# DetNet WG

## IETF #94, Yokohama

## Use Cases Consolidated Draft

Monday, November 2nd, 2015

Ethan Grossman, editor

Use Case Authors

**Pascal Thubert** (Cisco) (Wireless for Industrial)
**Craig Gunther** (Harman) (Pro Audio)
**Ethan Grossman** (Dolby)
**Patrick Wetterwald** (Cisco) (Electrical Utilities)
**Jean Raymond** (Hydro Quebec)
**Jouni Korhonen** (Broadcom) (Cellular Radio Access Networks)
**Subir Das** (Applied Comm Sci) (Building Automation Systems)
**Yu Kaneko** (Toshiba)
**Yiyong Zha** (Huawei Tech) (Mobile Networks, Video, Games, VR)

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    - draft-grossman-detnet-use-cases-00
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# Use Case Draft Goals

- Provide Industry context for DetNet goals
  - What are the use cases?
  - How are they addressed today?
  - What do we want to do differently in the future?
  - What do we want the IETF to deliver?
- Highlight commonalities between use cases
- Yardstick for functionality of any proposed design
  - To what extent does it enable these use cases?
- This DetNet use case draft explicitly **does not**
  - State specific requirements for DetNet
  - Suggest specific design, architecture, or protocols

# Use Case Draft Origin

- Same use cases presented at IETF93 DetNet BOF
  - https://www.ietf.org/proceedings/93/slides/slides-93-detnet-1.pptx
- Based on IETF93 (and new) drafts
  - Wireless for industrial applications
    - draft-thubert-6tisch-4detnet-01
  - Professional audio
    - draft-gunther-detnet-proaudio-req-01
  - Electrical utilities
    - draft-wetterwald-detnet-utilities-reqs-02
  - Building automation systems
    - draft-bas-usecase-detnet-00
  - Radio/mobile access networks
    - draft-korhonen-detnet-telreq-00
  - Mobile Networks, Video, Games, VR
    - draft-zha-detnet-use-case-00

# Use Case Draft Status

- A single Use Case document
  - To be owned by the WG
  - All use cases in one place
- Sufficient detail to show the use cases, not more
- Currently a copy-and-paste from individual drafts
- Work in progress - does not yet meet goals

# Use Case Draft Future Plans

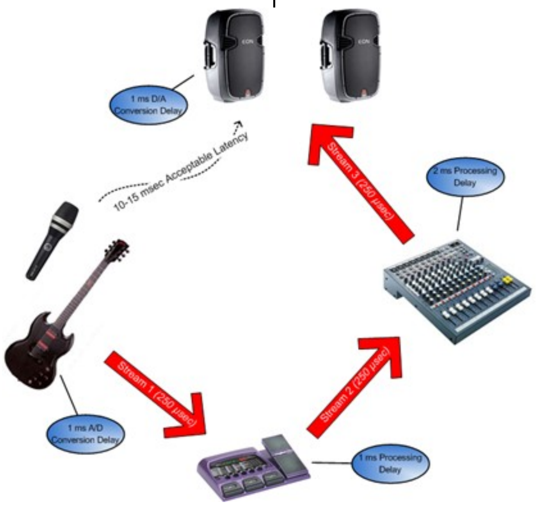
- Streamline details to the minimum required
  - Improve readability, ease of understanding
- Highlight commonalities between use cases
- Add more use case drafts as needed
  - Industrial (in process)

# Use Case Overview

- As presented at IETF93 DetNet BOF
  - Professional audio
  - Electrical utilities
  - Building automation systems
  - Wireless for industrial applications
  - Radio/mobile access networks
- Brief summary of each

# Professional Audio

- Music and Film Production Studios
- Broadcast
- Cinema
- Live (10-15ms worst case latency)
  - Stadiums, halls, theme parks, airports




Today

- Expensive proprietary networks
  - Intensive manual configuration of entire A/V network
  - Over provisioned bandwidth requirements
  - Separate networks for Data and A/V
  - Latency due to extra buffering (to avoid underruns)
- Separate AVB Layer 2 LANs
  - Can't route over IP, thus hard to scale up

# Pro Audio Future

- Share content between Layer 2 AVB segments within a Layer 3 intranet
  - 46 Tbps for 60,000 signals running across 1,100 miles of fiber
  - Geographically distributed
- Plug-and-play all the way up the protocol stack
  - Reduce manual network setup and admin
  - Allow quick changes in network devices and topology
- Re-use unused reserved bandwidth for best-effort traffic

