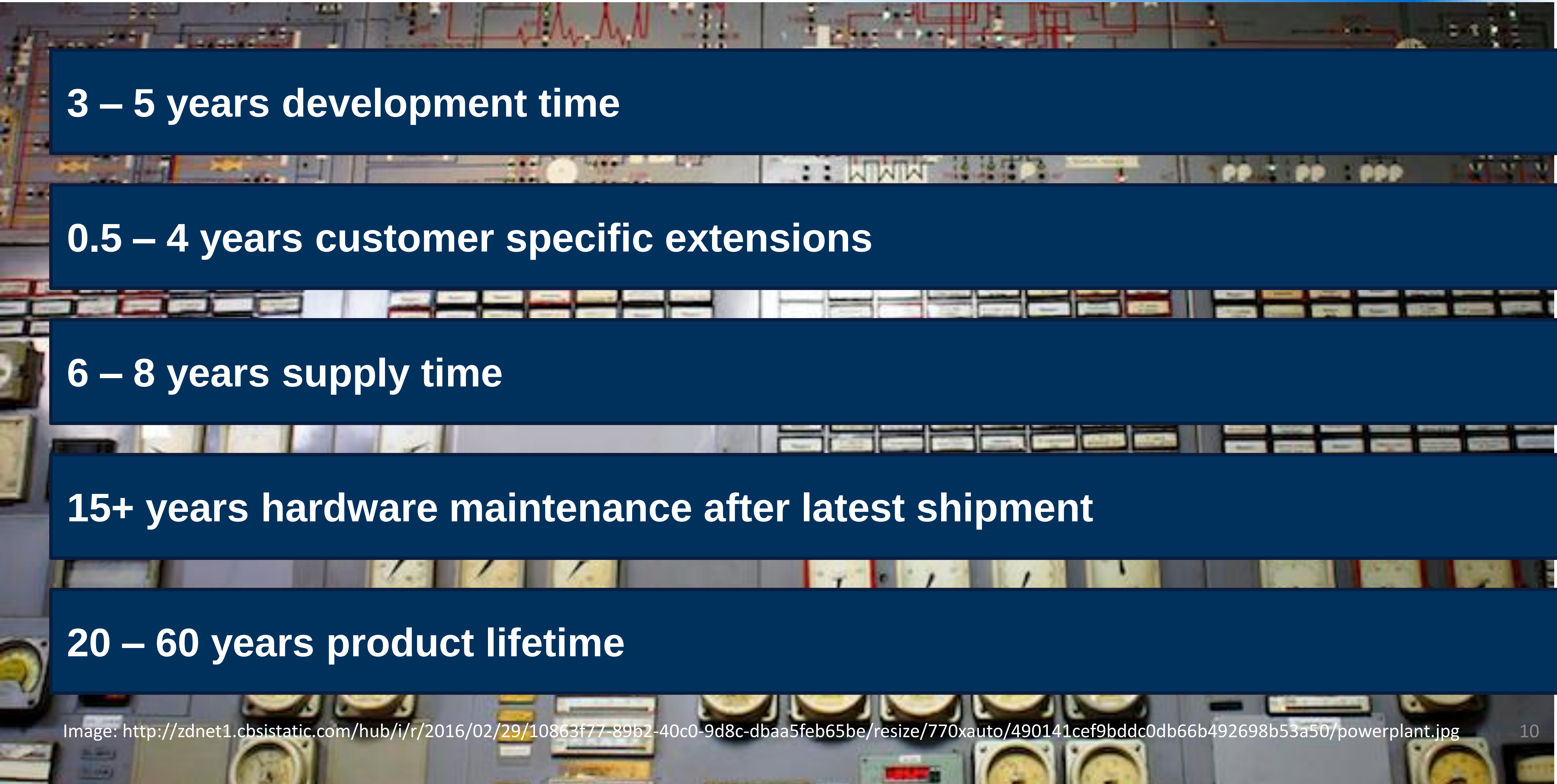
1 year initial safety certifications / authorization

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

Why maintaining old kernels?

