Using Deterministic Networks for Industry Operations and Control

draft-km-detnet-for-ocn-00

Authors

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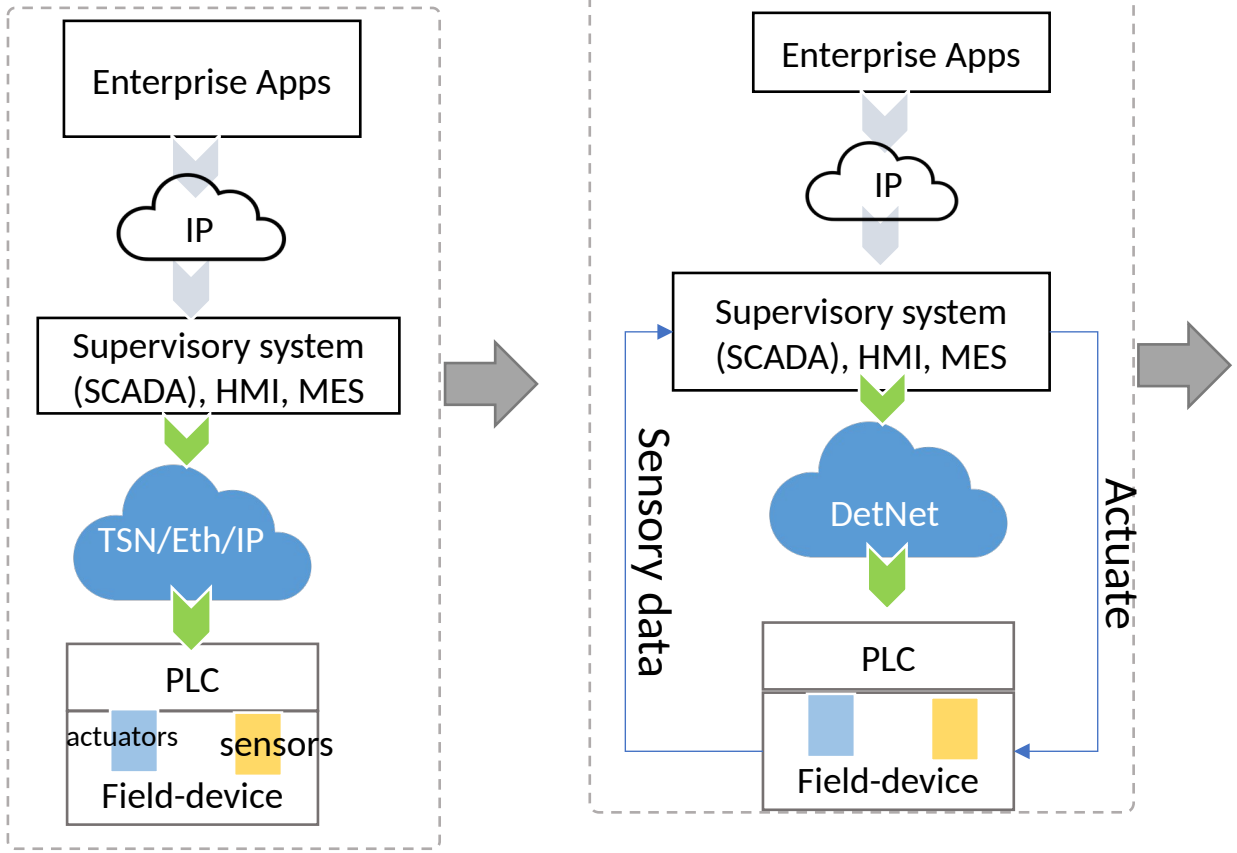
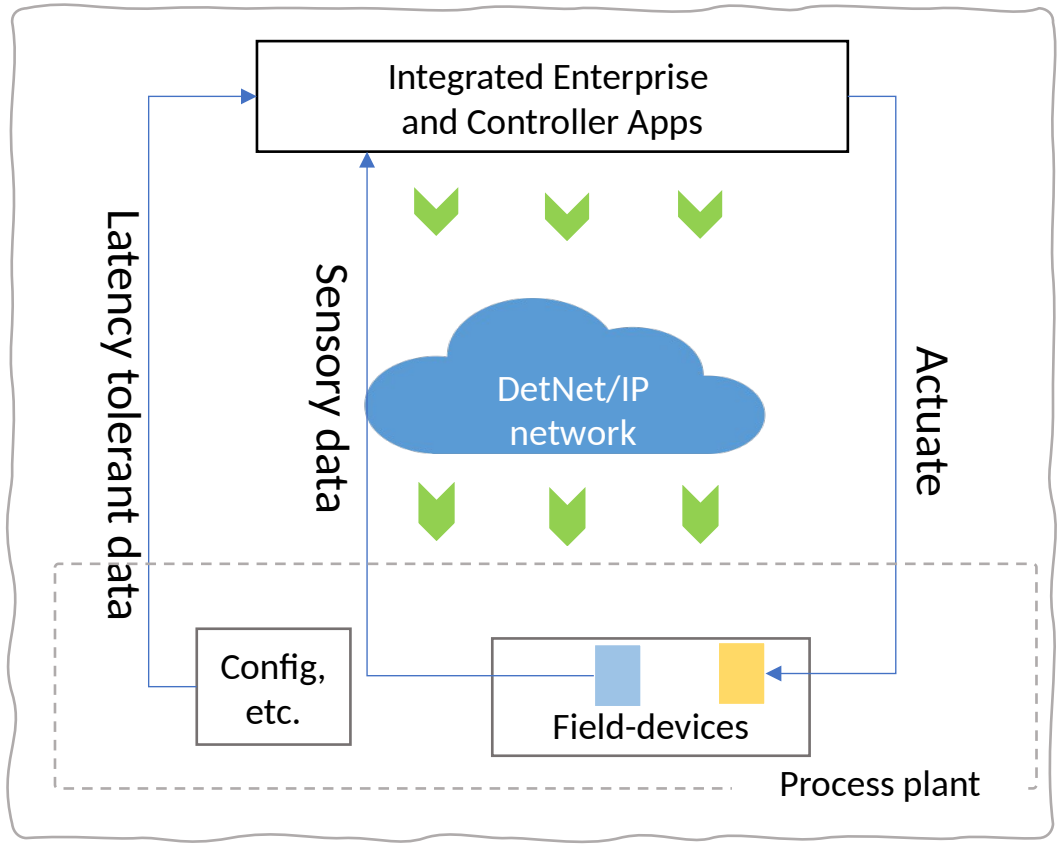
Problem Space

