IPTV Multicast Video End-to-end service

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Agenda

- IPTV vs IPVideo?
- Current Deployments
- Over-the-top Video

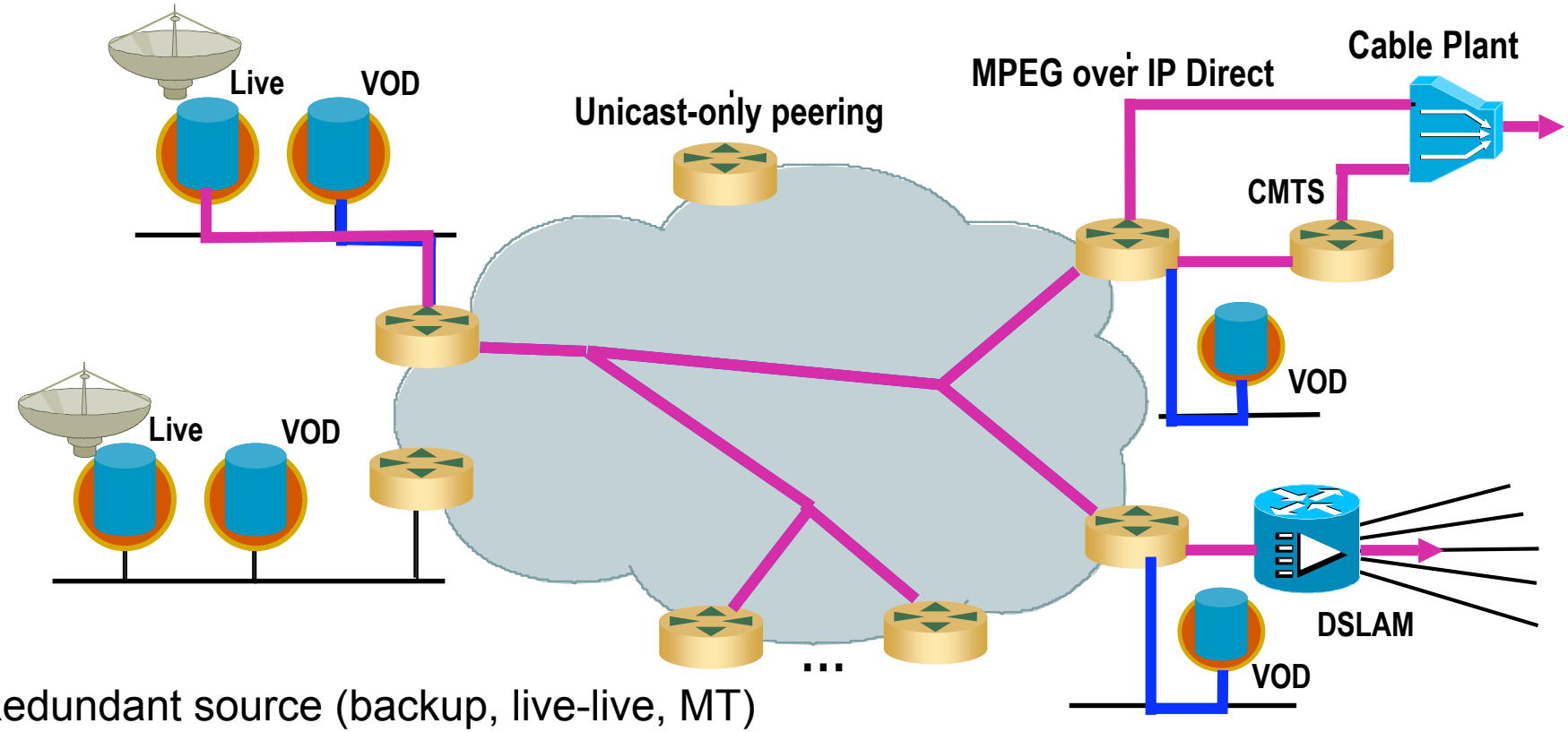
Lessons Learned
European Broadcasting Union

- IPTV = Video content to end consumer (assumed lower quality requirements)
- IPVideo = Production Video (assumed unique quality requirments)
- If it's MPEG over UDP, the only difference is bitrate
- Them: QoS = SLA (many/most of them lease services)
- Me: QoS = IPQoS
- I had to change my preso to prevent confusion
- "Is IP ready for Video?" presentation…
  - Leased an MPLS P2P circuit from a provider
  - Pushed IPVideo over the pipe
  - Didn't meet requirements - loss, latency, jitter
  - Conclusion: IP is not ready for video.. WHAT?

Solution Smoke…

- P2P and P2MP overlay networks only provide a circuit-switched human interface
  - It's still a packet-switched network
- MPLS wholesale services are a great way to oversell bandwidth
  - Elastic IP content can't tell, IPVideo/IPTV CAN tell
- Customer Confusion Example
  - Wanted unlimited per-customer / per-application provisioning
  - Configuration allows provisioning beyond physical queues
    - more smoke
  - Them - "What do I do if I have a new application or customer?"
  - Me - "Who's bandwidth are you going to take away to provision this?"
  - Configuration cannot make bandwidth

IPTV Content Service Networks Cable/DSL



Redundant source (backup, live-live, MT)

Cable and DSL with similar backbones (regional / national)

Numerous customer aggregation sites

Populate local VOD servers via multicast over the backbone

Live video over IP Multicast

Native IPMulticast core BUT Unicast-only peering = walled garden

IPTV Deployments today

- Two schools of thought in deployments today:
  1) I think I need 50ms cvg
  2) IPMulticast is fast enough
- IPMulticast is UDP
  - The only acceptable loss is 0ms
  - How much is “reasonable”?
- 50ms “requirement” is not a video requirement
  - Legacy telco voice requirement
  - Efforts for 50ms only cover a limited portion network events
- Where to put the effort?
  - Make IPMulticast better?
  - Improve the transport?
  - Add layers of network complexity to improve core convergence?

Impact of Packet Loss on MPEG Stream

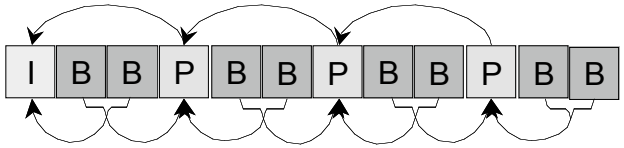
0% Packet Loss

Video is very susceptible to IP Impairments

0.5 % Packet Loss

5 % Packet Loss

Impact of Packet Loss on MPEG Stream



- Compressed Digitized Video is sent as I, B, P Frames
- I-frames: contain full picture information
  - Transmit I frames approximately every 15 frames (GOP interval)
- P-frames: predicted from past I or P frames
- B-frames: use past and future I or P frames

I-frame loss “corrupts” P/B frames for the entire GOP

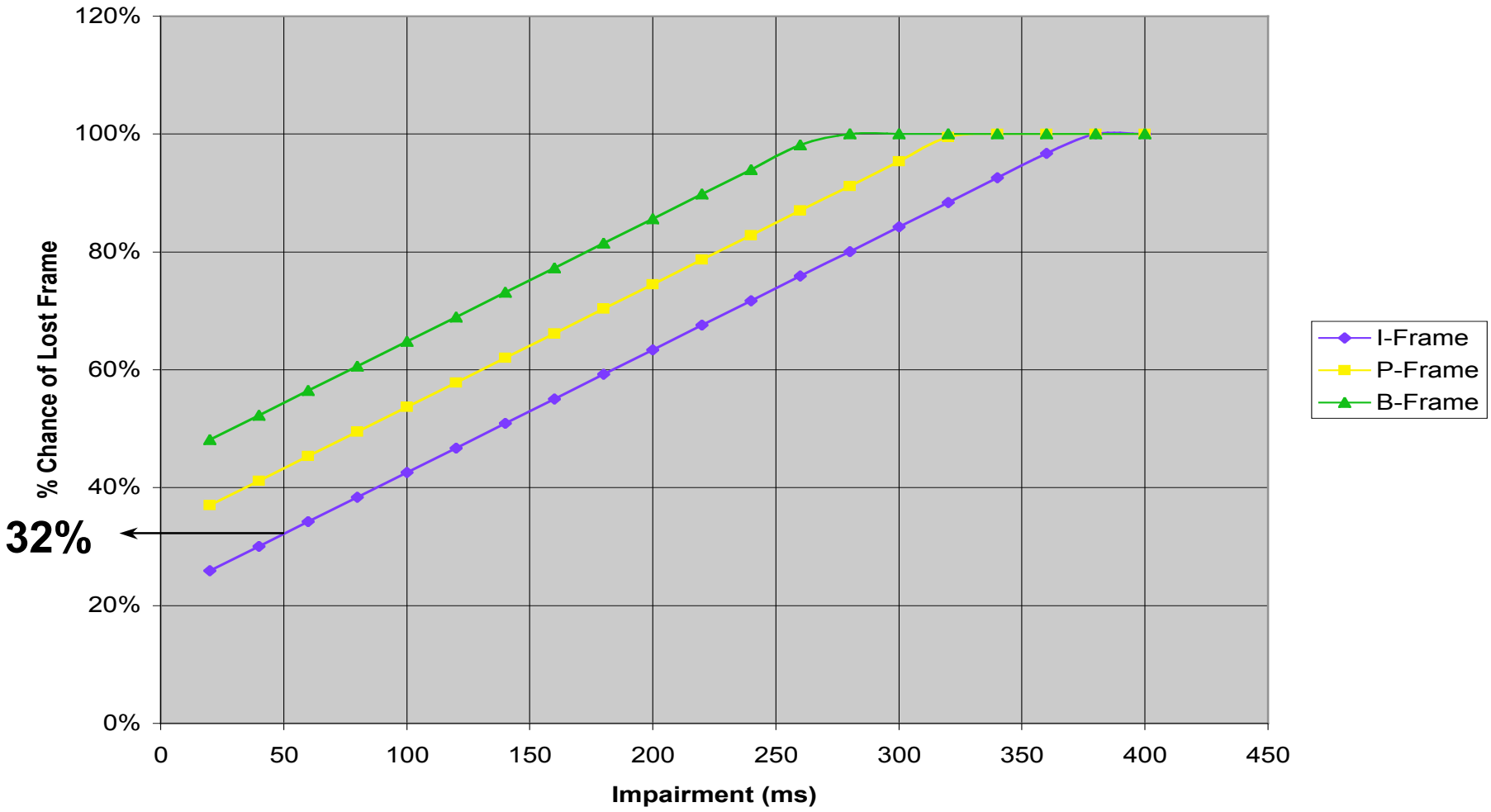
Impact of Packet Loss on MPEG Stream

Network events create correlated packet loss, not random single packet loss.