1. Fear of regressions in newer kernels
   (performance and system stability)

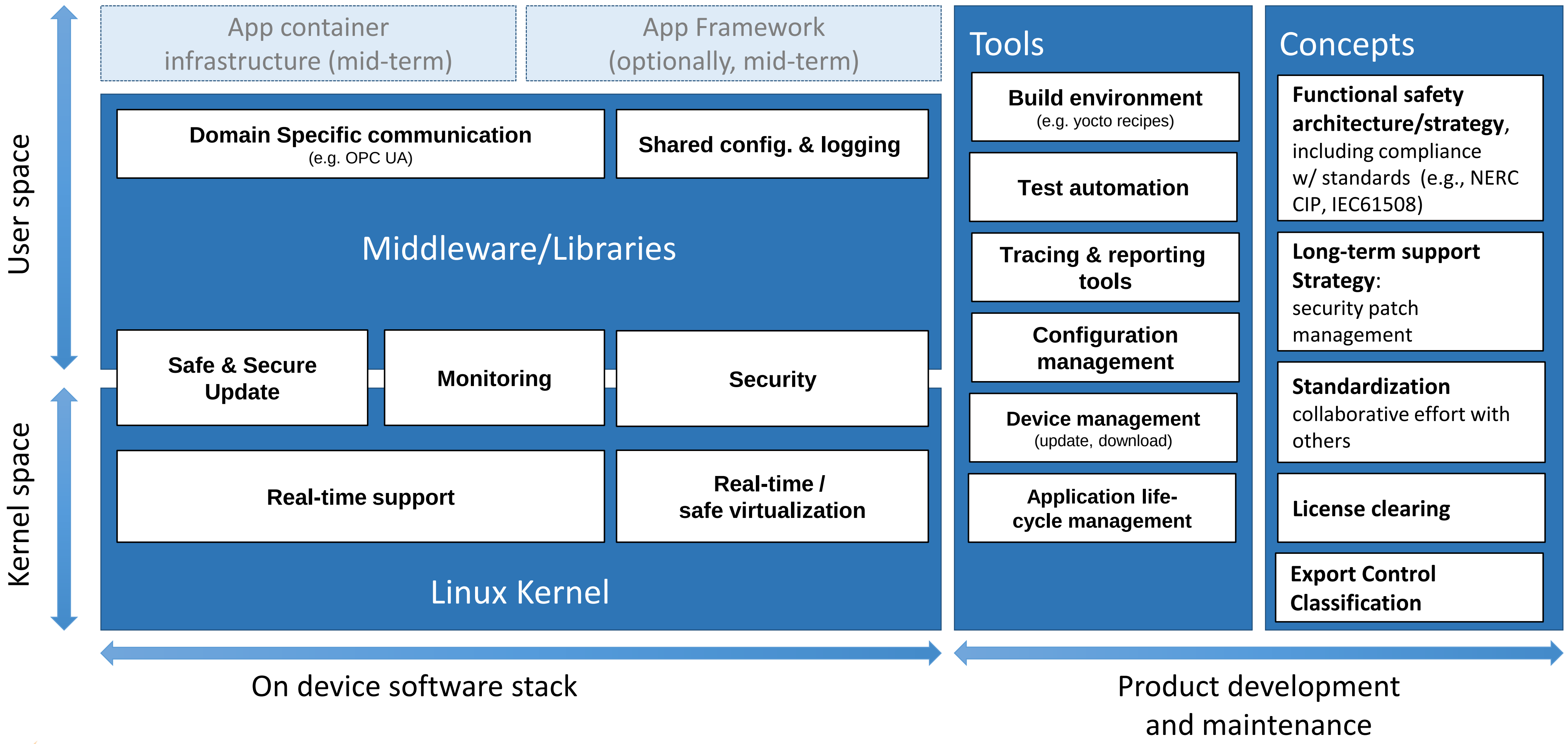
2. Reducing re-certifications costs and time by minimizing changes