- Machine-to-machine type communication involves plethora of systems and industry verticals use process automation
  - E.g., factory automation, energy grids, remote driving…
  - or anything involving operational technology (OT)
- Generalization of remote process automation
  - Support deterministic network interface from end-system's perspective.
- An appropriate description of end-system side of DetNet is missing
- Provide application to DetNet interface
  - According to DetNet-Arch[RFC8655] Section 4.1 Figure 5.
  - This is identified as an interface between end system and relay-node
  - An under-specified aspect of DetNet but equally important

Cloud-Native DetNet App Scenarios





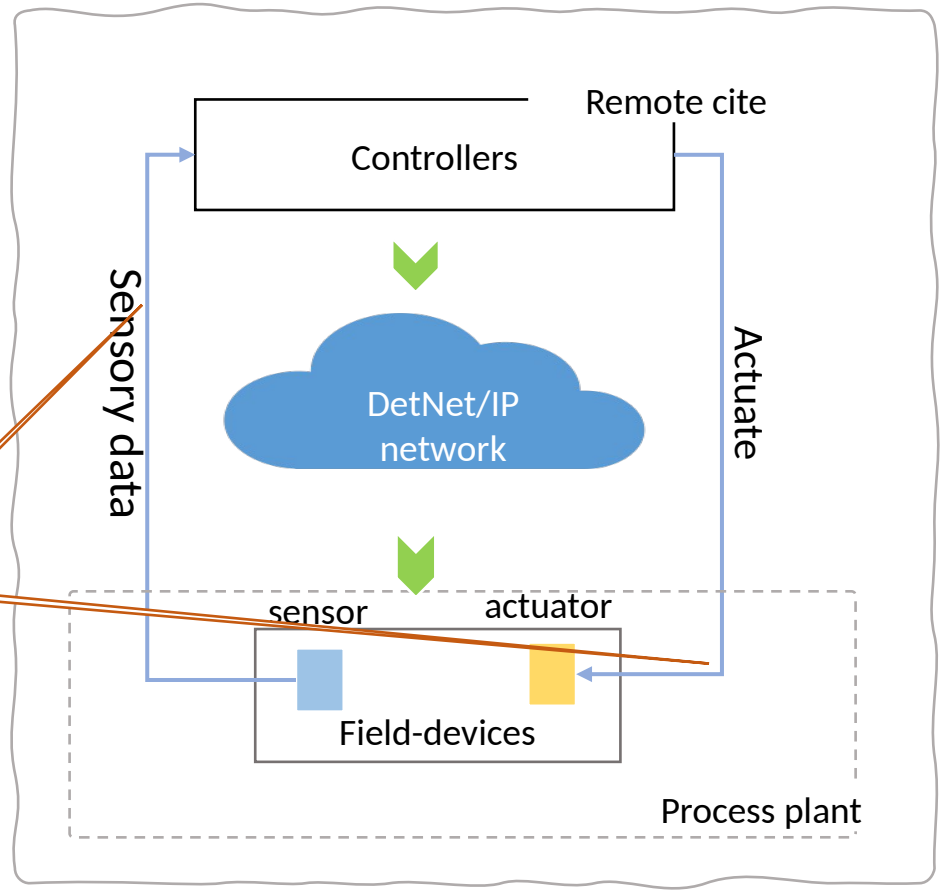
- **From L2 to L3**: DetNet helps with scalability by providing deterministic services over IP