# Pro Audio asks from IETF

- Campus/Enterprise-wide
  (*think size of San Francisco*)
- Layer 3 routing on top of AVB QoS networks
  - Content delivery with bounded, lowest possible latency
  - Intranet, i.e. not the whole Internet (yet…)
  - IntServ and DiffServ integration with AVB (where practical)
- Single network for A/V and IT traffic
  - Standards-based, interoperable, multi-vendor
  - IT department friendly

# Utility Networks

## Example - Quebec

- **514 substations**
  - Max 280 km between substations
- **60 generating stations**
- **143 administrative buildings**
- **10,500 km of optical fibre**
- **315 microwave links**
  - Covering 10,000 km
- **205 mobile radio repeater sites**
- Carries instantaneous electrical information
  - Currents, voltages, phases, active and reactive power…
- Carries real-time commands
  - Trip, open/close relay…

# Utility Networks Today

- Use of TDM networks
  - Dedicated application network
  - Specific calibration of the full chain (costly)
- No mixing of OT and IT applications on the same network

# Utility Future

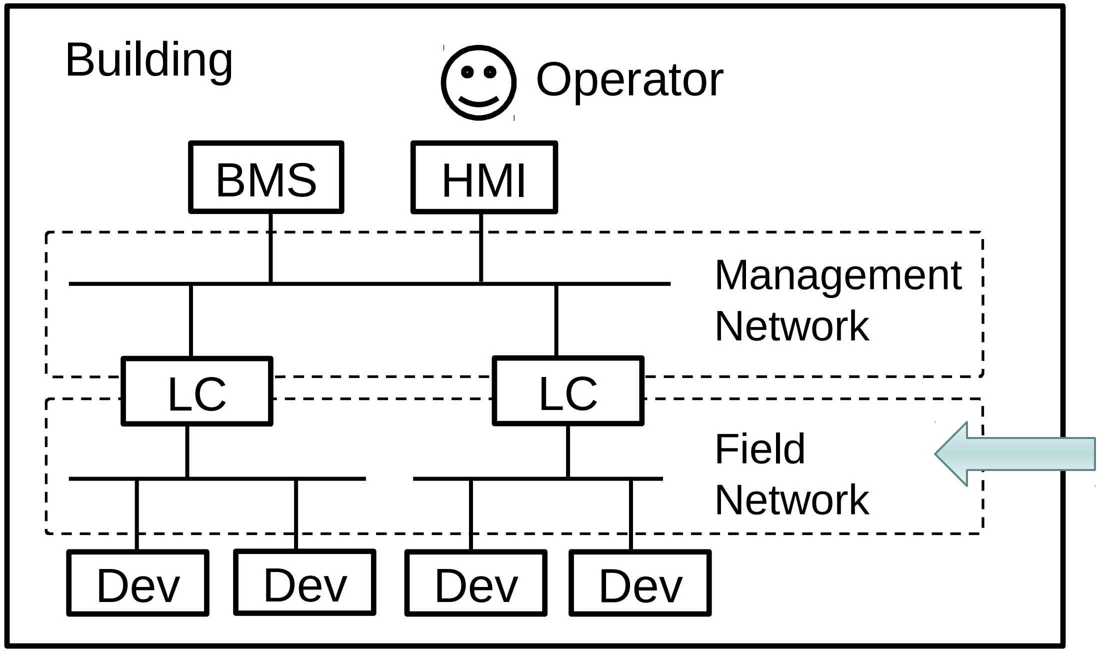
- Increase electric grid reliability / optimization
- Support distributed energy resources
- Move from TDM to Multi-Services network

# Utility asks from IETF

- Mixed L2 and L3 topologies
- Deterministic behavior
  - Bounded latency and jitter
  - High availability, low recovery time
  - Redundancy, low packet loss
  - Precise timing
- Centralized computing of deterministic paths
  - Distributed configuration may also be useful

# Building Automation Systems (BAS)

- Monitor and control the states of various devices
  - sensors (temperature, humidity), room lights, doors, HVAC, Fans, valves...




