How to make Smart Cities stay smart with Open Source Projects

Yoshitake Kobayashi, Toshiba Corp., CIP TSC Chair
Open Source Summit Japan, Tokyo, July 17-19, 2019
IoT today – connecting systems

**Connected Cars**
Find and rent cars via smart phone. Monitor fleets and provide service.

**Industry**
Collect data to improve processes (cost, quality, speed). Minimize downtimes by predictive maintenance.

**Smart City**
Multimodal transportation, intelligent traffic control, smart energy management, emergency
Civil Infrastructure and its challenges
“Hidden” Industrial IoT Systems

**Transport**
- Rail automation
- Vehicle control
- Automatic ticket gates

**Energy**
- Power Generation
  - Turbine Control

**Others**
- Building automation
  - Broadcasting
  - Healthcare

**Industry**
- Industry automation
  - CNC control
  - Industrial communication

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Smart Cities combine consumer & industrial IoT

**Consumer IoT**

End user interfaces and comfort features

- e.g. car

Single or few operator companies

End user

Permanent cloud connection required.
Quality and availability: Best effort
Low-cost / high volume

**Industrial (grade) IoT**

Digital backbone of connected systems

Traffic control

Multiple users with different roles at different levels

Backend eco-systems

Controlled network zone

Complex systems: local intelligence + centralized intelligence
24/7 operation even with no connection to backend.
Guaranteed latency, throughput, and responsiveness.

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Smart Cities need a smart infrastructure

IoT technology to be applied to industrial systems
A Power Plant System:

25-60 years products life-cycle

Very reluctant to perform product updates and upgrades of hardware and base software platform
Security

...for millions of devices
The key challenges

• Apply IoT concepts to industrial systems.

• Ensure quality and longevity of products.

• Keep millions of connected systems secure.
Solving the Key Challenges
Speed and efficiency: focus on differentiating parts

Handling increasing complexity with constant development resources

Join forces by leveraging commodity components, partnering, and adapting open source software.

Open source software ensures long-term availability, flexibility, and maintainability without vendor lock-in.

Up to 2000

Proprietary application, proprietary operating system

2000 – 2015

Proprietary application

Operating System

2016 and beyond

Proprietary application

Middleware

Communication

Domain-specific frameworks

HMI frameworks

Augmented reality platforms

Mobile

Enterprise IT interfaces

Device

Cloud

Cloud orchestration

Cloud frameworks

IoT backend

Stream processing

Open source software ensures long-term availability, flexibility, and maintainability without vendor lock-in.

Differentiating

Why to buy the product

Commodity

Invisible for customers

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Facts and Issues: Smart City uses Commodity Software

Facts

- Millions or trillions smart devices
- Similar software components (e.g. Linux)
- Industrial IoT requirements
  - Security
  - Sustainability
  - Industrial-grade

Issues

- A lot of products have to meet IIoT requirements
- Same development and maintenance efforts spent by many companies or even business units
- **No common solution** for base building blocks

picture taken from Pinterest

https://www.pinterest.de/pin/554646510344033382/

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CIP is the Solution

Establishing an **Open Source Base Layer** of industrial-grade software to enable the use and implementation of software building blocks for Civil Infrastructure Systems
What is “Open Source Base Layer (OSBL)”?

Layered Linux distribution for industrial products, utilizing and influencing the relevant Open Source projects:

- **CIP Core packages** (tens)
- **Additional packages** (hundreds)
- **CIP kernel** (10+ years maintenance, based on LTS kernels)

Scope of a typical Linux distribution:

- **Company-specific middleware and applications**

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CIP Civil Infrastructure Platform Project ([https://www.cip-project.org](https://www.cip-project.org))  
LTS Long Term Support  
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Mapping CIP into the company

Layered Linux distribution for industrial products, utilizing and influencing the relevant Open Source projects:

Up to 70% effort reduction achievable for OSS license clearing and vulnerability monitoring, kernel and package maintenance, application adaptation and testing for an individual product.
The backbone of CIP are the member companies

Open Source Projects (Upstream work)

Budget: ¥ € £ $ → Developers, maintainers

Optional: funding of selected projects

Contribution & usage / integration

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CIP lays the Foundation for Sustainable Smart Cities
Scope of activities

User space
- App container infrastructure (mid-term)
- App Framework (optionally, mid-term)
  - Domain Specific communication (e.g. OPC UA)
  - Shared config. & logging
  - Multimedia

Middleware/Libraries
- CIP Core Packages
- Safe & Secure Update
- Monitoring
- Security
- Real-time support
- Real-time / safe virtualization

Linux Kernel
- Super Long Term Supported Kernel (STLS)

On-device software stack

Kernel space

Tools
- Build environment (e.g. bitbake, dpkg)
- Test automation
- Tracing & reporting tools
- Configuration management
- Device management (update, download)
- Application life-cycle management

Concepts
- Functional safety architecture/strategy, including compliance w/ standards (e.g., NERC CIP, IEC61508)
- Long-term support Strategy: security patch management
- Standardization collaborative effort with others
- License clearing
- Export Control Classification

Product development and maintenance

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CIP governance structure and projects

**Governed by Board (GB)**

**Technical Steering Committee (TSC)**

1. **SLTS kernel**
2. **Real-time**
3. **Testing**
4. **CIP Core**
5. **Security WG (*)**
6. **Software update WG**