- **Towards cloud-native DetNet Applications:** helps with simplification of process plant infrastructure.
- Advances applicability to broader set of use cases.

Generalization of interfaces
between the connected End systems

- Controllers
  - Associate with one of more field devices
  - All operations are controlled from these end systems
- Sensor
  - Emit operational data – periodically or event-based
  - Emit critical alarms.
- Actuating end-systems
  - Bring mechanical or physical changes to environment
  - Receive commands from controllers

- Common attributes
  - In general interface to actuators and sensors across different vendors and protocols is quite similar
  - Similar command- structure parameter changes
  - Represented as {controller, field-device} pair as communication endpoints.



Potential Traffic Patterns and Constraints

- Control Loops
  - To measure (sensor), compare (controller) and adjust (actuate) process variables
  - Each step is a separate instruction or packet as against a continuous flow.
- Periodicity
  - Many devices emit different type of readings with different interval
- Ordering
  - Must be preserved, out of order packets will be catastrophic to control loops
- Urgency
  - Failures and alarms must have highest precedence in the network.

- A deterministic network could support these patterns.
- Connect end systems to the network:
  - How end system can clearly communicate these without getting into the details of DetNet

Explicit Parameters to DetNet Sublayer Mappings

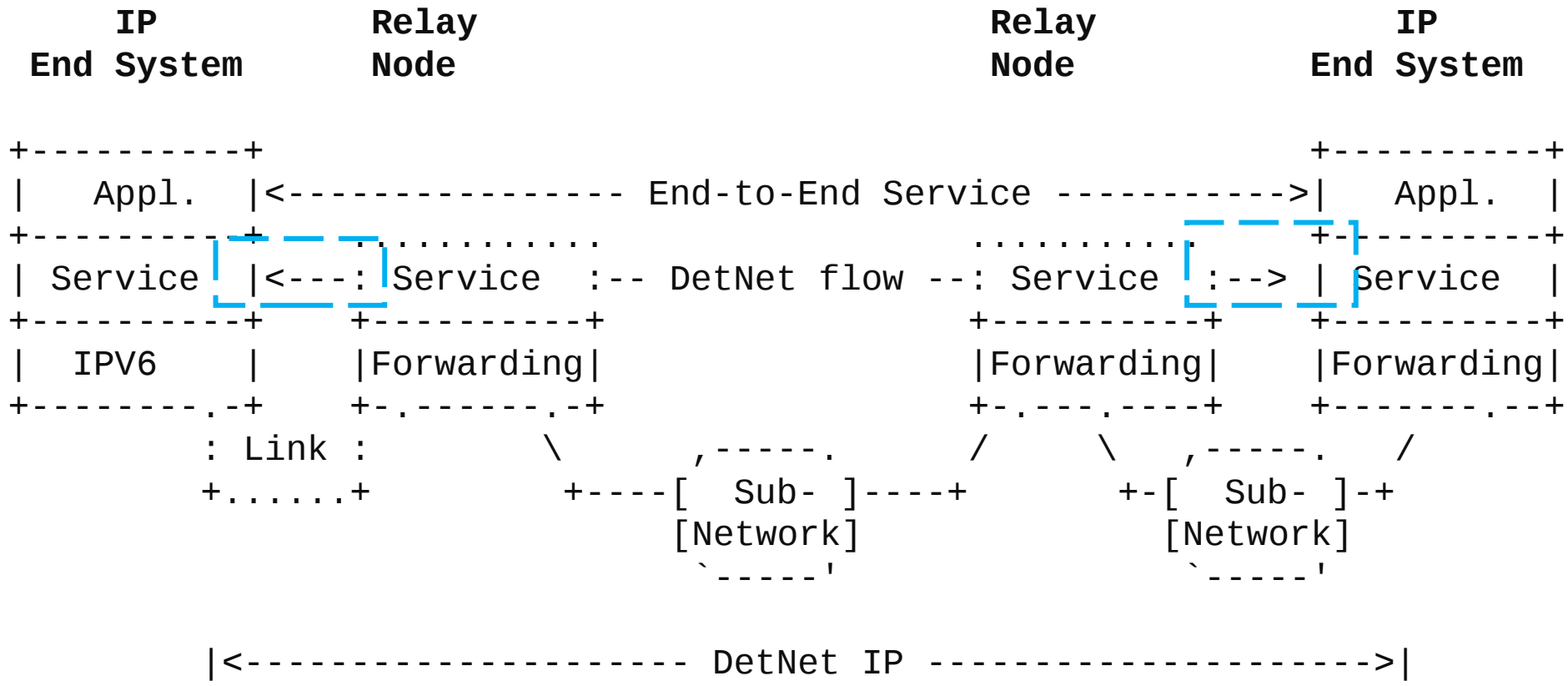


Figure 3: A Simple DetNet-Enabled IP Network, Ref. RFC8939

Considerations

- Operator vs Application view
  - Hide internals of various DetNet data plane from end-applications
  - End-systems are IP based, maybe design for IPv6 (no elegant way to extend on IPv4)
- Practical mapping of flow specific traffic treatment