What's the relationship between network CVG time and I-frame loss?

- Example Assumptions:
  - MPEG2 stream CBR = 4.8828Mbps
  - MPEG2 IP stream pps = 427.35pps
  - L3 pkt_size = 1487Bytes (encap IP + UDP + RTP)
  - GOP-size-in-msec 480
  - GOP-size-in-pkts 205

MPEG Frame Impact from Packet Loss



MPEG Frame Impact from Packet Loss

- P/B frame loss is less noticeable
  - Error concealment techniques in the receiver can mask some
- I-Frames loss is more problematic
  - I-frame loss can result in an entire GOP loss
  - A single packet lost from an I-frame corrupts the entire I-frame
  - I-frame (GOP) loss can result in blank screen for 1-2 secs
- 50ms is a phantom goal
  - 32% chance of I-frame loss
  - ..another way..
  - 32% of your streams will have 1-2 sec blank screen outage
  - Why then is this a goal for some?

What are the Impairment Contributors?

- Link Failures
- Node Failures
- Random Uncorrected Bit Errors
- Congestion

How do we measure these?

What are the Impairment Contributors?

- 1st: Need Quantify Impairments
  - Need some “standard”
  - Relevant to viewers’ experience

Impairments per 2 hours

- Representative of a typical movie duration
- Allow for comparing contributions over a standard window of time

What are the Impairment Contributors?

- Some Assumptions / Some Industry Standard Data / Some Customer Experience Data
- Total Value Across a Typical Provider Network

- Trunk Failures - .0010 Imp/2hr
- HW Card Failures - .0003 Imp/2hr
- SW Failures - .0012 Imp/2hr
  - NSF/SSO reduces the realized amount of this contribution
- SW Upgrades - .0037 Imp/2hr
  - Modular code (IOS-XR) reduces the realized amount of this contribution

What are the Impairment Contributors?

Trunk Failures:	.0010
HW Failures:	.0003
SW Failures:	.0012
Maintenance:	.0037
Total:	**.0062 Imp/2hrs**

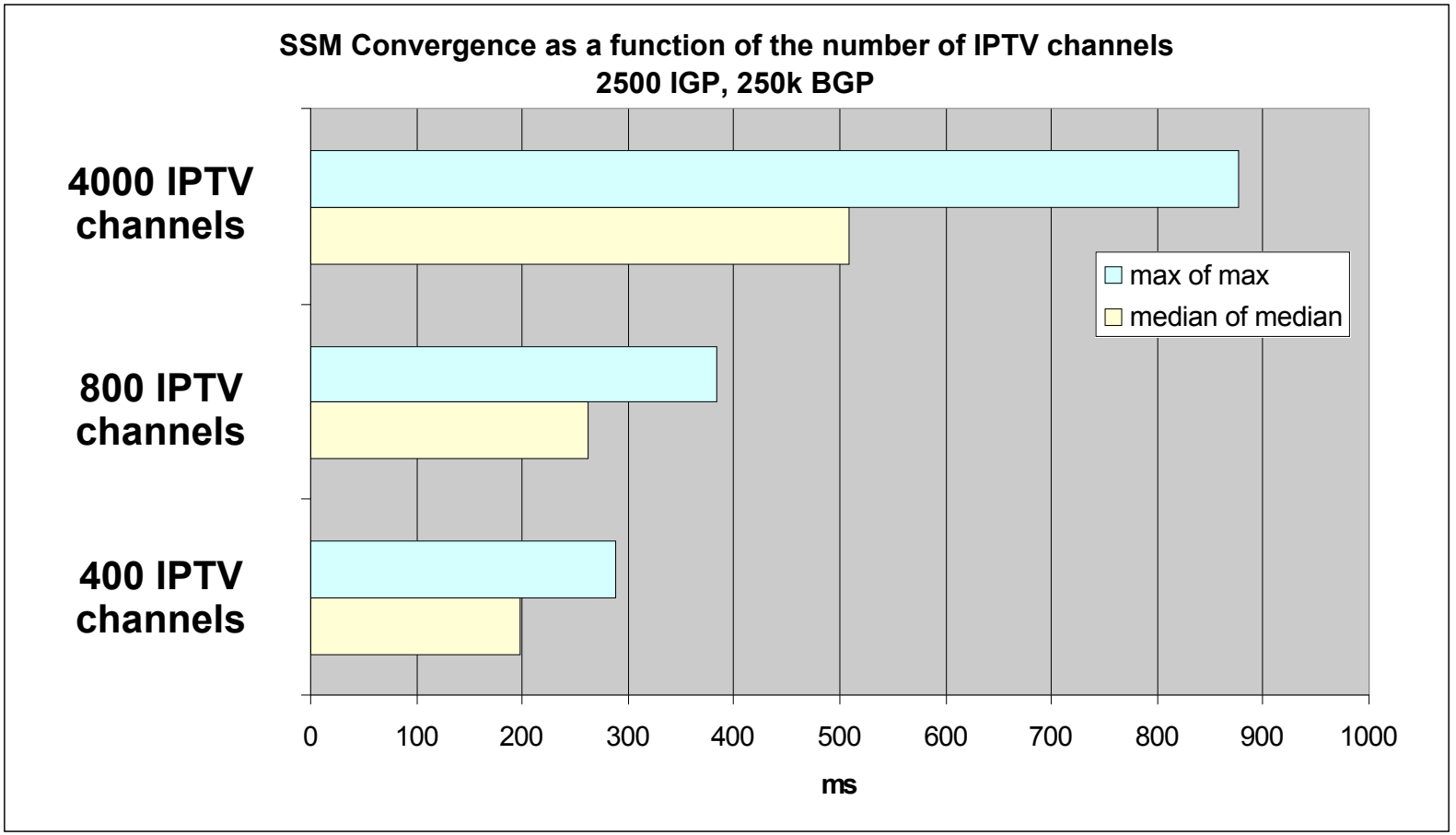
- **Uncorrected Bit Errors - 11.4629 Imp/2hrs**

  "Video over IP" by WesSimpson (page 238) - 10^{-10} per trunk

Network Impairment Contributors

- All HW/SW/Link failures combined do not compare to uncorrected bit errors
- Last-mile networks often most significant contributors
- SW failures/Maintenance each contribute much more than link failures
  - Stable, modular software with NSF/SSO can reduce this contribution even further
- Fast convergence in the core is a worthy goal
  - Improves core-contributed artifacts
  - Need to consider the balance of a solid platform vs. layered complexity
- Solid performing platform is more important than complex protocol solutions

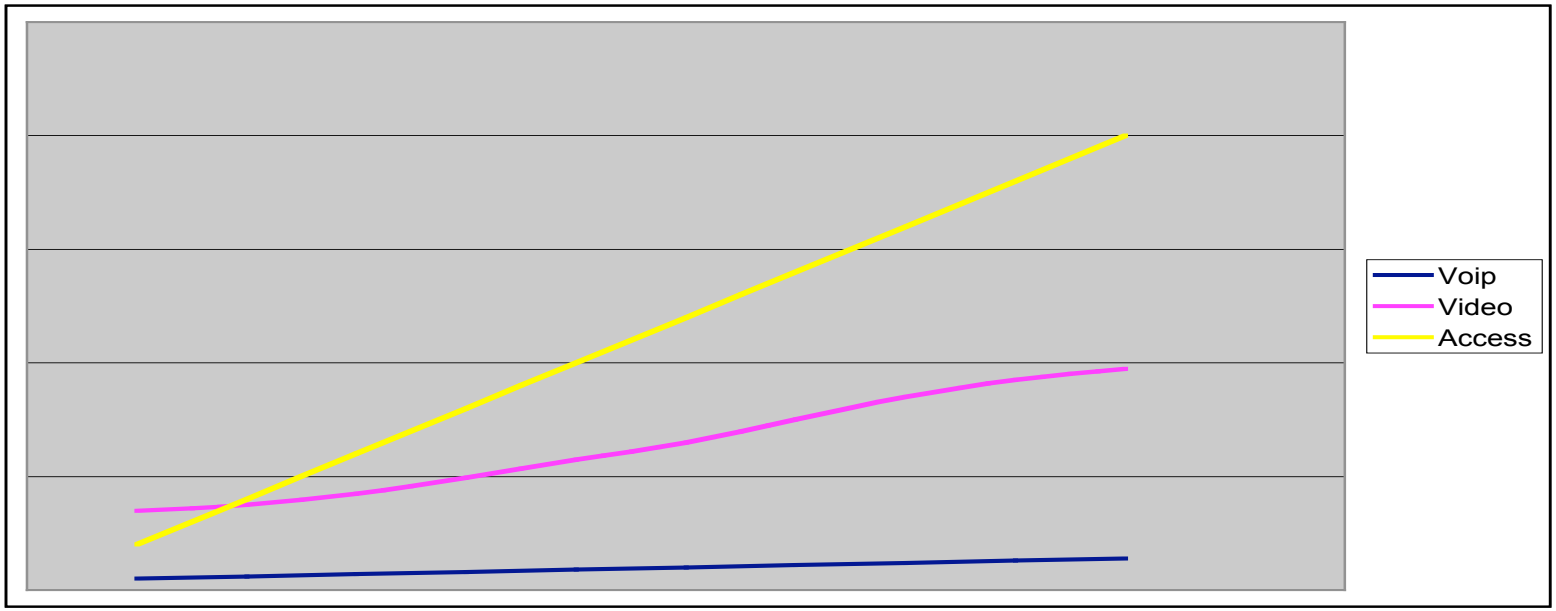
Some Vendor's IPMcast Cvg Performance



Access Provider Challenges

- Current IPTV is a value added service
  - On-net injection
  - PPV or local Advertising Revenue
- Walled Garden
  - Edge provider “owns” the customer
- Will this last?

Access Provider Challenges



- Access bandwidth is driven by competition
- Access bandwidth rapidly surpassing video bandwidth
- Video bandwidth is semi-bounded

Access Provider Challenges

- IPTV works as a Value Added service today
- Access bandwidth growth opens up new applications
- Over-the-top video is already here - in some form..
  - Joost, MacTV, YouTube, BitTorrent, AMT
- More available bandwidth will only improve these applications
- DVRs are changing how people watch TV
- Consumers don’t care how their DVRs are populated
- Will live-TV be relevant in the future?