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



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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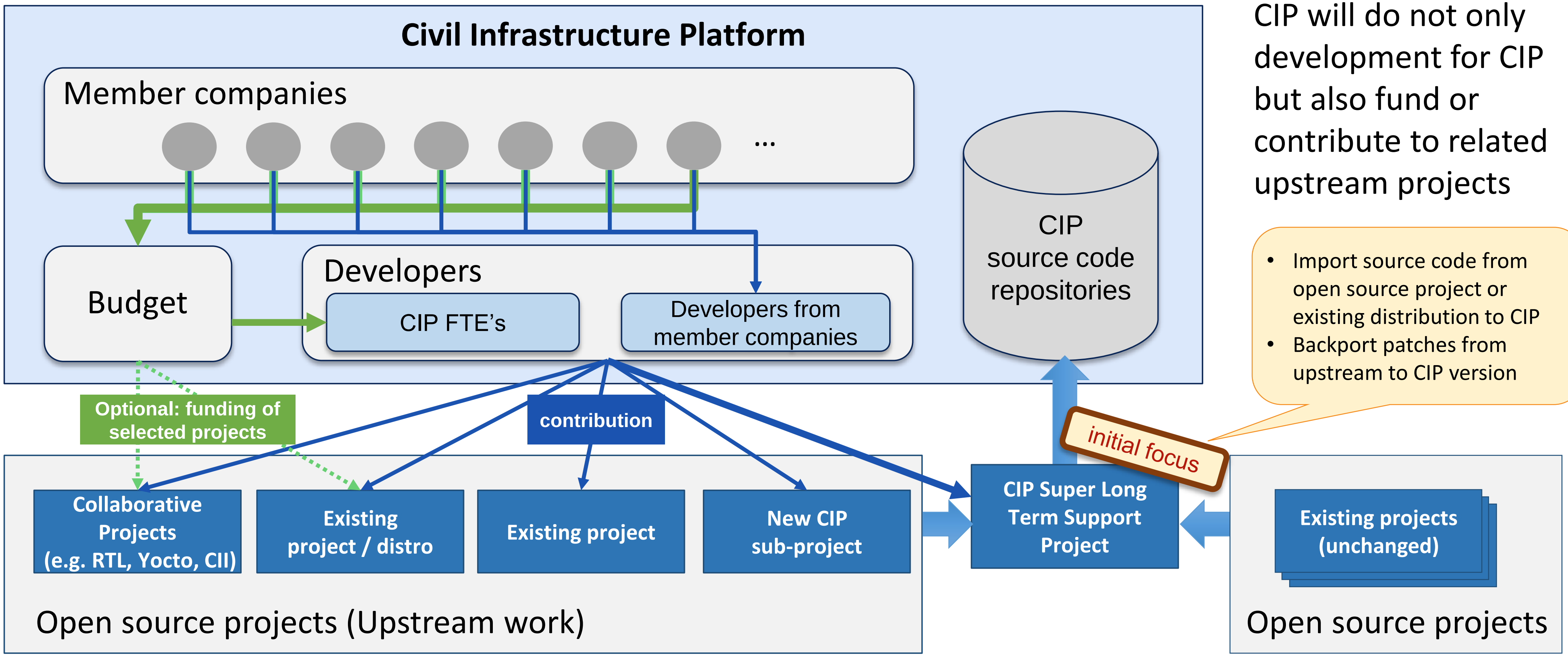
Relationship between CIP and other projects



