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Networking IPMX Traffic

Marc Levy, Chief Technical Officer, Macnica

Integrated Systems Europe (ISE)

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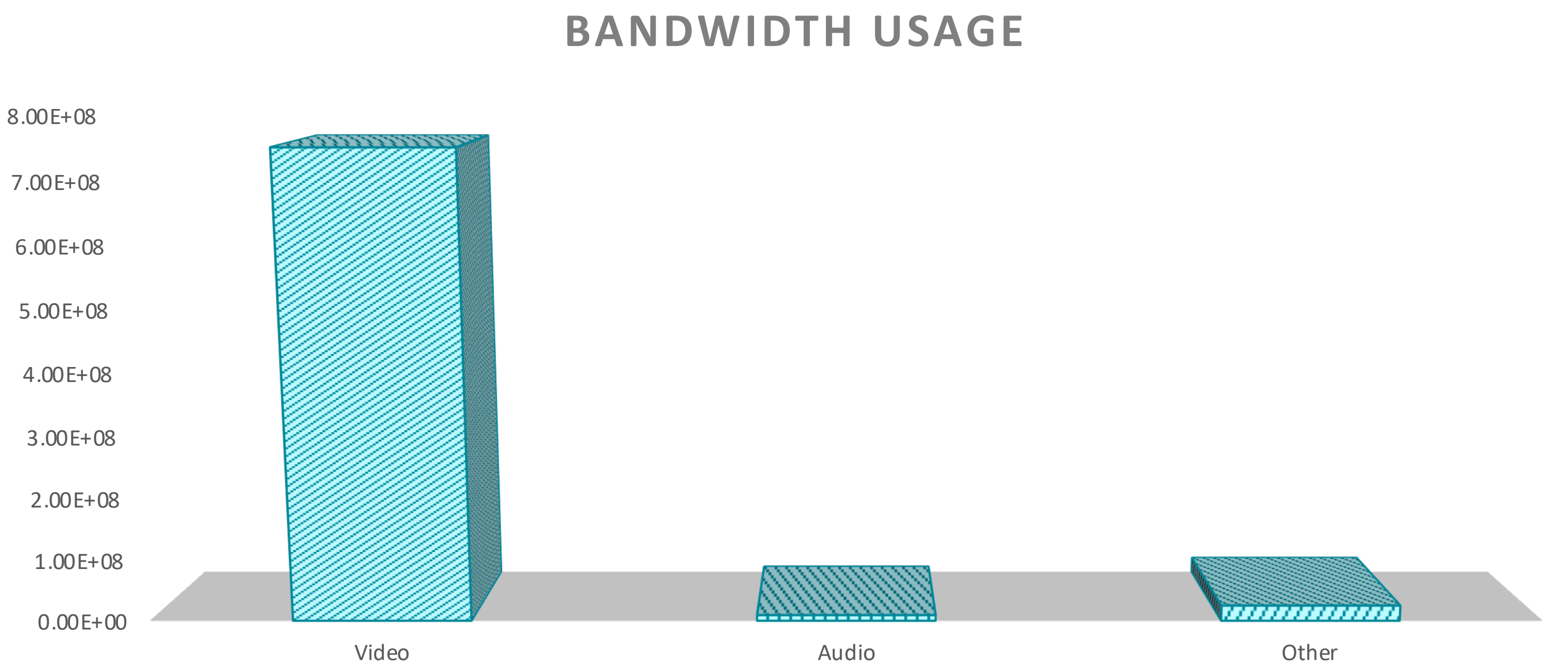
Agenda

- High level view of IPMX Traffic
- Switch Management
- IPMX Traffic vs ST2110 Broadcast traffic
- IPMX – Unicast + Multicast compared
- IPMX Networks for Example Use Cases
- Graceful Degradation
- Network Resiliancy Considerations
- Conclusions
- Questions

IPMX Bandwidth Utilization



IPMX Traffic

- Video Traffic – MOST DEMANDING!!!
  - Frame-based mezzanine light compression
  - High Bandwidth – assume a max of at least 750 Mbps (75% of 1G pipe)
  - UDP traffic (RTP is layered above UDP) – no retries, no guaranteed packet transmission
  - Forward Error Correction – not required or part of the standard
  - Error concealment – depends on implementation, may affect latency
    - Error concealment is not Error Correction – its lossy
  - Error tolerance – depends on implementation, this is a challenging problem.
  - Traffic Shaping – variable. Depends on hardware vs software sources, encoding implementation. No assumption on traffic synchronization between nodes can be made.
    - Expect substantial ordered and out of order jitter at source, additional network jitter.

