Life without a Safety Net?

Redundancy in Ethernet based Audio Networks

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Agenda

• Why redundancy matters
• Scope of this talk
• Existing standards and solutions
• Cost/Benefit Considerations
• Interoperability
• Summary/Conclusion
## Redundancy matters

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<th>Scenario</th>
<th>Requirements</th>
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<td>Live Venues</td>
<td>Get it right the 1st time</td>
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<tr>
<td>Broadcast</td>
<td>High quality experience</td>
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<td>Live Recordings</td>
<td>Danger to life and health</td>
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Redundancy matters

- Cables
- Devices
  - Loss of power
  - Hardware defect
  - Firmware Bugs
- Humans
  - Misconfiguration
  - „Can I unplug thi...“
Redundancy matters

- Less hardware = increased importance of each device/cable
- Networks obfuscates topology ("the cloud")
- Engineered networks require human resources & IT knowledge
- Synchronisation differs from traditional clocking
Scope

• Full Redundancy
• Network-related redundancy
• Automatic failover
• Local Area Networks
• Only Dante/Ravenna/AES67/AVB/TSN
Dynamic Redundancy

- Spanning Tree Protocol (today: RSTP/MSTP)
- physical mesh -> logical tree
- not glitchfree/hitless/seamless
- Recovery time hard to predict
- Single point of failure at devices
Methods & Technology

Dynamic Redundancy

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Methods & Technology

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Link Aggregation

- Link Aggregation Group (LAG) / Trunk
- Cable redundancy for important backbones
- Shorter recovery times than STP (more "deterministic")
Static Redundancy

- Double attached nodes (DANs)
- Redundancy handling in endpoints
- Basic Operation:
  - Provide sequence information (ID)
  - TX: Replicate packet
  - RX: Eliminate duplicated packet
- Industrial Ethernet: IEC 62439-3
Methods & Technology

Static Redundancy: Ring

- Reduced cabling and no switches
- One ring often impractical
- No Single Attached Nodes (SAN)
- Industrial Ethernet: HSR
- AVID AVB
Methods & Technology

Static Redundancy: Redundant Star

- Two independent LANs
- Automation Networks: PRP
- SMPTE 2022-7, IETF RFC 7198
- IETF DetNet
- Dante, Ravenna
Methods & Technology

Static Redundancy: Redundant Star

- Single attached nodes can’t use second network
- Control and non-audio traffic may not be redundant
Clocking

- Pandora's box
- Time-aware infrastructure?
- External clock input?
- PRP: Same grandmaster on both networks?
- $t_{\text{rec\_network}} \neq t_{\text{rec\_ptp}} \neq t_{\text{rec\_media\_clock}}$

- Media clock derived from PTP clock
Methods & Technology

Monitoring

• Dynamic Redundancy
  • Information usually available (i.e. SNMP)
  • Not used by solutions

• Static Redundancy
  • Notification in user interface
  • Information in log files
Cost-Benefit

- Cost for hardware: Devices & Infrastructure
- „Hidden cost“:
  - System integrator (initial setup)
  - IT expert (changing setups, troubleshooting)
  - Future proofness
- Convergence with other network services (Light, Video, Control)
Dynamic Redundancy

- „Special switches“ required (which are pretty standard)
- Recovery time depending on management*
- Scales well:
  - LAG (backbones)
  - RSTP „ring“
  - RSTP multiple redundant paths
- Convergence possible

* Redundancy optimization for networked audio systems; D. Kowalski, P. Kozlowski; Proc. 132nd AES Convention
Static Redundancy

- all-or-nothing: Ring or 2 LANs
- Duplicated management cost
- Increased complexity
- Convergence possible but interconnections require careful configuration
- But: still less expensive than analog or complex digital redundancy!
Cost-Benefit

- Static redundancy preferred
- RSTP/MSTP can be applied easily (even „on top“)

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Interoperability

- Solutions: Dante, Ravenna
- Protocols: AES-67, AVB/TSN
Interoperability

Special case: Dynamic Redundancy

- Failover done at infrastructure level
- Supported by all solutions and protocols
Interoperability

Solutions

• Dante
  • Devices interoperable if second network port exists

• Ravenna
  • Devices interoperable if second network port exists AND is already enabled
Interoperability

AES67

• „[redundancy is] outside the scope of AES67.“*

• „[…] can be added on top […]“*

• Responsibility of Media Networking Alliance?

* http://medianetworkingalliance.com/faq-aes67/
Interoperability

AVB/TSN

• Not specified in AVB

• Time sensitive networking (TSN, „AVB gen. 2“)
  • 802.1AS-REV: Redundant PTP grandmaster
  • 802.1CB: „Frame replication and Elimination for Reliability“ (FRER)
  • 802.1Qcc: Centrally-managed network

• Auto-configuration available

• Zero congestion loss
Interoperability

AVB/TSN

- Too good to be true?
- Work in progress
- Slow adoption predictable
- Too heavy for our industry?

Summary/Conclusion

- Different layers:
  - Network (not glitchfree without new switches)
  - Application (Dante, Ravenna)
  - System (not „one size fits all“)
Summary/Conclusion

• An ideal solution...
  • scales with size and requirements
  • is interoperable within a standard set
  • doesn’t add complexity for the user

• In reality...
  • this is only true with dynamic redundancy
  • neither AES67 nor AVB offer static redundancy
Summary/Conclusion

- Standards available for industrial ethernet
- TSN (AVB gen. 2) could be a solution
- Unlikely to supersede AES67 compatible solutions
- A new AES standard based on IEC 62439-3 or IETF RFC 7198 might help
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