LC needs to communicate devices at each **10ms~100ms with 99.9999% availability** for feedback control and emergency control (e.g., fire detection)

BMS = Building Management Server

HMI = Human Machine Interface

LC = Local Controller

# Building Automation Today

- There are many protocols in the field network
  - Different MAC/PHY specifications
    - Some proprietary, some standards-based

  ⬇

  - Low interoperability
    - Vendor lock in
    - High development cost for Local Controllers
    - Need protocol translation gateways

  ⬇

  - Expensive BAS

- Some field network protocols do not have security
  - Not so bad when isolated but now things have changed
    - IT and OT are on the same internal network

# Building Automation Future

- More and more sensors, devices
  - Large and complex networks
  - Fine grain environmental monitoring and control >> Reduction of energy consumption

- Connected to other networks (e.g., Enterprise network, Home network, Internet)
  - Better management of network to improve residents and operator’s convenience and comfort
    - Control room lights or HVAC from desktop PC in office, Phone apps and so on
    - Monitor and control device status via the internet

# BAS asks from IETF

- An architecture that can guarantee
  - Communication delay < 10ms~100ms with several hundreds of devices
  - 99.9999% network availability
    - detailed requirements depends upon BAS functions (environmental monitoring, fire detection, feedback control and so on)

- An interoperable protocol specification that satisfies the above timing and QoS requirements

# Wireless for Industrial

Where wired is not an option

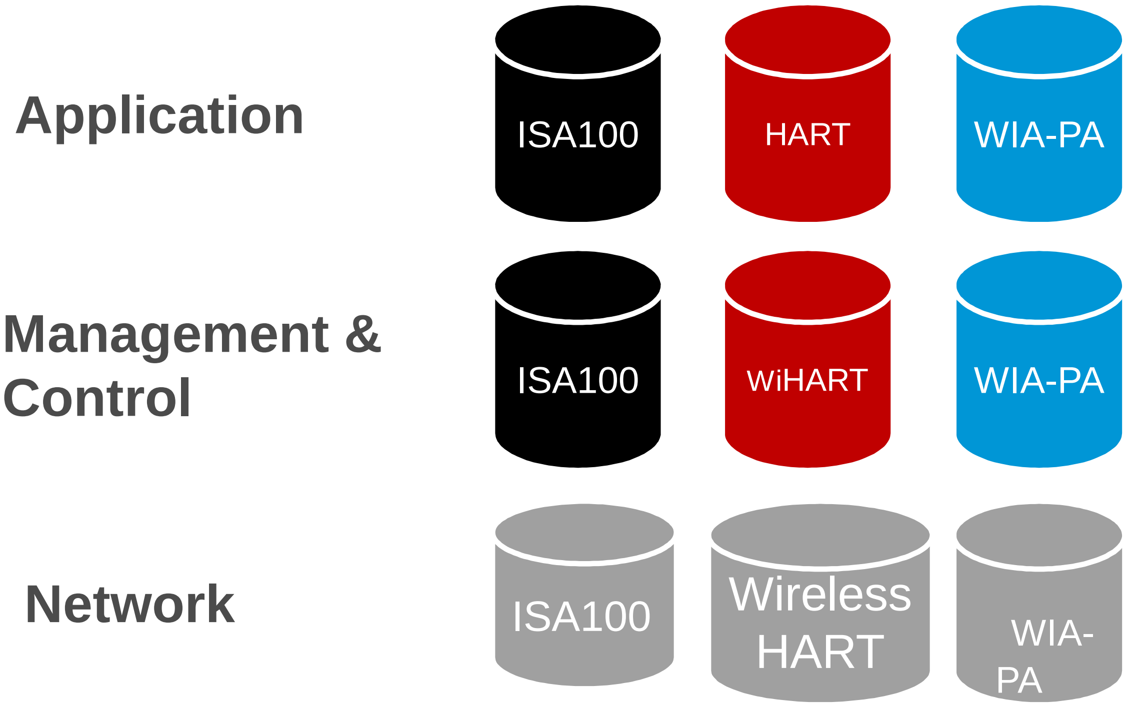
- Rotating, portable, or fast moving objects
- Resource-constrained (IoT) devices

- Real-time QoS required
  - Sensors and actuators
  - Control loops
- Huge networks, real-time big data
  - IoT, Factories
  - Distributed sensing and analytics
- Reliability, redundancy
- Security
- Huge, cost sensitive market
  - 1% cost reduction could save $100B