IPMX Audio

- Typically 48 KHz, 24-bit LPCM traffic, up to 8 channels. Total audio bandwidth 9.2 Mbps. That's around 1.2% of the video bandwidth
  - NOTE: Higher sampling rates are possible
- Similar to video – RTP over UDP
- Concealment is difficult (audio corruption is disturbing)
- Error tolerance is good – receivers can easily recover
- Traffic shaping is more consistent due to low bandwidth, jitter as a percentage of packet spacing is relatively low.

Other Traffic - PTP

- PTP is part of ST2110, and IPMX – generates synchronized timer across all nodes
  - Each node communicates with a Grand Master
  - Some switches have dedicated features to support PTP
    - Transparent Mode – each switch measures packet latency of required PTP packets, and adds latency value to a packet field.
    - Boundary Mode – switch acts as a PTP slave to the Grand Master, and a master to other switch nodes. Supports scalability
  - PTP used to synchronize playout time across nodes
  - PTP timer can be used to generate synchronized clocks across nodes
- The PTP support requirement may be a sticking point for some use cases – PTP can still be used for alignment, may not be good enough for video clock sync.

Other Traffic – ANC / USB / Control

- ANC is low bandwidth traffic synchronized with other media traffic
  - Generally easy to conceal errors, not difficult to deal with
- USB Traffic – generally for Human Interface Devices (HID), bi-directional traffic. Trade-off between latency and error tolerance (TCP vs UDP)
- Control traffic (NMOS IS Restful API traffic / other control / web GUI)
  - Relatively low bandwidth TCP traffic
  - May set up events that are synchronized with the media, so can be time sensitive traffic
  - Control traffic itself is not synchronized with media traffic

IPMX Traffic vs ST2110 Broadcast Traffic

ST2110 Broadcast	IPMX
Media genlocked (synchronized) at the source	Media not aligned or synchronized
Strict traffic shaping rules (ST2110-21) require hardware or high performance software sources	Designed to be compatible with a wide range of hardware and software sources with loose traffic shaping requirements.
Uncompressed video is the most common – but light mezzanine compression is an option. All other media is uncompressed.	Frame-based mezzanine compression is required – video is more compressed than for Broadcast ST2110.
Require high-end enterprise class switches with PTP protocol support. Switch vendors qualified their products in the ST2110 interops.	Switch requirements depend on use case, from low-end unmanaged consumer switches to enterprise class switches.
Immunity to switch errors improved through seamless redundancy switching.	Focus on error concealment, recovery from losses, and graceful degradation.
Switches are generally media only	Switches may be media only or converged