Access Provider Challenges

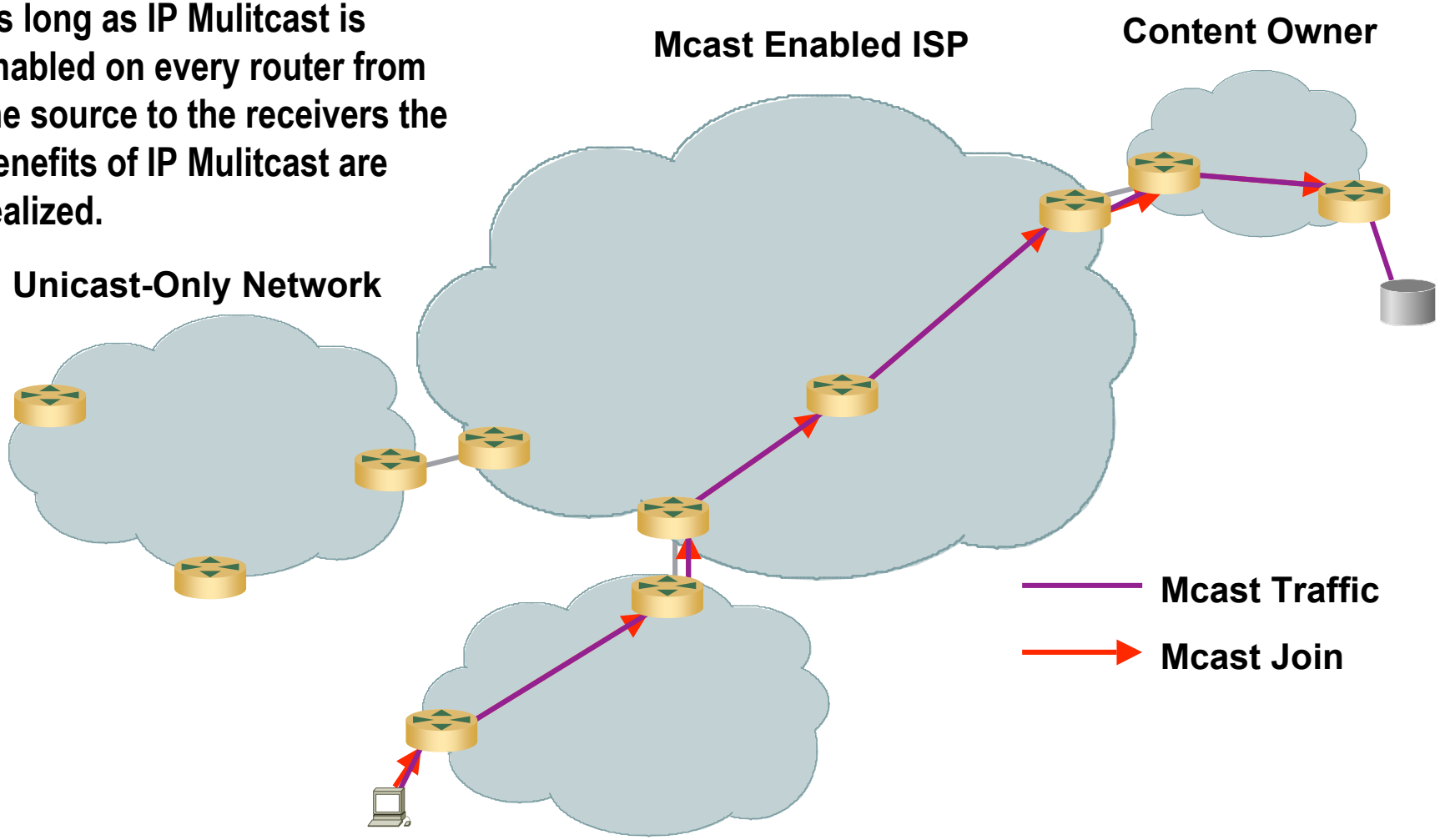
- How does a provider say in the food-chain?
- Continue to expand content offering
  - Stay ahead of the curve
- Open IPMcast transport to off-net content
  - Look for key strategic content partners
- Integrated Directory API
  - Cisco/SciAtl

What Happened to Global IPMulticast?

- What worked with IPMulticast?
- What didn’t work?

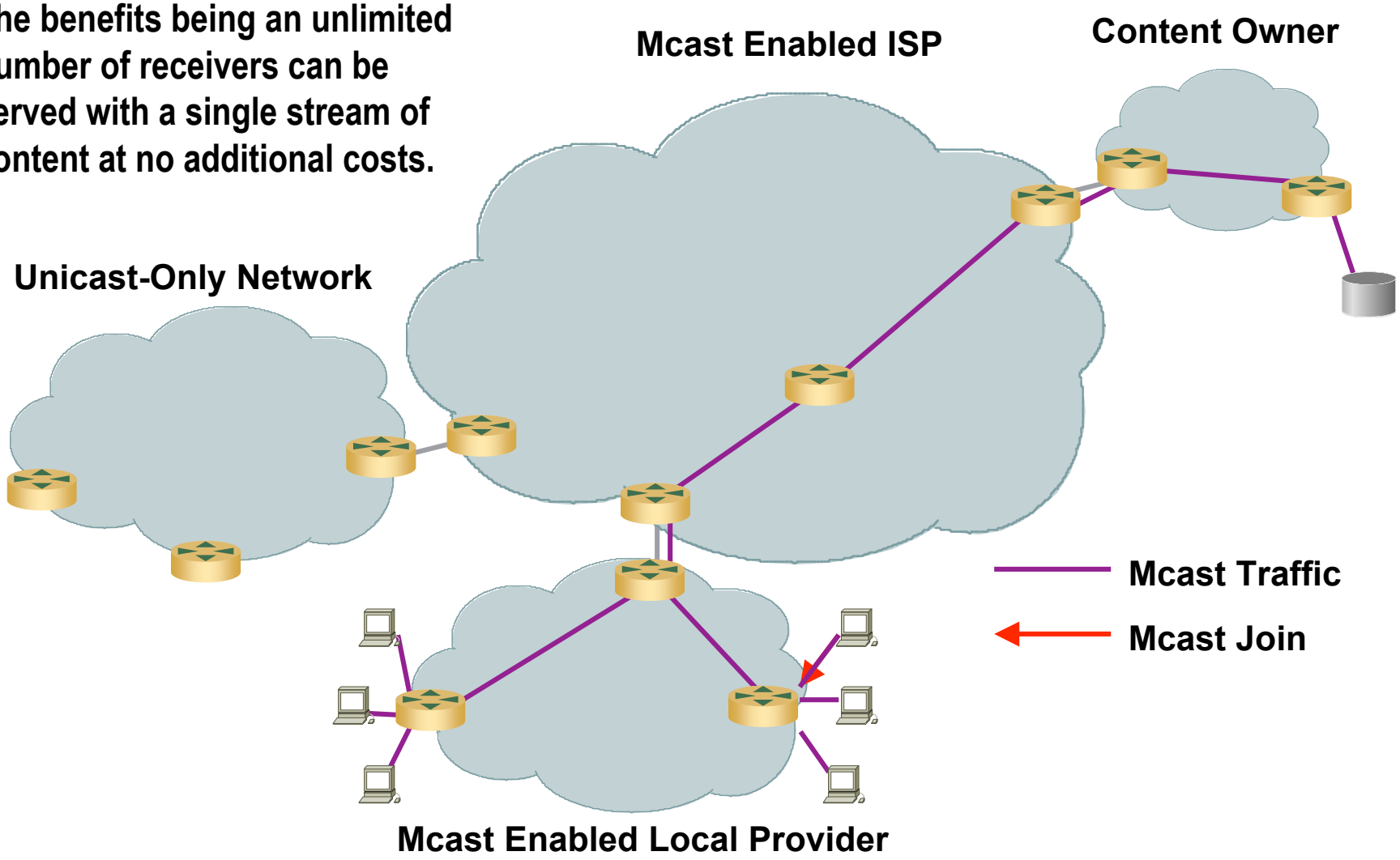
What Worked?

As long as IP Mulitcast is enabled on every router from the source to the receivers the benefits of IP Mulitcast are realized.



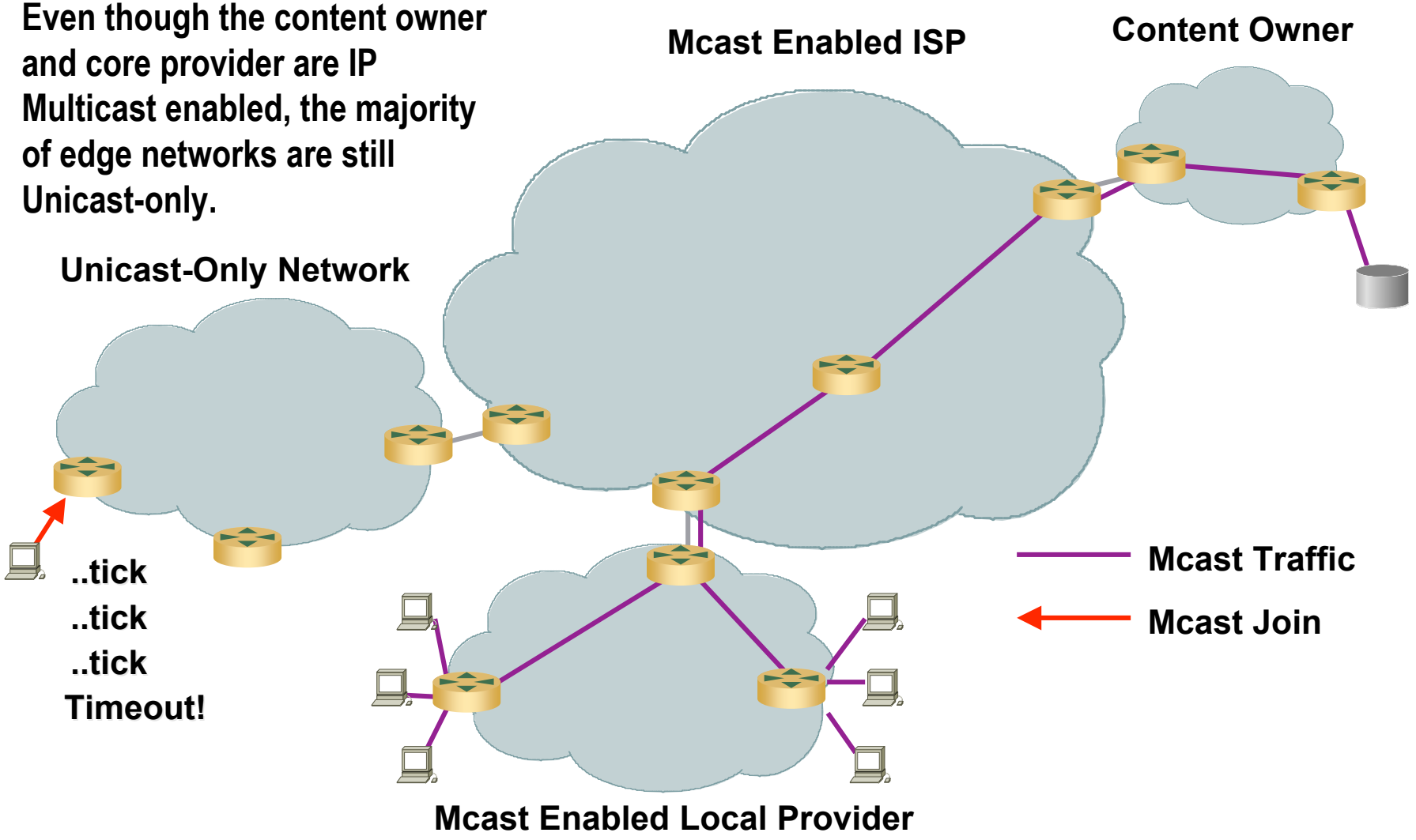
What Worked?