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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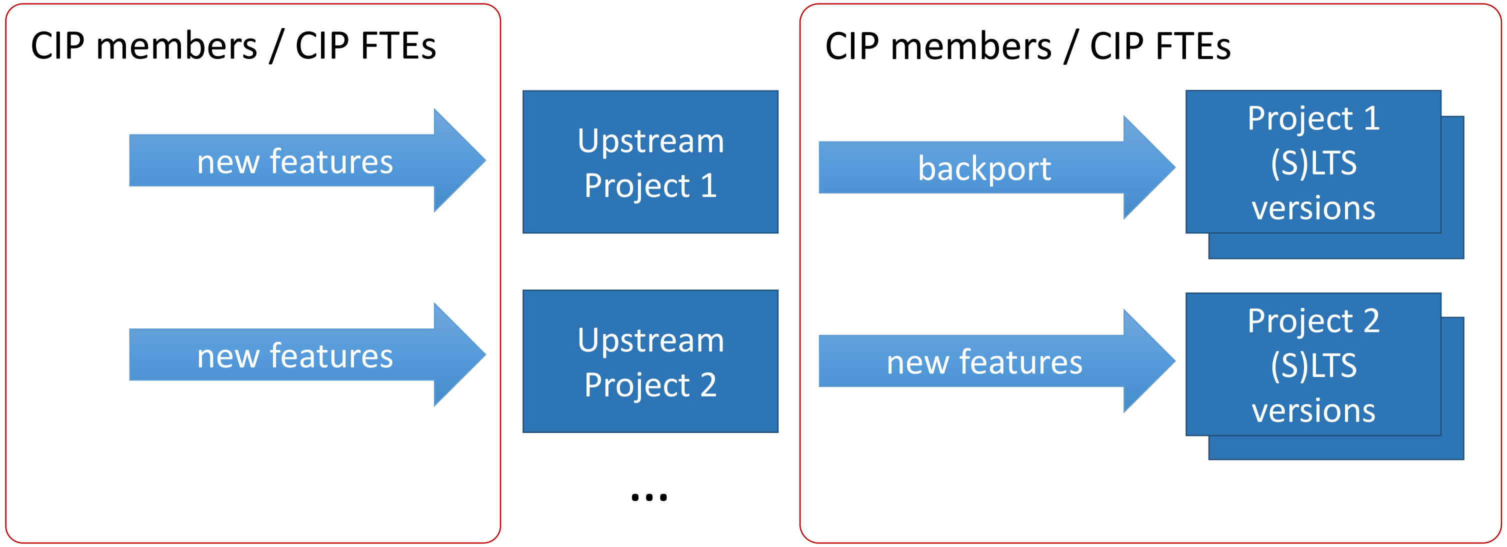
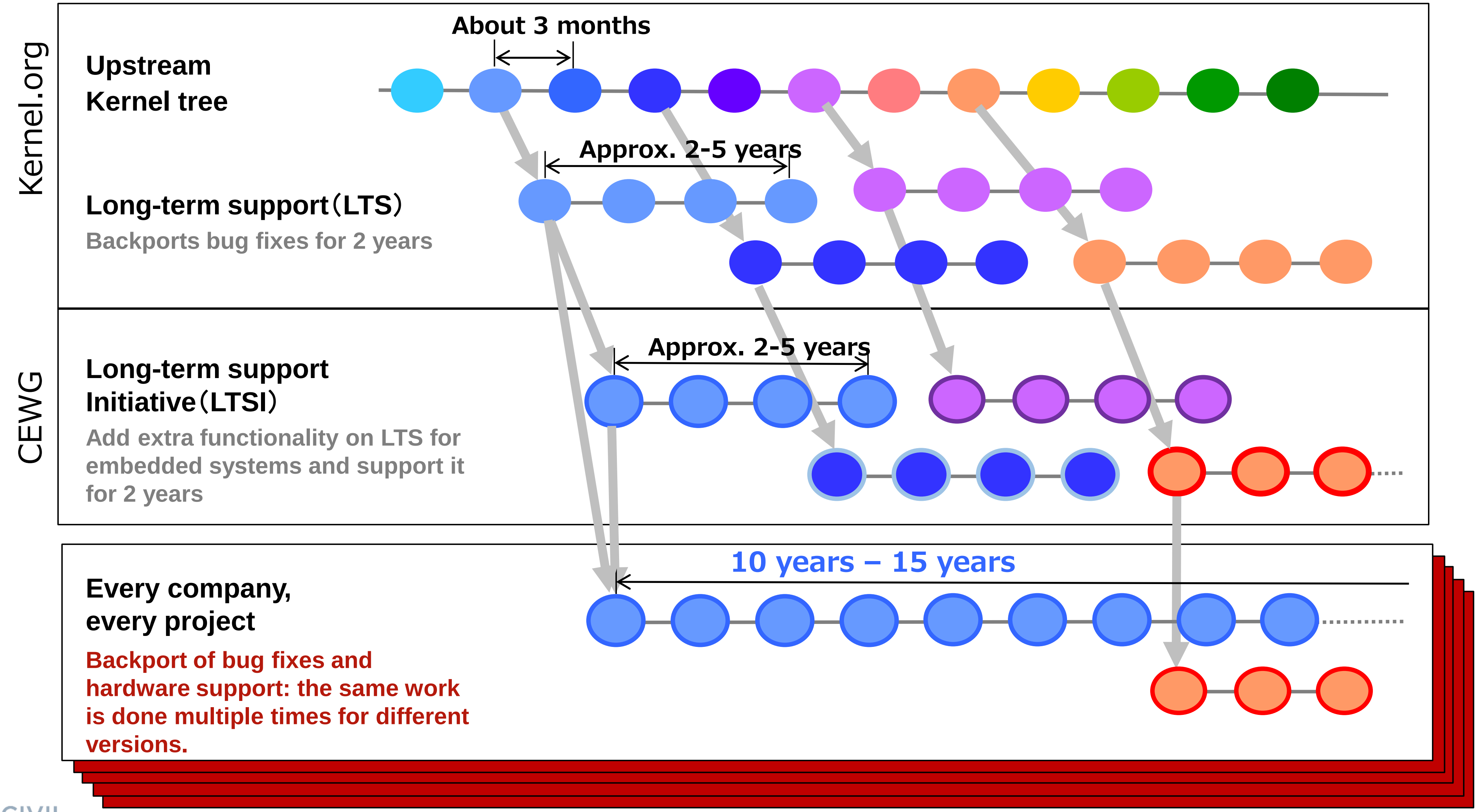
Upstream first policy for implementation of new features