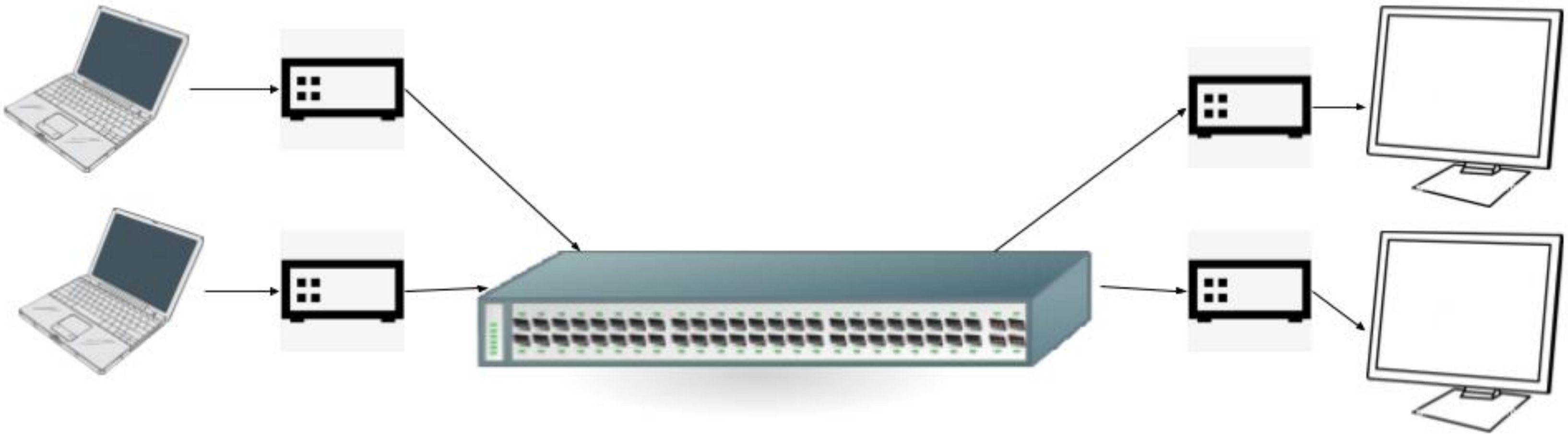
Switch Management

- Bandwidth Management
  - The bandwidth of each flow is known
  - The network can be designed for non-blocking operation across multiple switches
  - Higher level software (IS-06 / Netconfig) can manage port allocation and bandwidth
  - Bandwidth for media flows is predictable, and needs to be guaranteed
  - Bandwidth Management or non-blocking flows are needed
- Traffic Policing
  - Switch ensures flows and ports behave correctly – they don’t exceed their expected bandwidth through rate control
  - Switch needs to support Traffic Policing for secure networks when bw management is used.

IPMX – Unicast vs Multicast

Unicast	Multicast
Simple switch buffer management – packet is written once to the buffer, read once.	High bandwidth multicasting does best with sparse-mode protocol independent multicasting (PIM-SM). This is a relatively complex algorithm.
Easy to manage, unmanaged switches work fine.	Management is more complex.
Very good non-blocking performance. Even consumer switches have enough bandwidth for non-blocking full bandwidth connections on all ports.	Can provide very good performance if all the switches in the network support the required multicast algorithms – requires higher end switches and more management.
Latency is low and accumulates linearly across switches.	Each switch in the path is effectively a processing node, so latency less predictable.

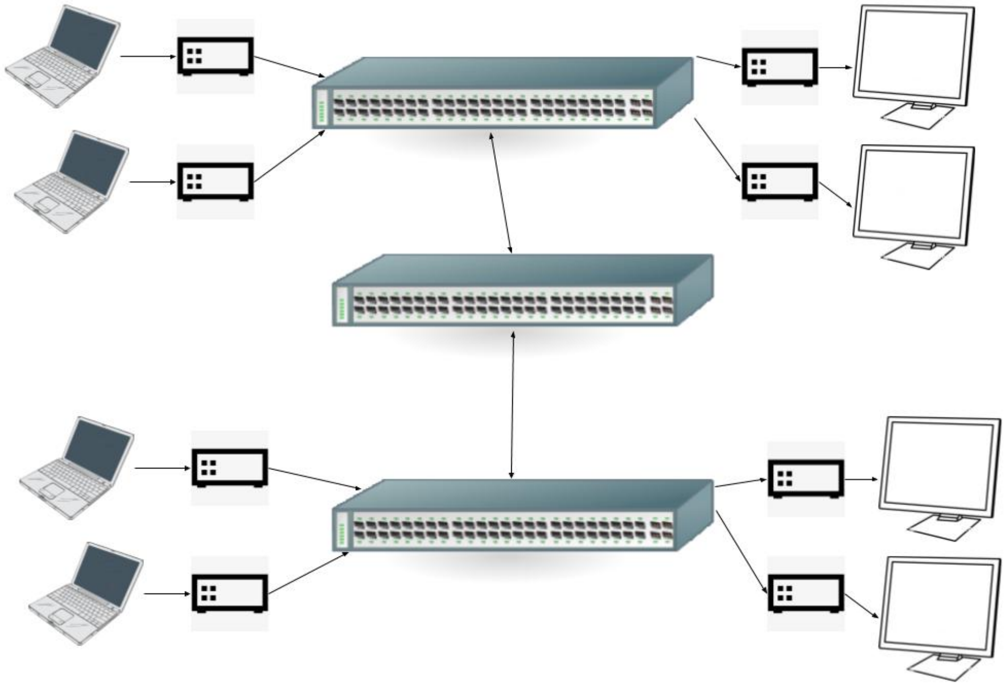
Example Use Case – small Unicast media-only network



Example Use Case – small Unicast media-only network

- Examples:
  - Small display wall
  - Home / small business KVM or Gaming
- Single switch, each source talks to one sink
- Inexpensive non-blocking 1G unmanaged switch would suffice
  - If number of ports grow beyond what a single switch can support (typically 48 – 24 sources, 24 sinks), the network is no longer in this category