The benefits being an unlimited number of receivers can be served with a single stream of content at no additional costs.



What Didn't?

Even though the content owner and core provider are IP Multicast enabled, the majority of edge networks are still Unicast-only.



What's Wrong?

- Multicast in the Internet is an all-or-nothing solution
  - Each receiver must be on an IP Multicast enabled path.
  - Many core networks have IP Multicast enabled - but few edge networks do.
- Even Mcast-aware content owners are forced to provide unicast streams to gain audience size
- Unicast will never scale for streaming content
  - Splitters/Caches just distribute the problem
    - Still has a cost-per-user
- But is there a future for streaming? (without AMT perhaps not)

AMT
Automatic Multicast Tunneling

- Automatic IP Multicast without explicit Tunnels

  http://www.ietf.org/internet-drafts/draft-ietf-mboned-auto-multicast-09.txt

- Allow multicast content distribution to extend to unicast-only connected receivers.

  Bring the flat scaling properties of multicast to the Internet

- Provide the benefits of multicast wherever multicast is deployed.

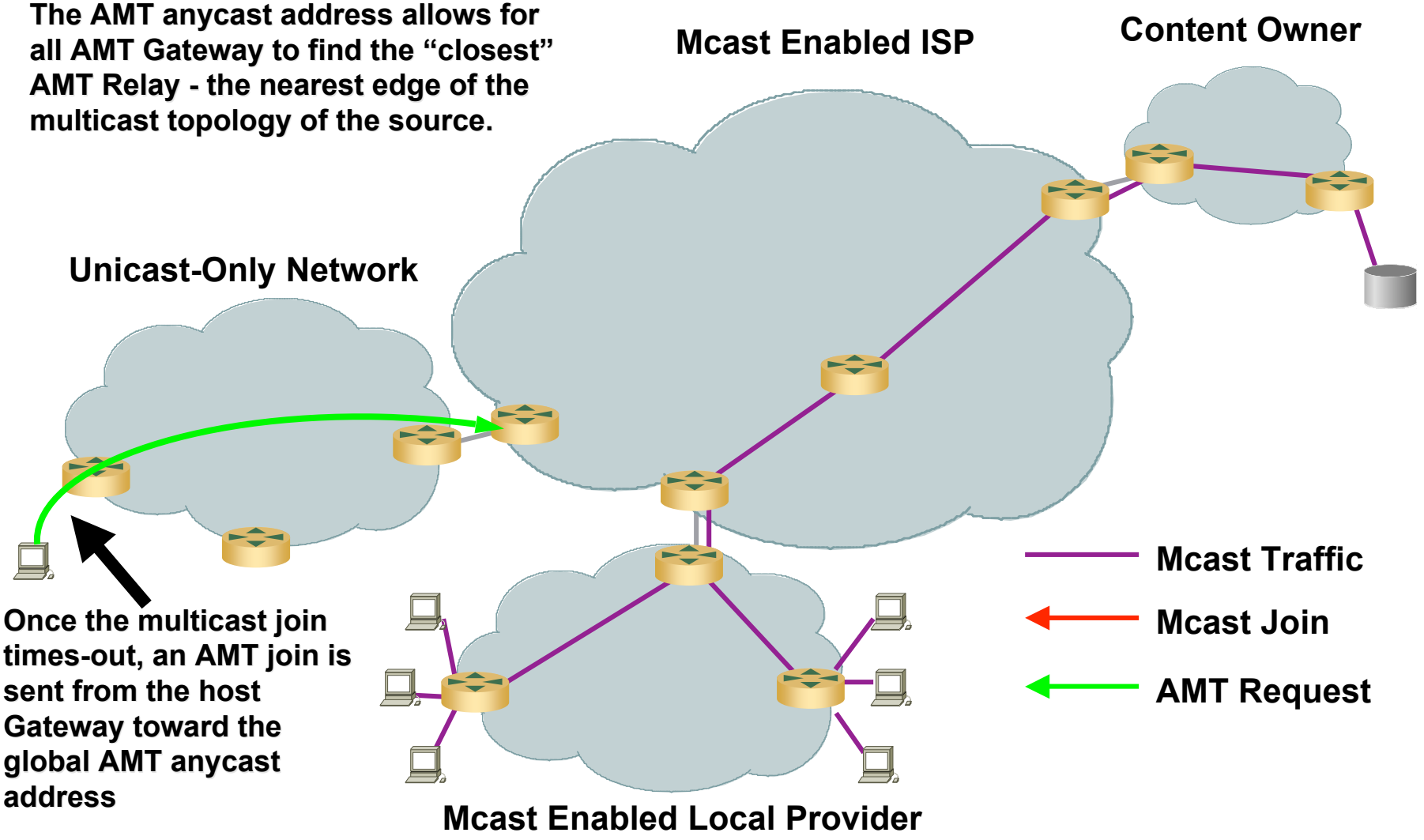
  Let the networks which have deployed multicast benefit from their deployment.

- Work seamlessly with existing applications

  No OS kernel changes

AMT
Automatic Multicast Tunneling

The AMT anycast address allows for all AMT Gateway to find the "closest" AMT Relay - the nearest edge of the multicast topology of the source.



Once the multicast join times-out, an AMT join is sent from the host Gateway toward the global AMT anycast address

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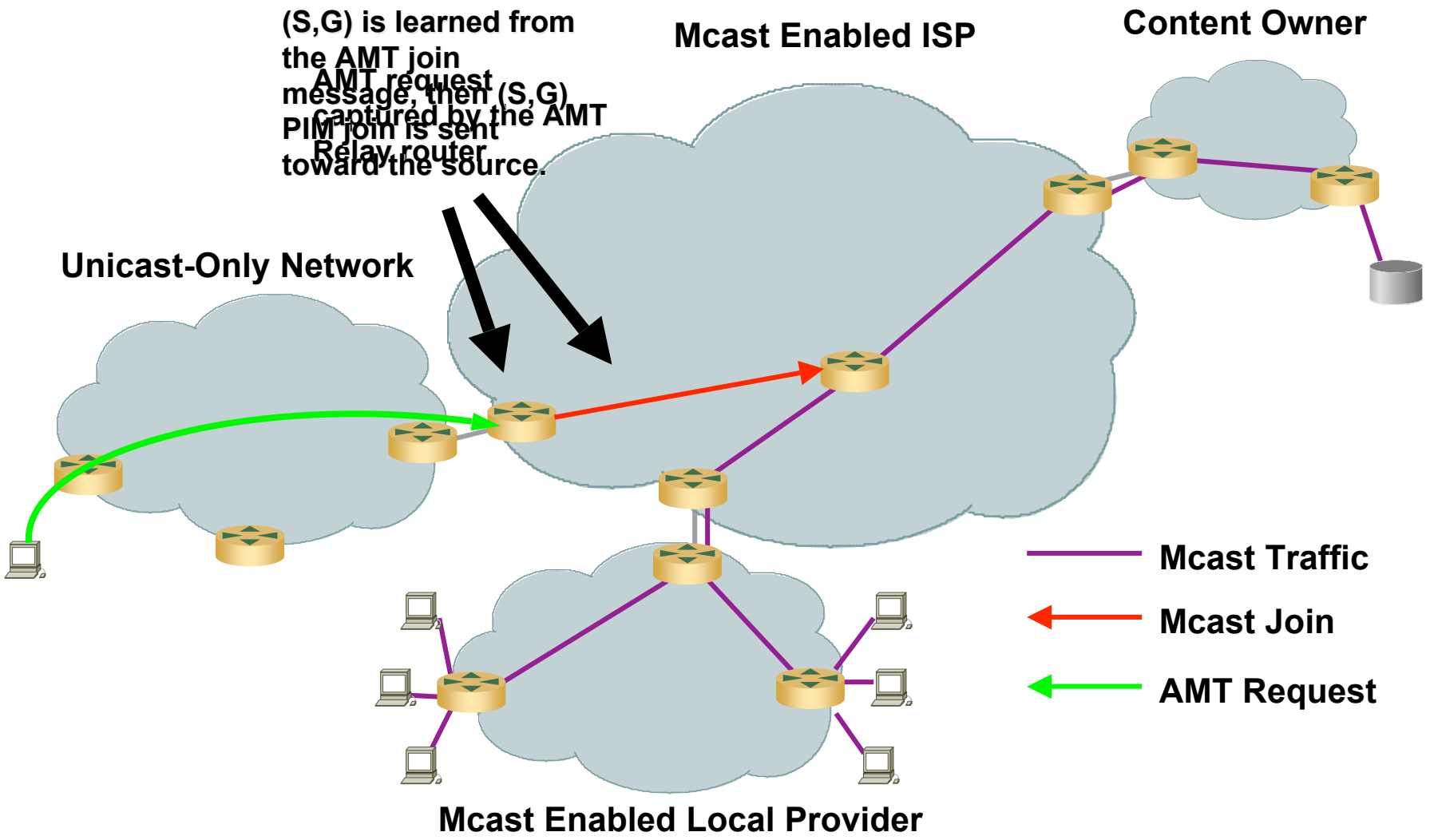
Automatic Multicast Tunneling