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



Super Long Term Support - Motivation



Release / Maintenance release

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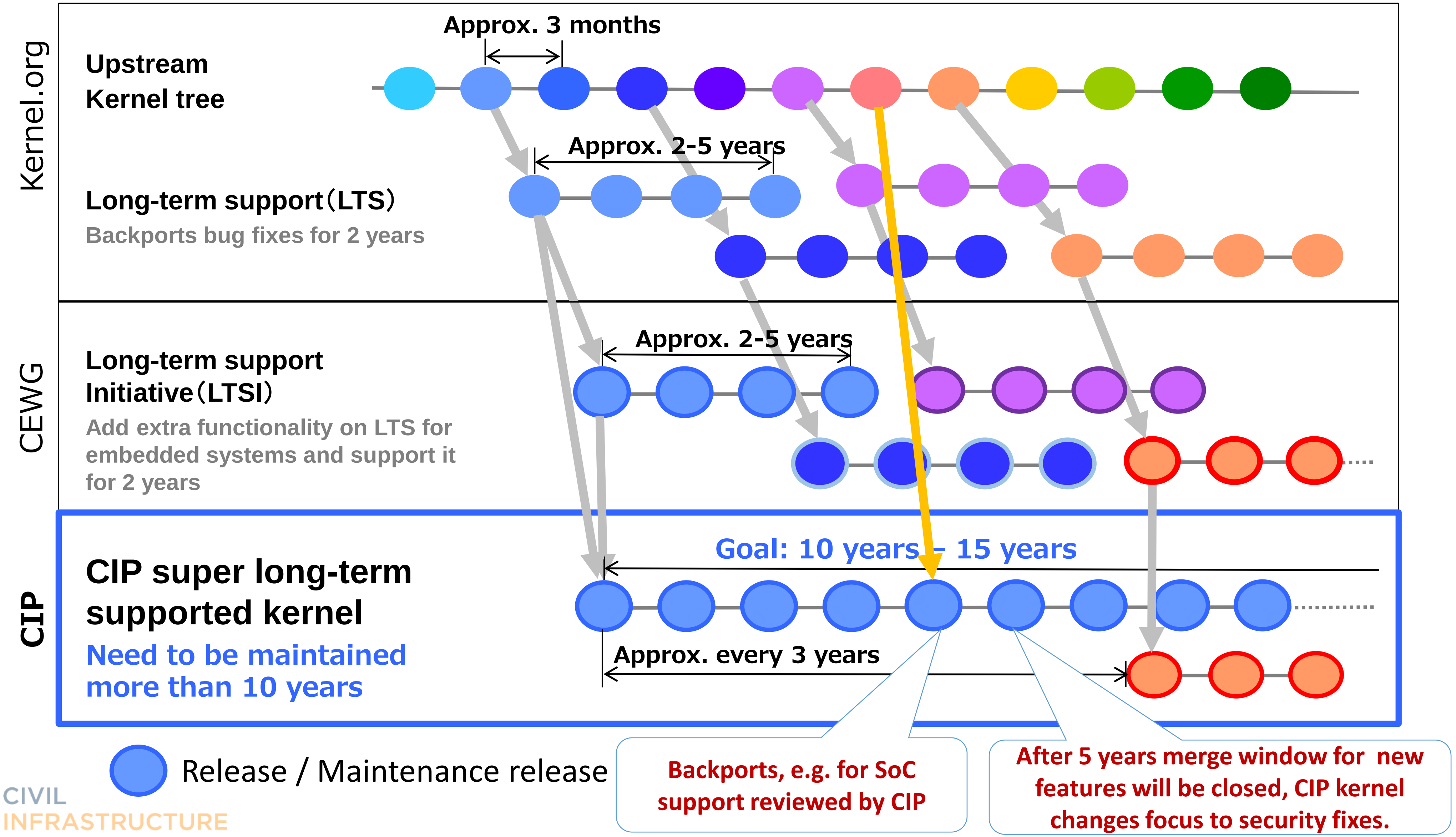
CIP kernel super long term support (SLTS) overview