# Wireless Industrial Today

**Multiple deterministic wireless buses & networks**

- **Incompatible with each other and with IP traffic**

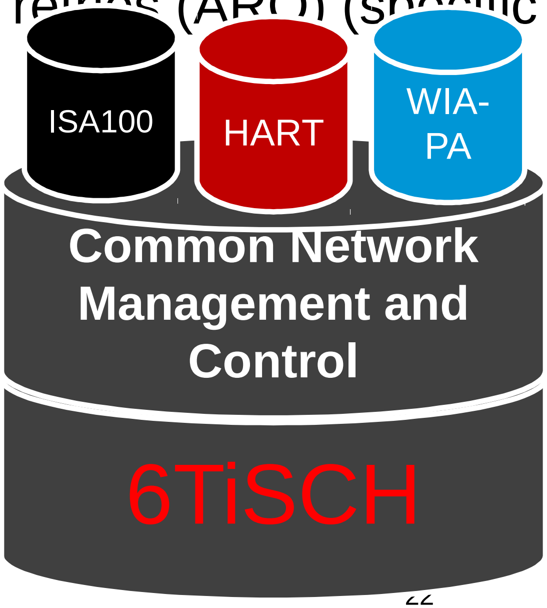


## Wireless Industrial future using 6TiSCH

- Unified network and management
  - Support deterministic and best-effort traffic
  - Wide Area, IP routing
  - Reduce cost – replace multiple buses
  - Enable innovation – optimize, gather previously unmeasured data
  - Leverage open protocols (IETF, IEEE and ETSI)
  - Use IPv6 to reach non-critical devices for Industrial Internet
- Use 6TiSCH for deterministic wireless
  - Time-Slotted Channel-Hopping Wireless MAC

# 6TiSCH asks from IETF

- 6TiSCH depends on DetNet to define
  - Configuration (state) and operations for deterministic paths
  - End-to-end protocols for deterministic forwarding (tagging, IP)
  - Protocol for packet replication and elimination
  - Protocol for packet automatic retries (ARQ) (specific to wireless)



# Radio Access Networks

- Connectivity between the remote radios and the baseband processing units
- Connectivity between base stations
- Connectivity between the base stations & the core network

Base band to radio heads – *very* *strict* latency & jitter and BER requirements. High BW needs. Precise synchronization.

Core to base station – business as usual so far. Latency becoming a concern.

```
       Y  (remote radios)
        \
  Y__    \.--.                  .--.         +------+
      \_(     '.    +---+     _(Back'.       | 3GPP |
Y------( Front  )----|eNB|----(  Haul  )----| core |
      ( `   .Haul )  +---+   ( `   .  )  )  | netw |
      /`--(___.-'      \      `--(___.-'    +------+
   Y_/     /            \.--.      \
        Y_/            _( Mid`.     \
                      (   Haul )     \
                      ( `  .  )  )    \
                       `--(___.-'\_____+---+    (small cells)
                              \        |SCe|__Y
                            +---+      +---+
                         Y__|eNB|__Y
                            +---+
                          Y_/   \_Y ("local" radios)
```

Between base stations – developing towards tighter latency, jitter & synchronization requirements.

# Radio Access Networks Today

- Front-haul (base band to radio)
  - Dedicated point-to-point fiber connection is common
  - Proprietary protocols and framings
  - Custom equipment and no real networking

- Mid-haul (between base stations) &
  Back-haul (core to base station)
  - Mostly normal IP networks, MPLS-TP, etc.
  - Clock distribution and sync using 1588 and SyncE

# Radio Access Networks Future

- Unified standards-based transport protocols and standard networking equipment that can make use of underlying deterministic link-layer services
- Unified and standards-based network management systems and protocols in all parts of the network

# Radio Access Networks asks IETF

- A standard for data plane transport specification
  - Unified among all *hauls
  - Deployed in a highly deterministic network environment
- A standard for data flow information models that
  - Are aware of the time sensitivity and constraints of the target networking environment
  - Are aware of underlying deterministic networking services (e.g. on the Ethernet layer)

# Use Case Themes (1/2)

- Unified, standards-based network
  - Extensions to Ethernet (not a ”new” network)
  - Centrally administered (some distributed, plug-and-play)
  - Standardized data flow information models
  - Integrate L2 (bridged) and L3 (routed)
  - Guaranteed end-to-end delivery
  - Replace multiple proprietary determinstic networks
  - Mix of deterministic and best-effort traffic
  - Unused deterministic BW available to best-effort traffic
  - Lower cost, multi-vendor solutions

# Use Case Themes (2/2)

- Scalable size
  - Long distances (many km)
  - Many hops (radio repeaters, microwave links, fiber links...)
- Scalable timing parameters and accuracy
  - Bounded latency, guaranteed worst case maximum, minimum
  - Low latency (low enough for e.g. control loops, may be < 1ms)
- High availability (may be 99.9999% up time)
  - Reliability, redundancy (lives at stake)
- Security
  - From failures, attackers, misbehaving devices
  - Sensitive to both packet content and arrival time
- Deterministic flows
  - Isolated from each other
  - Immune from best-effort traffic congestion

# Open Discussion

- Is the WG ready to adopt this draft?
- Input on future direction for this draft?
  - Relation to formal requirements?
  - Scope?
  - Breadth and depth sufficient?
- Authors for additional use cases?
- Other?