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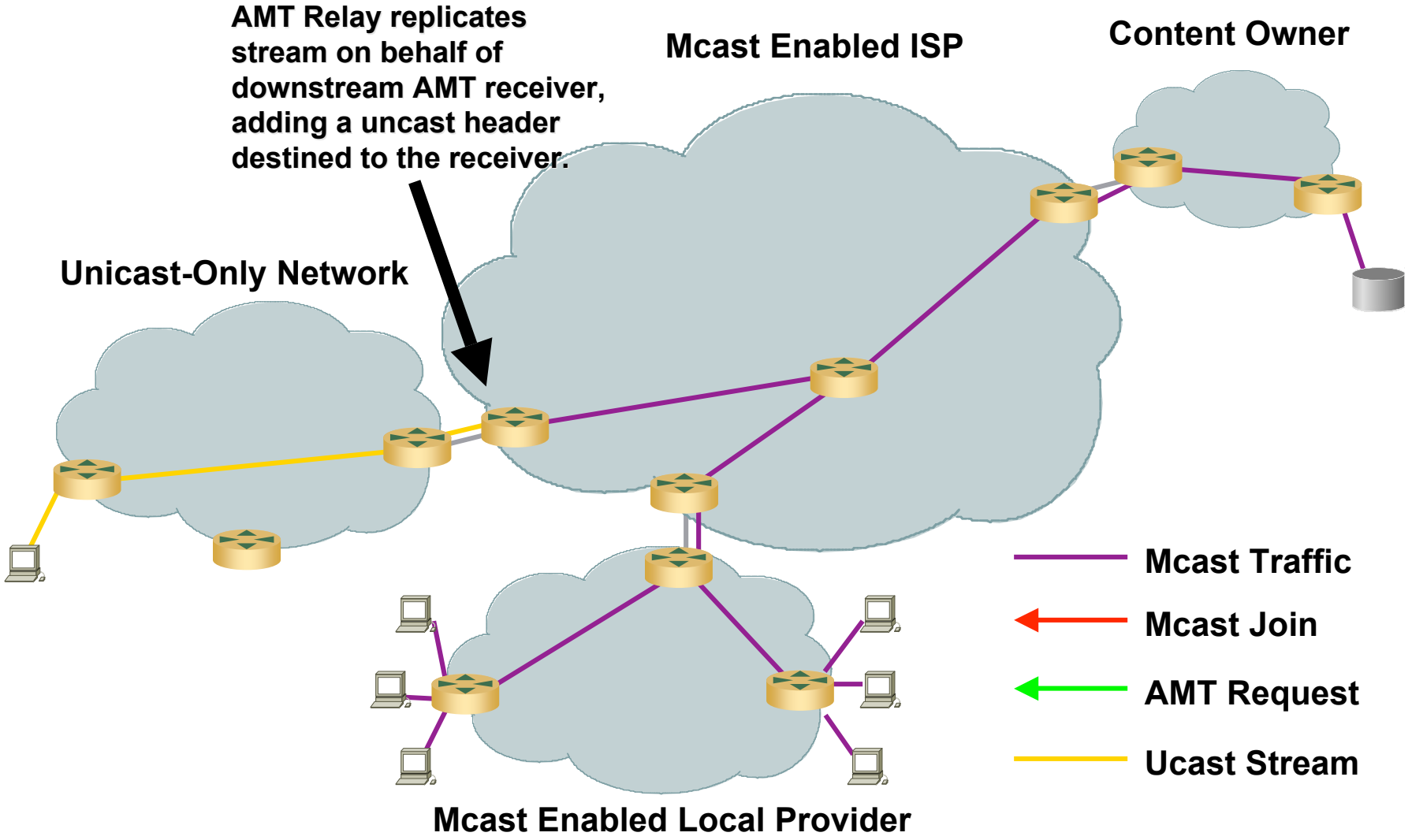

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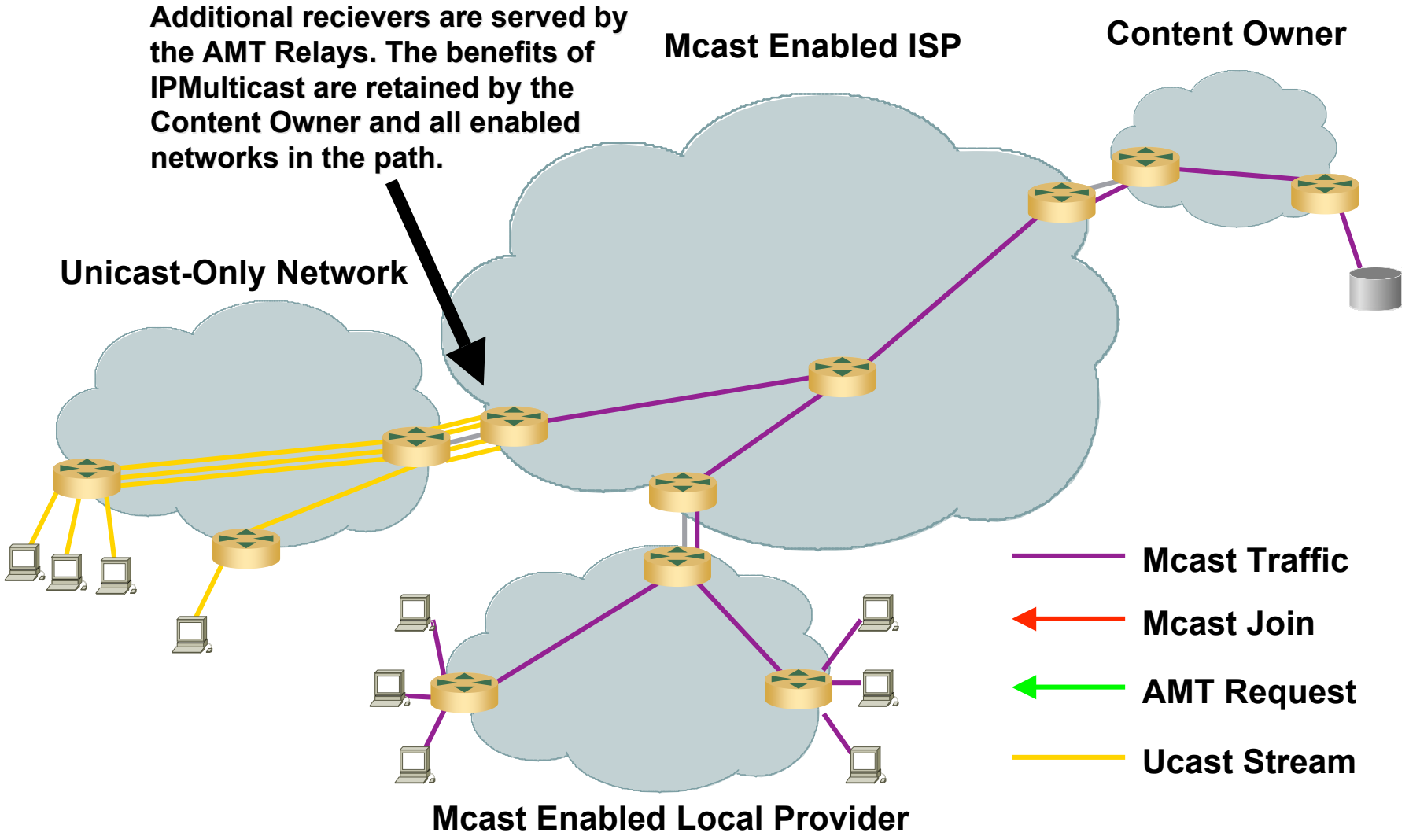

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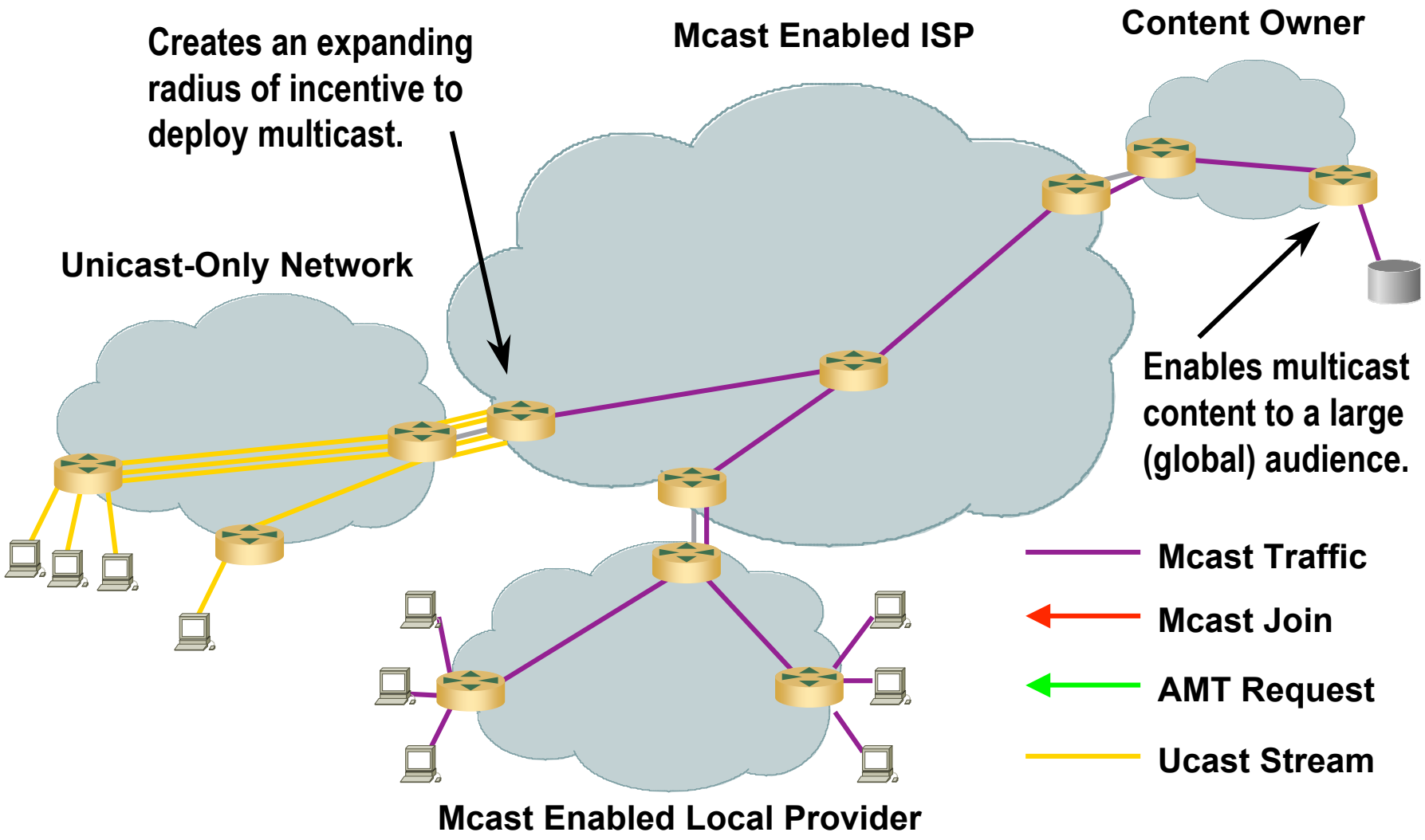