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CIP Projects and its scopes

- **Industrial grade**
- **Sustainability**
- **Security**

(*) Workgroup

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Collaborative development with other OSS projects

Contribute, Collaborate and use by CIP

Upstream Projects
- mainline
- LTS
- Real-Time LINUX
-debian
- LAVA
- Reproducible Builds
- yocto
- KernelCI
- EDGE FOUNDARY

Contributing by CIP members as future candidates
- Jailhouse
- Fuego
- hawkBit
- 360

1. Upstream first
2. Use the upstream code
3. Integrate

CIP Open Source Base Layer (OSBL)

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Collaborative development with other OSS projects

Contribute, Collaborate and use by CIP

Upstream Projects
- mainline
- Debian
- RealTime
- LINUS
- KernelCI

CIVIL INFRASTRUCTURE PLATFORM

1. Upstream first
2. Use the upstream code
3. Integrate

CIP Open Source Base Layer (OSBL)

Contributing by CIP members as future candidates
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CIP SLTS kernel development (Upstream first development)

- **Goal**
  - Providing CIP kernels with more than 10 years maintenance period
    - Super Long Time Stable kernel

- **Status**
  - CIP SLTS kernels has been released
    - Linux 4.19.58-cip6 (July 12th)
    - Linux 4.4.185-cip35 (July 12th)
    - [https://git.kernel.org/pub/scm/linux/kernel/git/cip](https://git.kernel.org/pub/scm/linux/kernel/git/cip)
  - CIP kernel team participate into LTS review process
Real-time Linux development (PREEMPT_RT)

• Goal
  • CIP joins RT Linux project as Gold member to Work with them to upstream Real-time enhancement
  • Provide CIP SLTS kernel with real-time enhancement by using RT patch

• Status
  • CIP SLTS RT kernels has been released
    • Linux 4.4.166-cip29-rt21
    • Linux 4.19.13-cip1-rt
    • https://git.kernel.org/pub/scm/linux/kernel/git/cip
  • Test results are available on CI-RT
    • https://ci-rt.linutronix.de/RT-Test/

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### CIP Testing

**Goal**
- Providing a test environment to test the CIP kernel and more
- CI testing for CIP kernel and CIP Core

**Current status**
- First release was B@D
  - [https://gitlab.com/cip-project/board-at-desk-single-dev](https://gitlab.com/cip-project/board-at-desk-single-dev)
- Move to distributed testing environment on AWS with LAVA
- Integrating with GitLab-CI
CIP Core

• **Goal**
  - Provide a reference implementation with CIP core packages for testing
  - Following implementations are provided
    - Tiny profile
      - E.g. Small IoT devices
    - Generic profile
      - E.g. IoT gateways

• **Status**
  - CIP Core Tiny profile has been released
    - [https://gitlab.com/cip-project/cip-core](https://gitlab.com/cip-project/cip-core)
  - PoC implementation is available for Debian profile
Security working group

• Goal
  • Provide guidelines and reference implementations to help developers to meet cybersecurity standard requirements (IEC 62443)

• Status
  • Started for feasibility study
  • A demonstration scheduled at OSS Japan in July

* Noted that this image is under planning and for only illustrative purposes.
Software update working group

• Goal
  • Incorporate a common solution for software updates into CIP core
    • Device management
    • Deployment
    • Safe update

• Status
  • Selected OSS update tools
  • Demonstration will be shown at OSS Japan in July

Eclipse IoT hawkBit
SWUpdate
Suricatta
SWUpdate

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Summary

- CIP today focuses on
  - **Kernel maintenance**: maintaining Linux kernels for very long time including real-time support
  - **Testing**: providing a test infrastructure and evolve tests
  - **CIP Core packages**: a set of industrial-grade components that require very long-term maintenance including the required build tool chains
  - **Security**: Improving to have security features and to follow Cyber Security Standard
  - **Software update**: Incorporate a common solution for software updates into CIP core
  - **Collaboration**: Linux, Debian/Debian-LTS, Real Time Linux, Reproducible Builds, EdgeX Foundry
Conclusion

• Our Civilization needs an Open Source Base Layer of industrial-grade software
  • CIP provides this, using Linux
• Sustainability is ensured by
  • The backing of big industrial and semiconductor companies
  • Close cooperation with and building with mature Open Source projects
    (Debian, PREEMPT_RT, KernelCI, …)
  • Providing suitable tool chains
  • Ensuring in-depth tests
• **Contribution and collaboration with upstream projects are the key CIP activities**
Join us

CIP for sustainable Smart Cities with Open Source Software

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Contact Information and Resources

To get the latest information, please contact:

• CIP Mailing list: cip-dev@lists.cip-project.org

Other resources

• Twitter: @cip_project
• CIP Web site: https://www.cip-project.org
• CIP news: https://www.cip-project.org/news/in-the-news
• CIP Wiki: https://wiki.linuxfoundation.org/civilinfrastructureplatform/
• CIP source code
  • CIP GitLab: https://gitlab.com/cip-project
  • CIP kernel: git://git.kernel.org/pub/scm/linux/kernel/git/cip/linux-cip.git
Question?
Thanks you