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Plans for CIP SLTS kernel development

- Development Process
  - CIP will establish development process similar to LTSI
    - Merge window for feature backporting from upstream kernel
    - Validation period after the merge window
  - CIP will have periodical merge windows and validation periods for feature backporting

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

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 (TBA)
- 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

Selection Criteria for First SLTS Kernel Version

- LTS version, ideally synchronized with LTSI
- Broadly used for civil infrastructure systems
  - Currently deployed products
  - **Upcoming products**
- We are open for discussions / proposals!
- Final decision by CIP Technical Steering Committee

→ onging: CIP kernel maintenance policy

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

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

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
- Again: 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

Core Packages (SLTS)

- Bootloader
  - U-boot
- Shells / Utilities
  - Busybox
- Base libraries
  - Glibc
- Tool Chain
  - Binutils
  - GCC
- Security
  - Openssl
  - Openssh

Maintain for Reproducible build

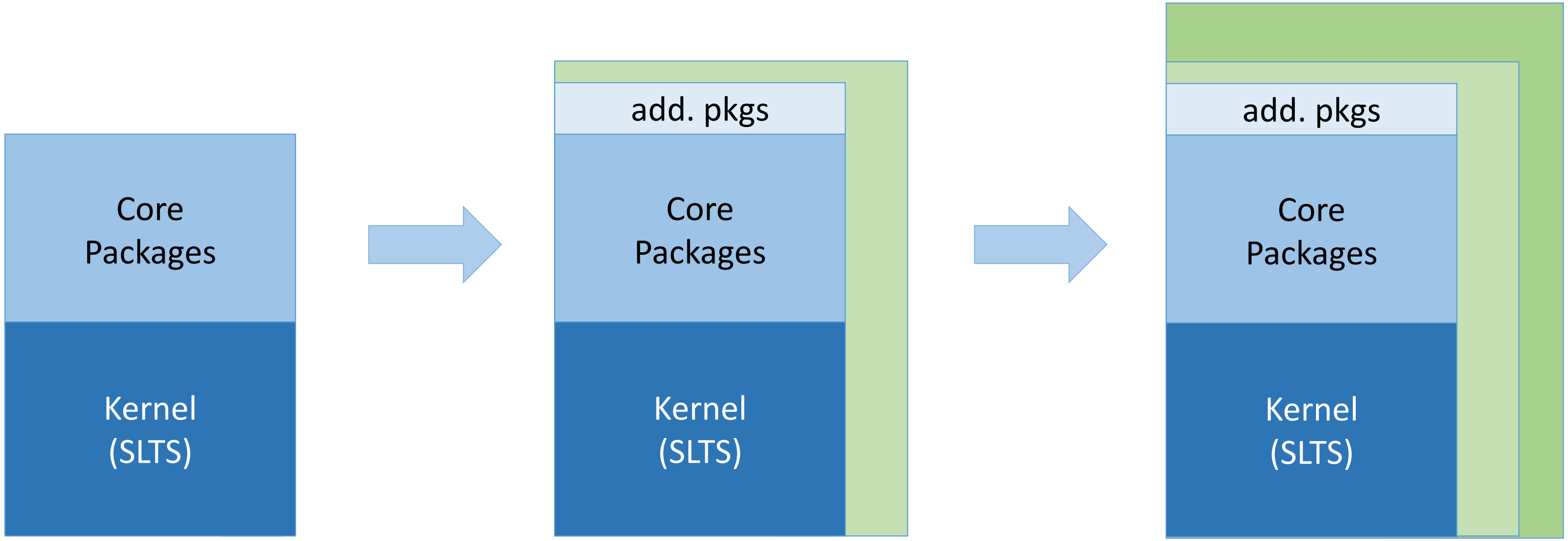
Dev packages

- 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.

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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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

Please join!

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

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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?

Thank you!