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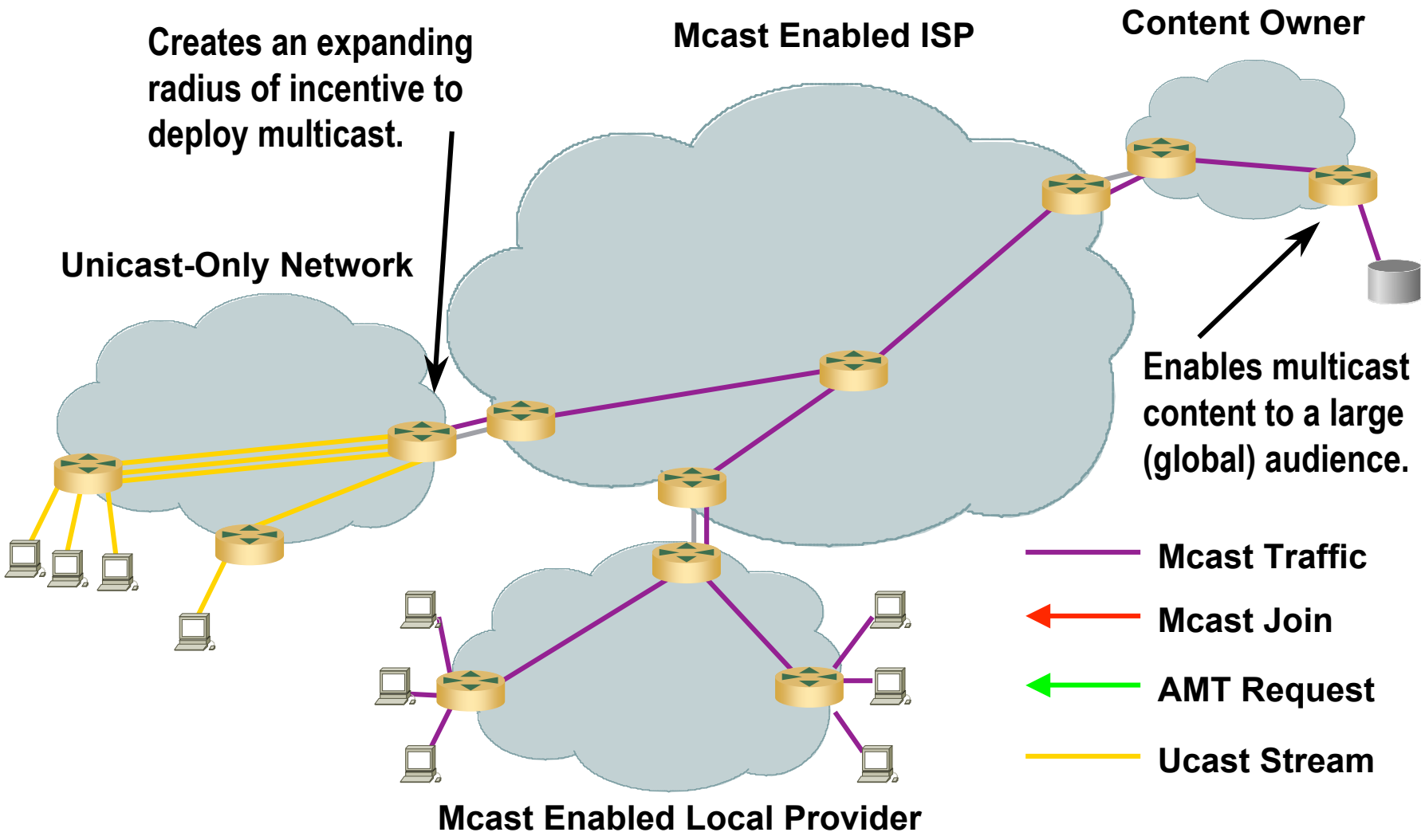

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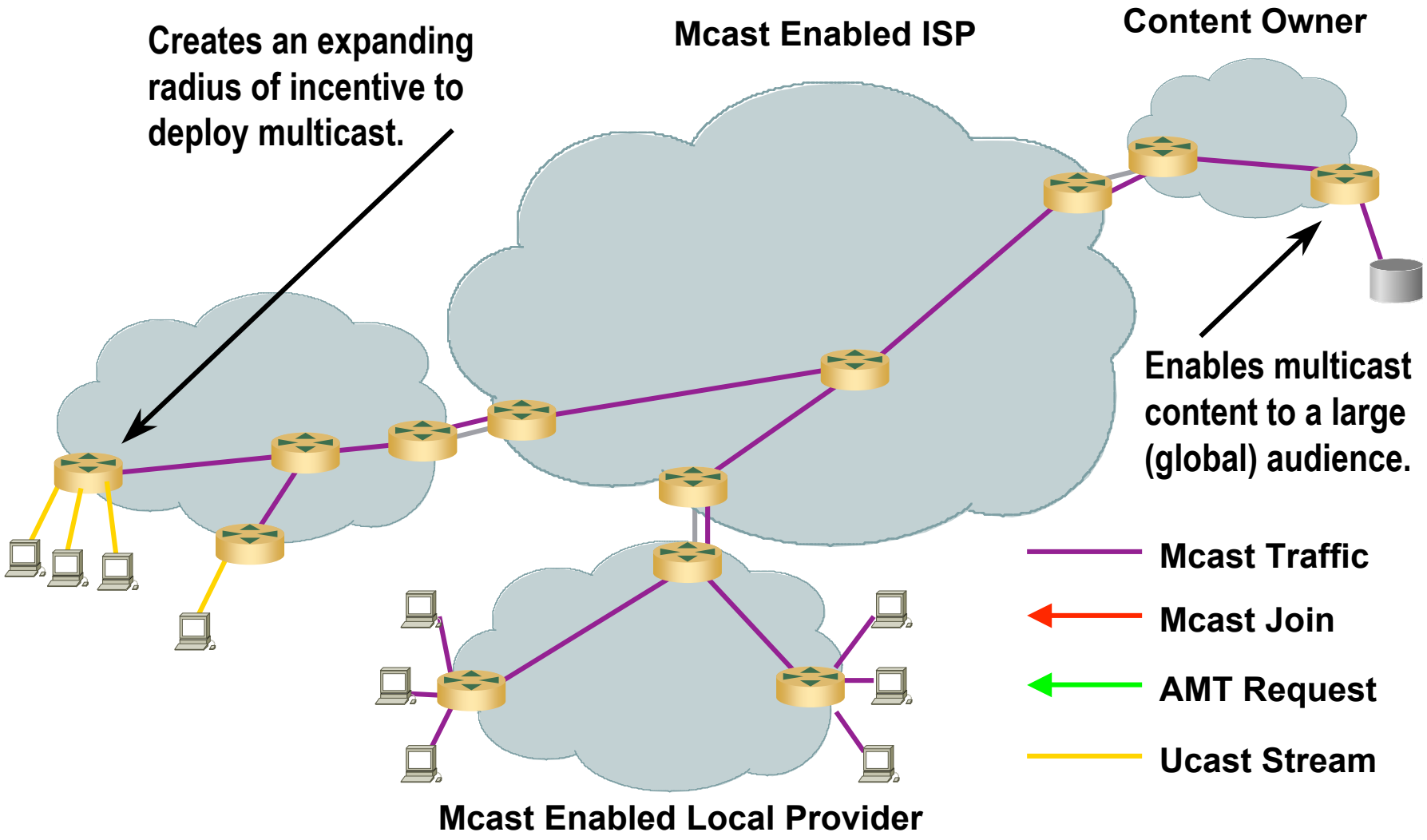
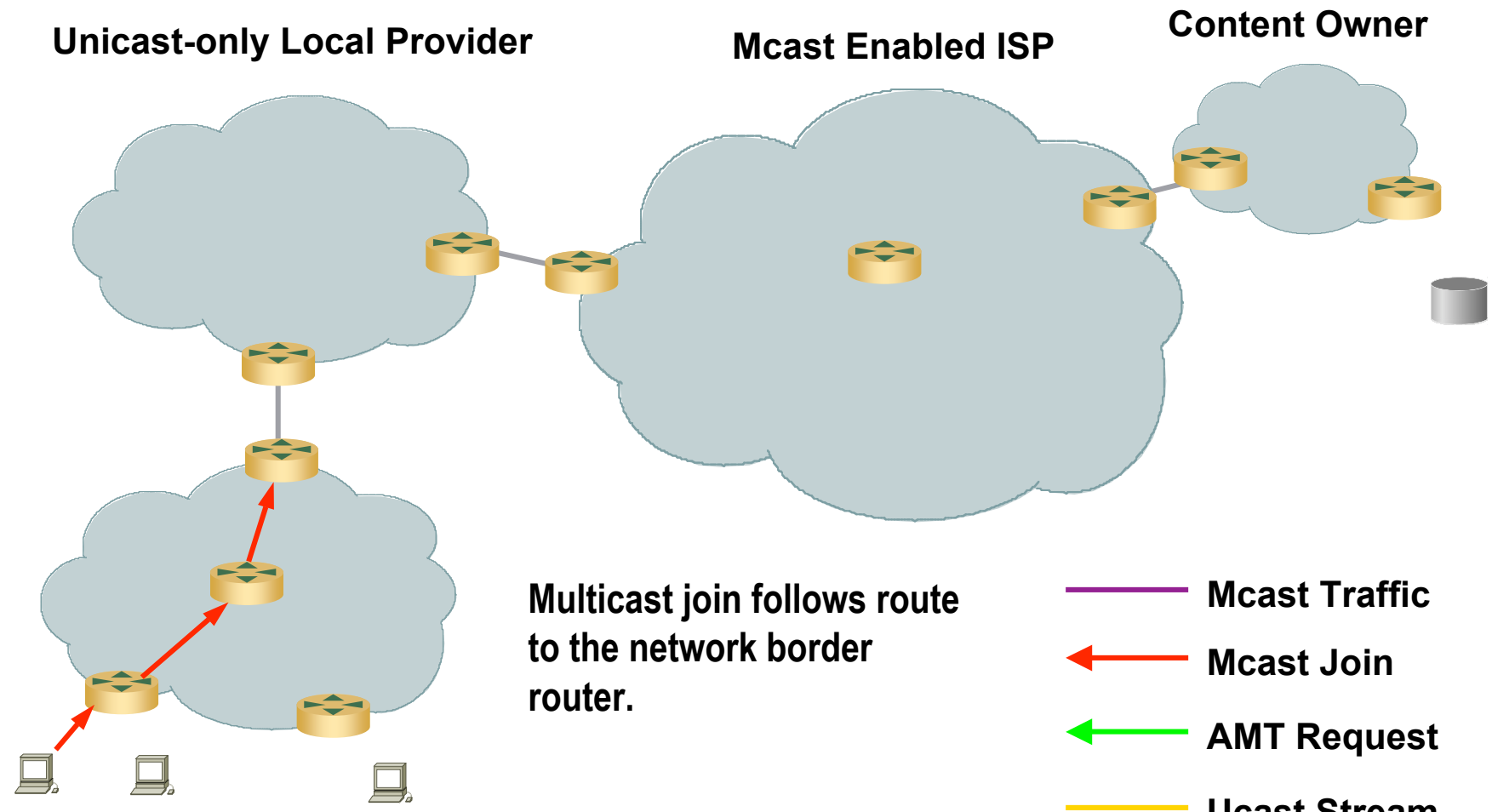