  - In DetNet-IP [RFC 8939] section 5.3, flow id determines traffic treatment provisioned in the DetNet.
  - This could lead to scalability challenges [on going DP enhancements]
  - Limitations with service sub-layers
- Split Traffic flows
  - Architectural consideration. Most process automation is on-site,
  - With only support for remote monitoring
- Variety of traffic patterns within and for different {controller-field-device} pairs
  - Different latency bounds, urgent/alarm messages, closed control loops (bi-directional latency bounds) – these are per packet constraints
  - Generally long-lived DetNet flow reservations only provides coarse-granularity.

OCN Option (OCNO) as an EH option

- Motivated by HBH enhancements [draft-ietf-6man-hbh-processing-06] Nodes should not drop HBH packets if they don't process them.
- Forward looking cloud-based systems will support IPv6

Flag	Description
U	send message immediately. its an alarm
P	periodic packet (intervals in ~ms)
F	part of flowlet. see Nonce and seq
L	bounded latency spec provided
R	Reliability with no packet loss tolerance
V	Delay variation with no packet loss tolerance

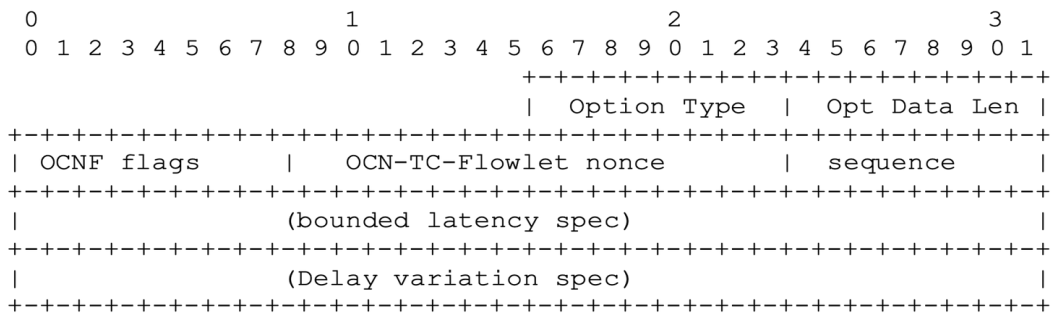


Figure 4: Explicit Traffic Control HBH Options

- Provides a reasonable way to interact with the DetNet Relay nodes
- Programmatic interface is application friendly (M2M Comm.)

Take aways and Discussion

My comments

1. Applications should not have to understand the intricacies of a DetNet service
2. IPv6 based solutions more suitable for end-hosts
3. interface provides lot more flexibility (consider different DETNET-DPs)
4. How to describe finer-details in a DetNet flow? E.g. {controller-fielddev} pair.

Request to the group

5. Feedback on the problem space
6. Does this align with DetNet WG scope
7. Comments on the solution approach? Any other options we can explore?

Thank you!