IP Multicast

“The Good, the Bad and the Ugly”

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John Lyons
Zen Internet, UK
Background

Spent the last few years designing, implementing & troubleshooting multicast networks in:

- Research and education networks
- “Multi play” ISP delivering IPTV over FTTH/ETTH/ADSL2+
- Traditional UK ISP with native multicast delivery for BBC trial

Disclaimer: All views/opinions/rants are my own personal views/opinions/rants
Multicast deployment

- Multicast deployment has historically been very poor
- Lots of reasons: “the code’s not stable”, “there’s no business case”, “no-one else is deploying it”, “I don’t have time to learn it” ...
- In the last 12 - 24 months this has finally begun to change
Who’s deploying it?

- “Multi Play” ISP’s
- Research and education institutions
- Traditional ISP’s
- Large scale content providers
- Financials
- 3G Wireless providers
I want to deploy it!

- Great! :-)
- I could paint a rosy picture but I’d be lying
- Multicast has its fair share of problems
- However, with good preparation & design many of these problems can be worked around
- My experiences with multicast have fallen into 3 categories - “The Good, the Bad and the Ugly”
The Good ...

- General benefits
- Well designed ASM networks
- SSM
- PIM Bidir
- Configuration
- Results
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General Benefits

Unicast

Multicast
The Good ...

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Well designed ASM

- Any Source Multicast (ASM) is the most widely deployed form of multicast today (Using PIM-SM, some legacy PIM-DM)
- It works best on well designed, hierarchical networks
- Relies on RPF and PIM-SM to make intelligent forwarding decisions
- Is now being used widely to deploy “closed garden” IPTV solutions
The Good ...

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SSM

- SSM is the answer to “one to many” applications
- No need for complications such as RP’s or MSDP
- No shared tree
- No address allocation issues
- Improved security
- Requires host kernel support for IGMPv3
- Still not widely deployed, mainly due to vendor support
The Good ...

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PIM Bidir

- The answer to “many to many” applications such as video conferencing & financial applications
- Relies on shared tree to forward all traffic
- Greatly reduces the amount of state which a router must store
- Is not widely deployed, yet
- Still relies on an RP (although only a logical RP) but not MSDP
The Good ...

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Configuration

- It’s simple to configure:

  **Sample configuration for Cisco router:**

  ```
  ip multicast-routing
  ip pim rp-address 10.193.0.1
  int x
  ip pim sparse-mode
  ```

  **MSDP gets more complicated but still relatively simple:**

  ```
  ip msdp peer 85.91.0.6 connect-source Loopback2
  ip msdp cache-sa-state
  ip msdp originator-id Loopback2
  ip msdp mesh-group mesh-group-magnet-internal1 85.91.0.6
  ```
The Good ...

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Results

• A lot of networking projects give subtle results which are difficult to explain to management

• Deploying multicast usually results in streaming a DVD or TV channel network wide

• Never underestimate the wow factor :-(
The good...

- That all looks great
- Some reading and preparation and I’m ready!
- Well ... yes and no
The bad ...

- ASM limitations
- Inter-domain ASM
- Troubleshooting
- Ongoing support
The bad ...

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ASM limitations

- Unfortunately basic ASM (PIM-SM, RP, MSDP, IGMP) has a lot of limitations
- Security (more in the “ugly” section)
- Address allocation for inter-domain multicast
- Lots of state
- SSM and PIM Bidir were built to address these problems
The bad ...

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Inter-domain ASM

- Global ASM - MSDP used to maintain list of sources, MBGP used to maintain RPF
- Requires a large amount of state on RP and has potential to cause significant problems
- Inter-domain multicast is frustrating to troubleshoot and requires a lot of cooperation with other AS’
- Inter-domain multicast is not being tested heavily in production, there are very few global sources outside of the NREN’s
- Consensus has been reached within operators that global ASM does not scale and is not the way forward
The bad ...

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Troubleshooting

- This is a separate talk all on its own
- Poses significant problems as it’s receiver driven, is unidirectional in nature, has complicated rules and needs state debugging on all participating network devices
- It is possible to troubleshoot effectively but requires a significant initial effort to develop a step by step process
- Even still, in inter-domain multicast troubleshooting you will have to rely heavily on other people/networks
Multicast troubleshooting – John Lyons
(12/04/06) V2.1

- Gather relevant information
  * Identify designated router for multicast subnet
  * Identify receiver interest in group traffic on receivers RPF interface
  * Verify knowledge of active source on receivers DR

If receiver DR has no knowledge of active source:

- Verify correct RP address on receivers DR
  * Verify RPF path (from receivers DR) to RP is correct and PIM adjacency is correct
  * Verify RPF path and PIM adjacency on all routers in path to RP
  * Verify RP has knowledge of active source

If RP has knowledge of source:

- Troubleshoot until RP has knowledge of active source

If RP has no knowledge of active source and RP different for both DRs:

- Troubleshoot until RP has knowledge of active source

If RP has knowledge of active source and RP the same for both DRs:

- Check receivers DR to make sure it is F for set
  * Check RP to make sure it has learned source from MSDP
  * Determine IP address of sources RP, and determine MSDP peer SA should be learned from
  * Conform MSDP peer and check for SA in their MSDP cache
  * Troubleshoot F setup, if not, pair problem

- Troubleshoot until RP has knowledge of active source

If RPF path and PIM-SM adjacencies correct:

- L2 problem (OAM, looping, CGMP etc.)
  * Forwarding correctly

- Troubleshoot until RP has knowledge of active source

- Verify that receivers DR is forwarding packets to the correct interface

- Troubleshoot until RP has knowledge of active source

Commands (Cisco):

- Show ip route
- Show ip pim summary
- Show ip pim neighbor RPF interface
- Show ip pim groups
- Show ip pim pim-address
- Show ip pim-pim mapping

Commands (Juniper):

- Show pim on interface
- Show multi-addr address
- Show ipv6 group group address
- Show ipv6 interface RPF interface
- Show multi-addr usage
The bad ...

- ASM limitations
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- Troubleshooting
- Ongoing support
Ongoing Support

- Finding (and keeping) multicast literate engineers is difficult
- If you rely on multicast to deliver a critical service you will require experienced multicast engineers
- Training current staff can be difficult, but it is possible with the right methods
The Bad ...

- That still looks fine
- I’m ready, give me the books and enable/config access!
- Well, there are some other things you should know ...
The Ugly ...

- MAC address 32:1 overlapping
- Security
- Software bugs
- Vendor support
- Tunneling
- Inappropriate usage
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MAC Addresses

- Multicast L3 addresses are 28 bits long (/4), Special MAC addresses reserved for multicast, but due to lack of funding for OUI’s, only 23 bits long

- There are 32 IP multicast L3 addresses with the same MAC address

- Host takes care of MAC address crossover but has to de-capsulate packet

- Particularly ugly if you choose to use multicast addresses which overlap with special case addresses such as 224.0.0.0/24 (224.0.0.1 or 239.0.0.1 = 01:00:5e:00:00:01)

- Renumbering is never fun
The Ugly ...

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Security (Or lack thereof)

- Lots of security concerns (Mainly DoS through excess state)
- Bogus PIM-SM DR/IGMP querier elected
- Host joining too many groups
- Host sending to many groups
- Host sending to existing group
- Most of the fixes involve ACL’s or using rate-limiting which can inadvertently affect legitimate users
The Ugly ...

- MAC address 32:1 overlapping
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- Inappropriate usage
Bug ID #CSCdx82485

Symptoms: Under rare circumstances, a router that is configured with Protocol-Independent Multicast (PIM) may pause indefinitely.

Workaround: Use a different Ethernet card, or avoid using PIM
Software bugs

• Here’s where it can all go wrong
• Multicast software bugs are numerous
• One particular problem in a University led me to the bug tool for a Cisco 6509 with an older software revision, it had 350 multicast bugs
• Choose your software versions and hardware vendors wisely
• For critical services, find a stable image and stick to it, don’t move without rigorous multicast lab testing
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Vendor support

• Many vendors visibly wince when asked about their multicast support

• Workarounds for PIM problems will include fixes such as turning off PIM to resolve the problem

• Vendors can take significant time to find reasons for faults and even longer to resolve issues

• Long term - Business requirements and reliance on multicast for critical revenue generating services will solve this problem

• Short term - Ask questions and choose wisely
The Ugly ...

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Tunneling

- If you have non multicast aware boxes (particularly firewalls) you may need to tunnel around them
- Static mroutes are non-intuitive and ongoing maintenance of them is time consuming
- Need to ensure tunnel endpoints are capable of pushing high quality videostreams through tunnel interfaces
- Increases complexity for troubleshooting
The Ugly ...

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Inappropriate usage

- Some people will try and persuade you that it’s a good idea to run video conferences with many participants in many Universities around the world using interdomain multicast.
- These people obviously **do not** troubleshoot multicast problems.
- A survey of GRID users using AccessGRID showed that > 20% of users “usually cannot” or are “never able” to use multicast.
  
- Go figure
Conclusions

- Multicast finally has some problems to solve
- Multicast adoption will continue to rise, particularly in “walled garden” environments
- Global multicast will rely on SSM
- With preparation and hard work you can use it to run production services
- We all need to work with vendors to ensure software and hardware problems are resolved and new protocols are supported
Resources

- Developing IP Multicast Networks - Beau Williamson
- Inter-domain IP Multicast - Edwards, Giuliano, Wright
- “A methodology for troubleshooting IP Multicast“ - Litvanyi / Nickless (NANOG 27)
- “In the Trenches with IP Multicast” - Greg Bell (LBLnet)
- Internet 2 Multicast workshops
- Vendor documentation
Thank you for listening

Q & A

john@techvictim.net
www.techvictim.net