Example Use Case – large unicast media only network



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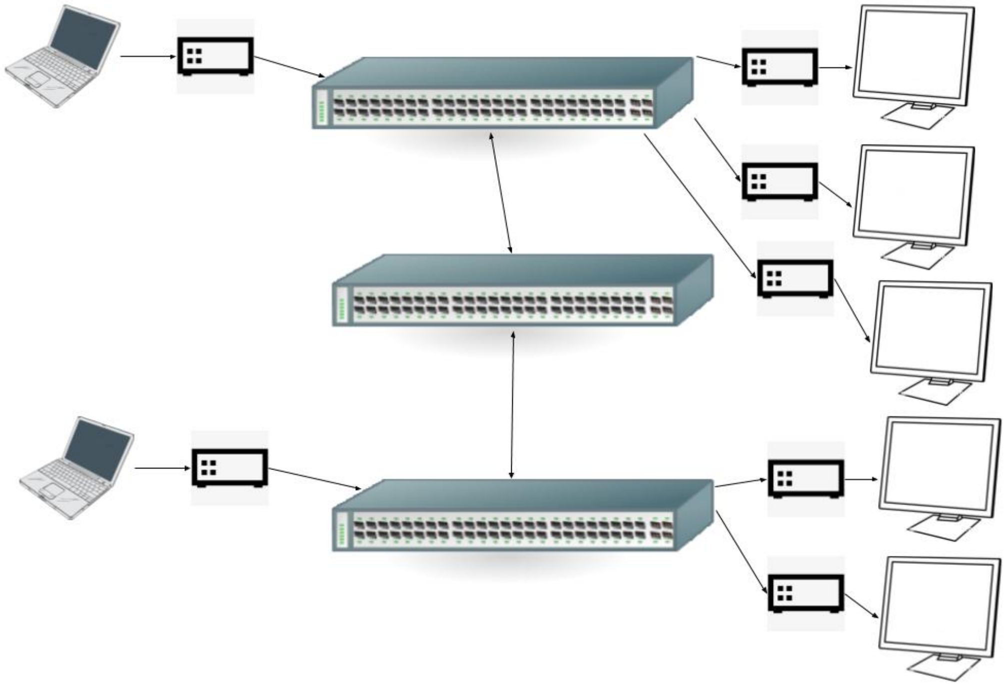
Example Use Case – large unicast media only network

- Examples:
  - Large display wall
  - Enterprise KVM or Gaming
- Multiple switches, each source talks to one sink
- Small-business (SMB) or enterprise 1G managed switches with high bandwidth uplink
- Enterprise high-bandwidth managed Top of Rack switch

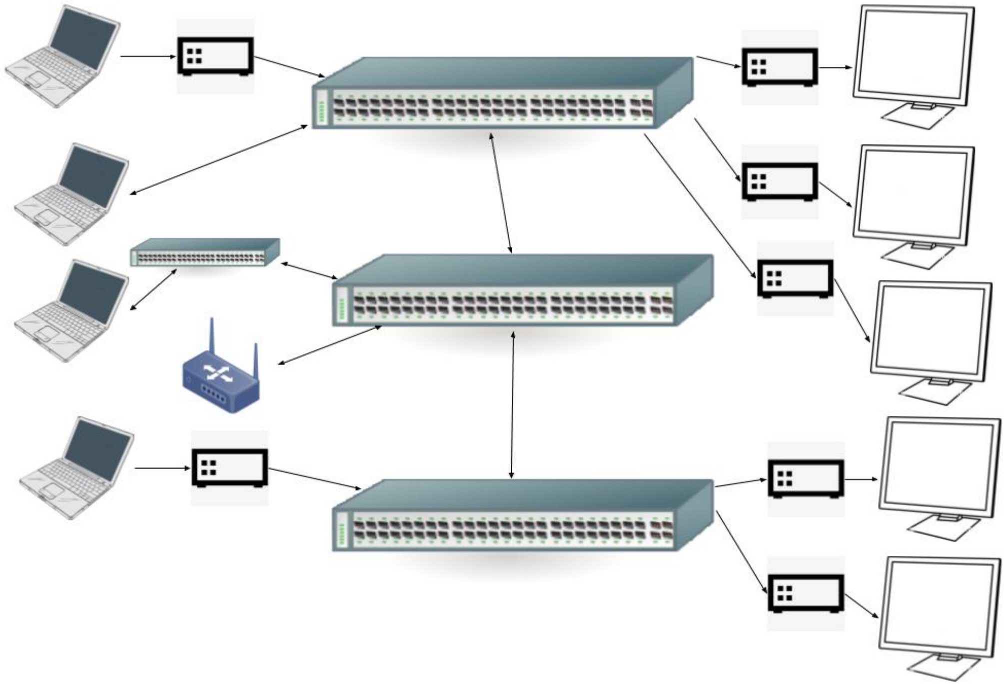
Example Use Case – Multicast Media Only network



