Virtualization of PLC in Industrial Networks - Problem Statement

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Changes since last meeting

- Renaming

  draft-iotops-km-iiot-frwk draft-km-iotops-iiot-frwk

- Title

  Framework Virtualization of PLC

- Complete rewrite (should have started a new one)
  - Upon feedback on lack of motivation – ‘what’ and ‘why’

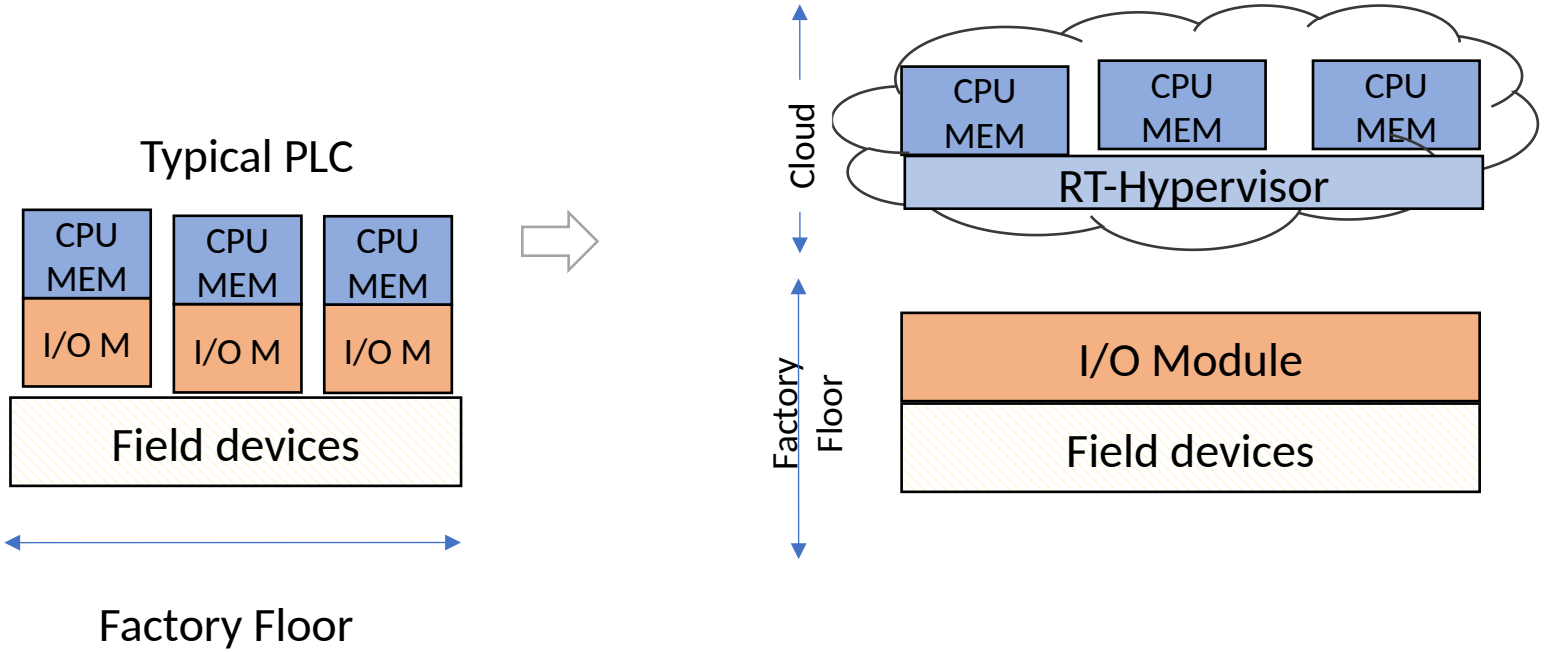
Industrial IoT:
Behind every device there is a rugged computer

- That Rugged Computer is Programmable Logic Controller that should survive harsh environmental conditions
- Definition:
  - PLC is a computer used to control and monitor devices. They run programs to monitor different inputs and logically manipulate the outputs for the desired control.
- PLCs are the basic building blocks of Automation everywhere
  - Programmable sequence of actions – smart manufacturing
  - Robotics based motion control
  - Continuous monitoring of operations based on sensors