AMT
Connecting Multicast Islands



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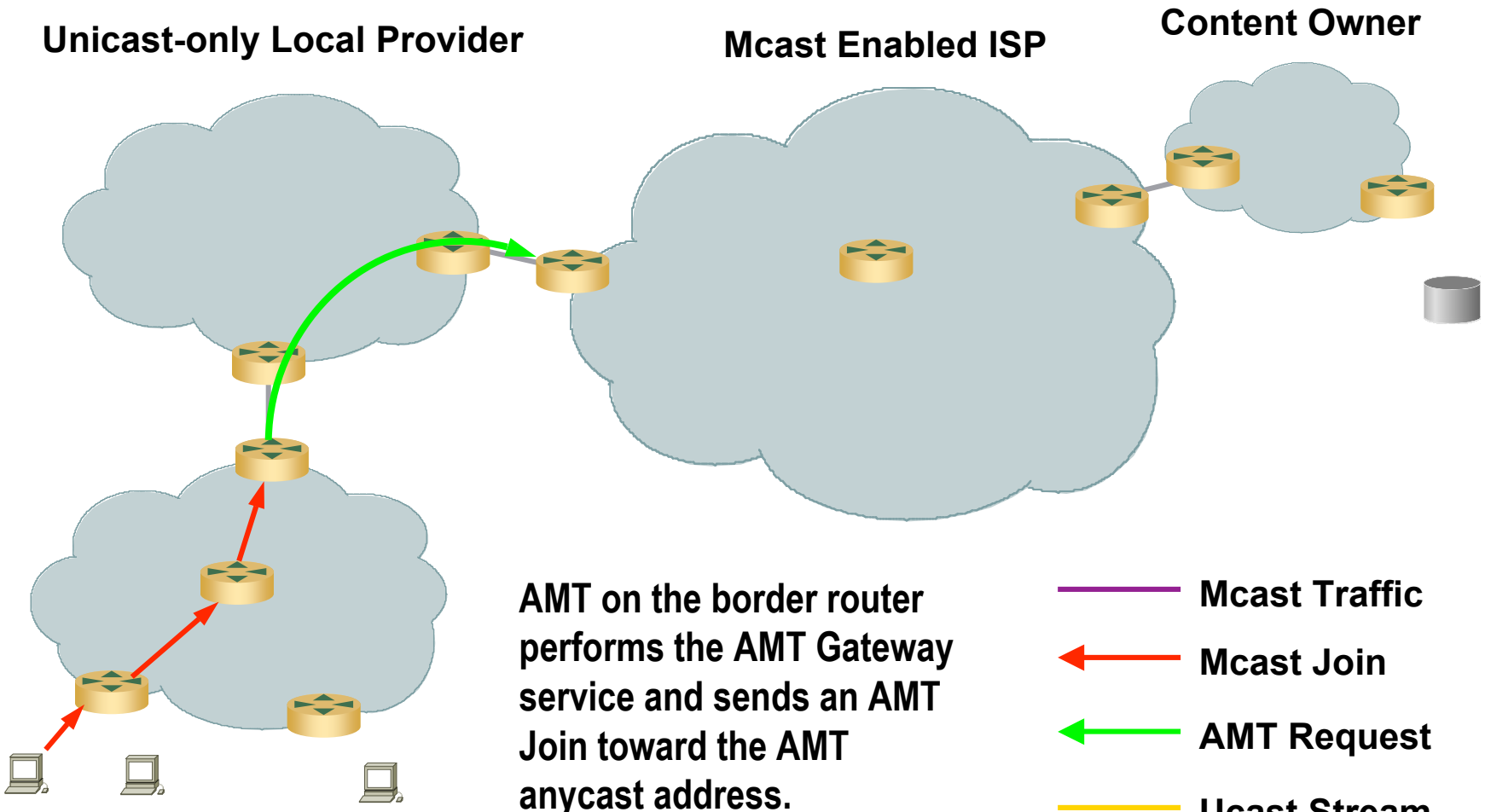
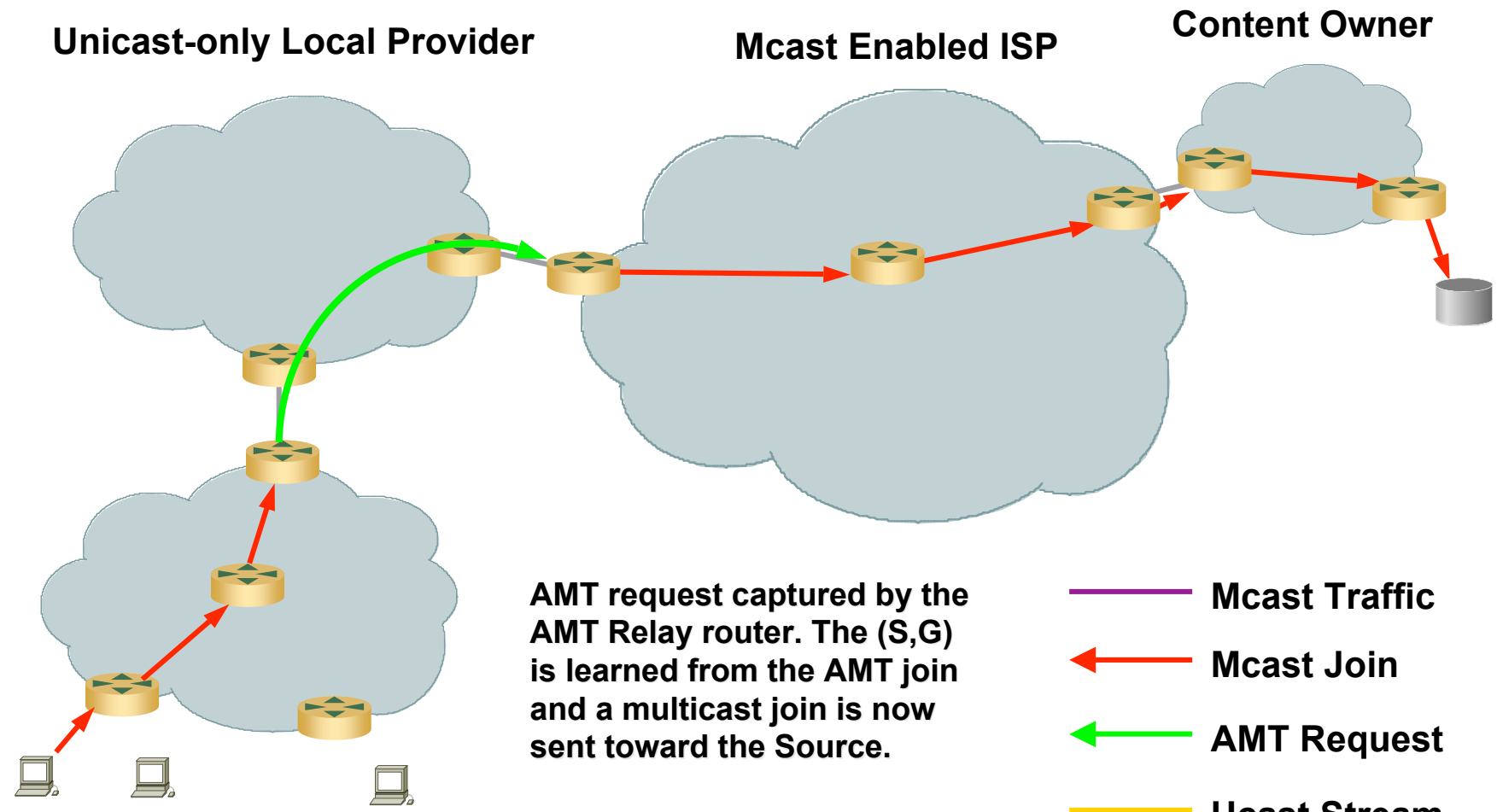


AMT on the border router performs the AMT Gateway service and sends an AMT Join toward the AMT anycast address.