Example Use Case – Multicast Media Only network

- Examples:
  - Corporate Events / concerts / Houses of Worship / College campuses
  - Live sports
  - Enterprise KVM with live screen sharing
- May be a single switch (for small events) or multiple switches
- Enterprise switches with high level management are required
- Significant IT knowledge is required to manage and deploy these networks
- Synchronization accuracy may require switches that support PTP

Example Use Case – Converged Network



Example Use Case – Converged Network

- Examples:
  - Enterprise events / conferencing / KVM
  - Other file-based (general office / internet / video) using the same network
- This is a challenging network management problem, but:
  - Cost of re-cabling is very high compared to switch upgrade cost
  - High-end enterprise switches, combined with IPMX bandwidths, are up to the task
  - IT expertise is available in these environments
  - Converged networks allow for centralized maintenance, network security, and scalability – so there is a strong motivation.

Graceful Degradation

- Why degrade gracefully?
  - Some functionality is usually better than no functionality (but not always)…
  - Network management can be complex, its easier to bring up a system with a degraded network than no connectivity
    - Video quality is poor, but all the screens are up!
    - The latency of my gaming has gone up, and the video isn't smooth – is someone downloading a big file?
    - Video quality went down on a multicast stream – are limits and permissions set up right?
  - Much of the underlying technology needed for graceful degradation is required for network status monitoring

Graceful Degradation

- Examples of graceful degradation:
  - Frame sync mode – last good frame is played. Lost packets result in more replayed frames, so video can become jumpy.
    - Can be implemented at the playout node without participation from the source
    - May not be graceful – with compressed video and no drop in source bandwidth, the number of complete received video frames may drop to 0 very quickly.
  - Variable Frame Rate – source can drop frame rate (and therefore bandwidth) if network drops are occurring at sinks.
    - Degradation is graceful
    - Latency goes up – not suitable if low latency is a requirement

Graceful Degradation

- Examples of graceful degradation:
  - Adjust compression ratio – source reduces number of bits per pixel (and therefore bandwidth) if network drops are occurring at the sink
    - Degradation is graceful
    - Latency is not affected
    - Applications with high quality video requirements (like KVM) may not tolerate video quality degradation
  - Adjust resolution – source changes its video resolution to reduce bandwidth
    - This is a lossy solution – the source must force a switch to a lower bandwidth (for example, forcing a Hot Plug event + new EDID for HDMI)
    - Latency not affected
    - Video quality (in terms of accuracy / absence of compression artifacts) is not affected

Graceful Degradation

Method	Encoder	Decoder	Switch BW	Latency	Resolution	Img Quality
Frame Sync	NO	YES	Same	Increased	Same	Same
Variable Frame Rate	YES	YES	Lower	Increased	Same	Same
Compression Ratio	YES	NO	Lower	Same	Same	Lower
Reduce Resolution	YES	NO	Lower	Same	Lower	Same

Network Resiliancy of IPMX End Points

- As IPMX becomes a standard, interoperability of implementations will be tested and certified.
- Can network resiliency be certified or characterized? More difficult…
- What to look for?
  - Sources
    - Good traffic shaping
    - Graceful degradation features if required
  - Sinks
    - Good suite of network status monitoring features - Packet loss per stream, measure network NRO (Non-Re-Ordering) and RO (Re-ordering) jitter
    - Flexible buffering solution - variable depth, frame sync, packet reordering
    - Support for graceful degradation features

Conclusions

- The IP network itself is a critical part of any networked media system
  - The right switched network for the job depends on the use case
    - Broadcast ST2110 is the “gold standard” – but gold is expensive!
  - Managing the switched networks is a complex task, and networked live media will add more complexity
    - PTP may be challenging! Compromises or creative solutions may be needed.
  - The end point has its role to play
    - Clean sources help
    - Resilient sinks are critical
    - Graceful degradation is a viable compromise

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QUESTIONS?