Traditional PLC
Different size, types and Functions

Of course, choice of PLC depends on scenarios and applications

PLC sizing Nano	**I/O points** < 15
Micro	16-128
Medium	129-511
Large	512+ I/O



- **Problem**: As automation grows, solutions need bigger PLCs – occupy factory floors … *And some other limitations (covered in the draft)*
- **Solution**: Virtualize PLCs – Get all the same functions at scale and in elastic manner

Defining virtual PLC

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Virtualized PLC is a hardware-agnostic abstraction of
the control unit and memory functions of a PLC. It is
hardware- independent and still needs an interface to
communicate with the I/O modules.
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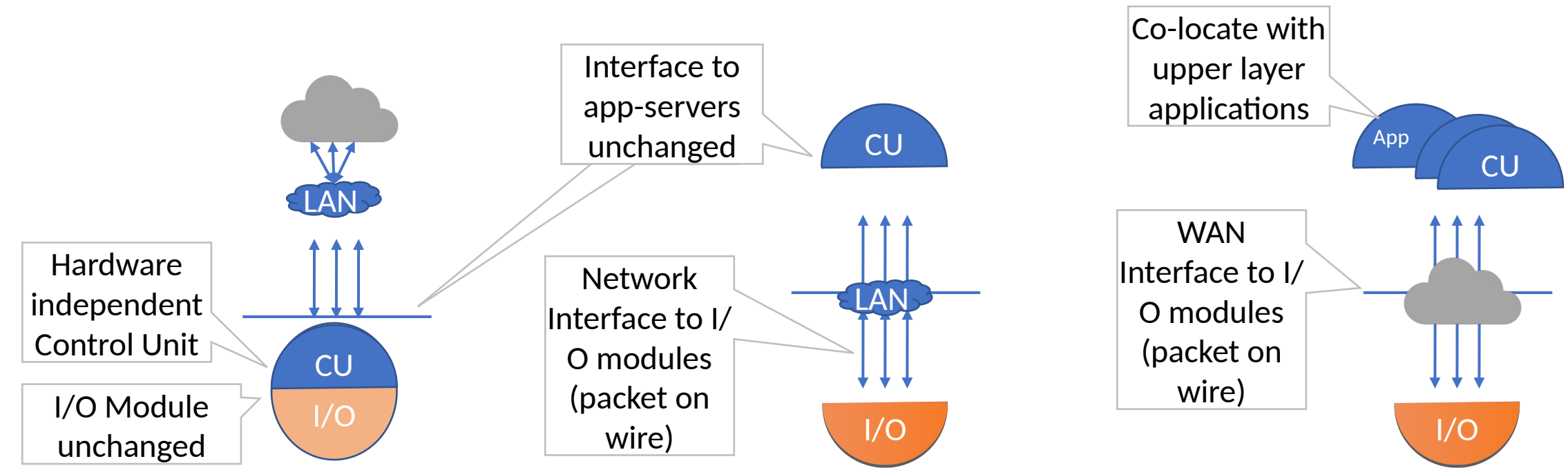
- There’s already few related trends
  - Virtualization of HMI, SCADA MES – other OT equipment is already happening
    - To use general purpose scalable hardware
    - Integration of HMI and higher-level functions with PLCs require higher processing power
  - Effectively, PLCs is the last component on the shop-floors that could be moved to cloud for rich processing capabilities and more memory.

Benefits over Conventional PLCs

- Leveraging more sophisticated compute and memory and virtualization technologies
  - Complex processes that require several steps
  - Integrate multiple PLC operations on a single platform – more compact data movement *(Hint: NFV or SFC)*
- Tighter application Integration
- Virtualization of PLCs will facilitate edge compute network support
  - Leased or own Edge data centers. Realtime constraints can still be met (*Hint: Detnet & High precision technologies*)
  - Physical space taken up by ‘rugged gear’ is reduced. Since Control unit can be remote.
- Virtual PLCs are closer to simulations *(Hint: realization of digital twins)*

Different Realization Approaches (Placement)

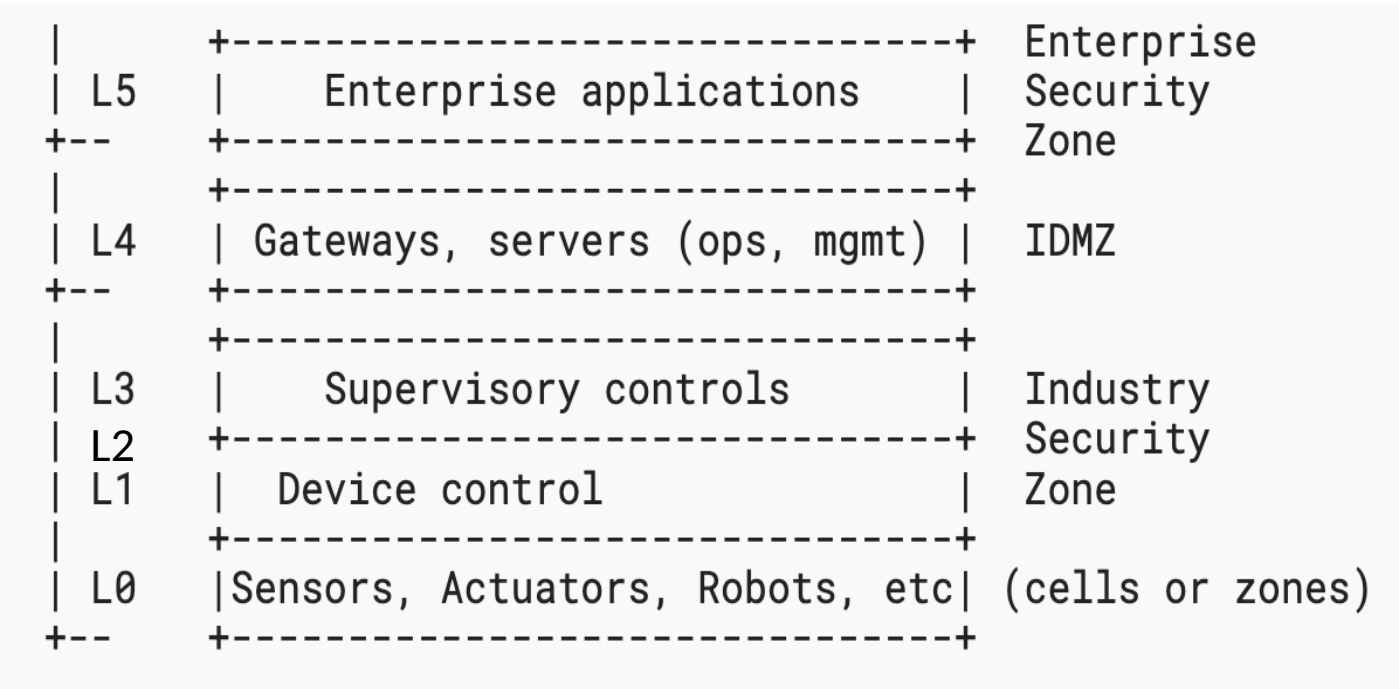


Hardware Independence

Intra-zone disaggregation

Disaggregated (cross-zone boundary)

Not So Easy – disaggregation is necessary



- Moving virtual PLCs to cloud requires breaking away hierarchical structure and security zone since PLCs were at L1-L2, now they could be at any level.
- So, the network architecture changes – perhaps is simplified

Problem Statement

- Associating virtualized PLCs with IO Devices
  - Should there be one PLC that speaks to an I/O module or any PLCs
  - How is it determined where a virtual PLC is located – edge or shop floor
- Expectations from the Networks
  - All the programmable components are abstracted out, this enables use of common interface from the virtual PLC to I/O modules.
  - Preservation of zone security and safety of operations utilize IETF technologies and non-DPI policy techniques.
- Limitations with Hierarchical Structure
- Multiprotocol fieldbus devices support –relates to interface to I/O modules

Requirements

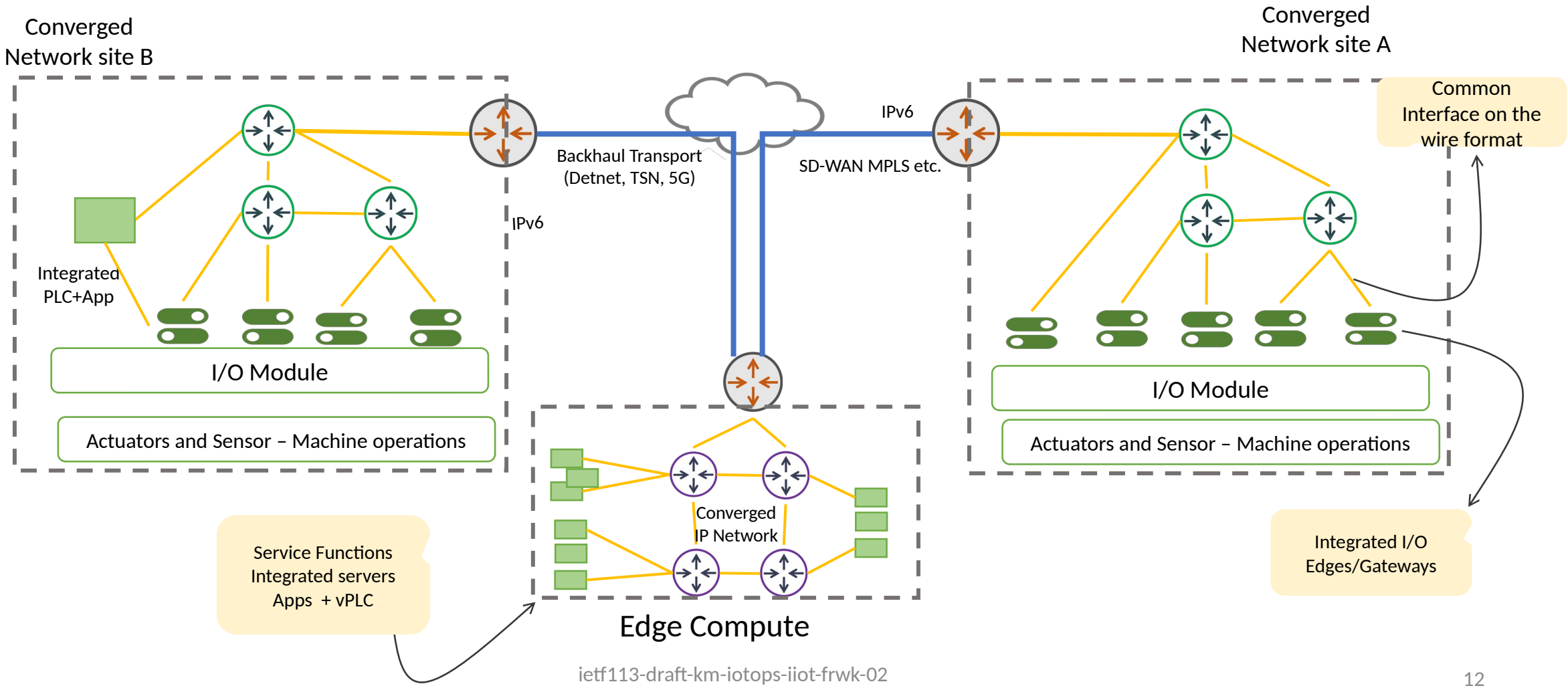
- Virtualized PLC Requirements
  - Addresses, network identifiers, scope, authentication
  - Associating I/O devices to controllers
- Key Performance Indicator Requirements
  - Security, reliability, safety of operations between Device and virtual PLC
  - Assume TSN/DETNET is leveraged
- Network Requirements
  - Common interface between device and vPLC
  - Converged/Unified/One fabric for all types of endpoint
    - With device to edge to cloud support

Feedback

- Start with evaluation - this problem statement and requirements
  - How to design network aspects of a virtual PLCs? – the address, verifications, authentication, security?
  - How Edge compute networks get utilized ?
  - How to disaggregate security zones?
  - What type of Converged Industry network fabric could emerge?
  - How to apply IETF technologies to Industrial networks?
  - How to maintain the safety of PLC operations?
- Lead into a framework that answers
  - Informational/best Practices type of document – to share with other SDOs.

Thank you

Backup - Converged Fabric with virtual PLC



Backup - Organization of the Document

Virtual PLCs

Definition & Feasibility (literature)

Benefits

General – focusing on the virtualization and abstraction aspects

Vs. Physical PLCs – Limitations in terms of size and general inflexibility

Problem Statement

Network Perspective - what will it take to support virtual PLCs

Or different ways they get deployed

Requirements

Derived from problem statement