- Mcast Traffic
- Mcast Join
- AMT Request
- Ucast Stream

AMT
Connecting Multicast Islands



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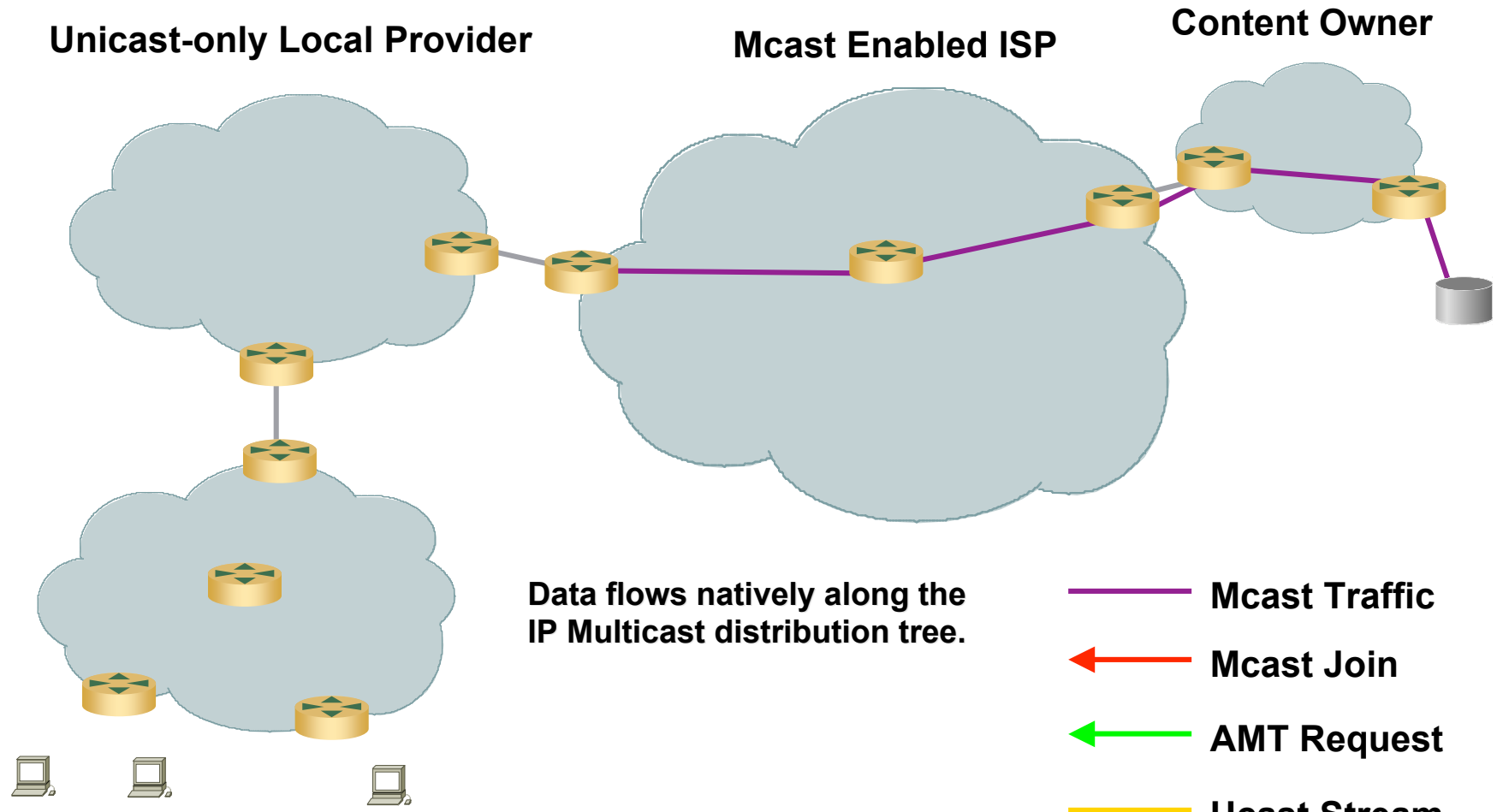

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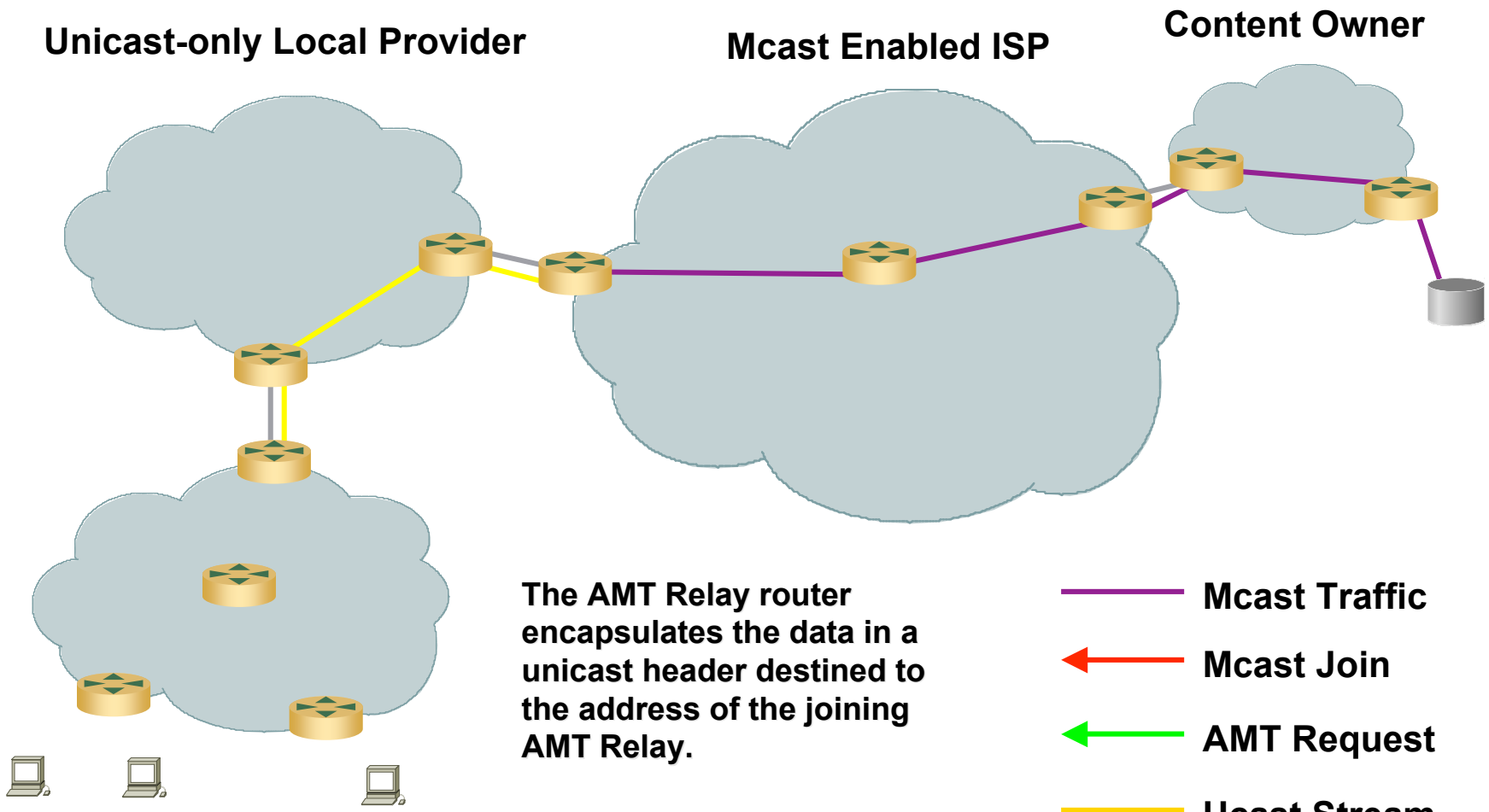
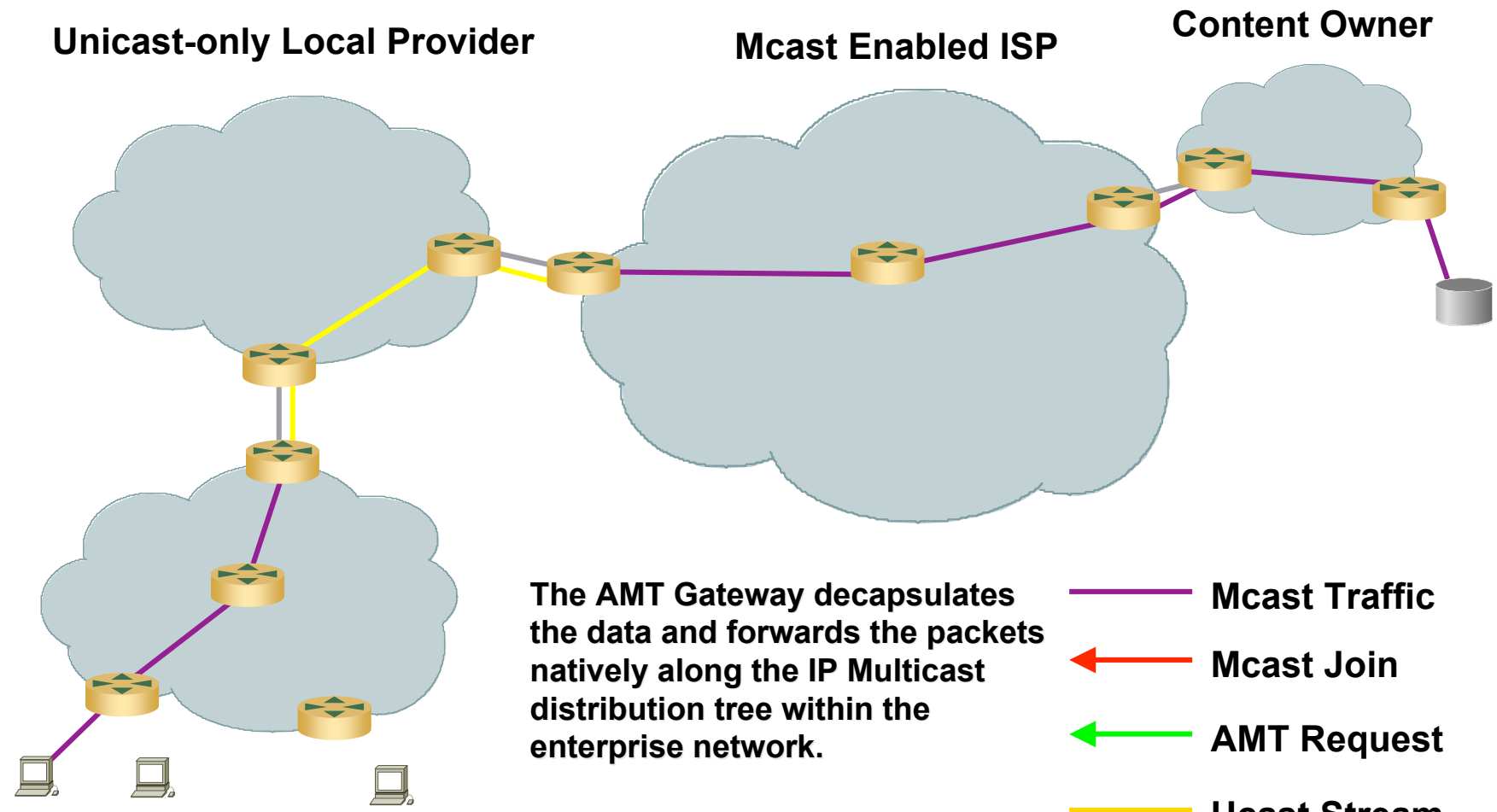


The AMT Relay router encapsulates the data in a unicast header destined to the address of the joining AMT Relay.

- Mcast Traffic
- Mcast Join
- AMT Request
- Ucast Stream

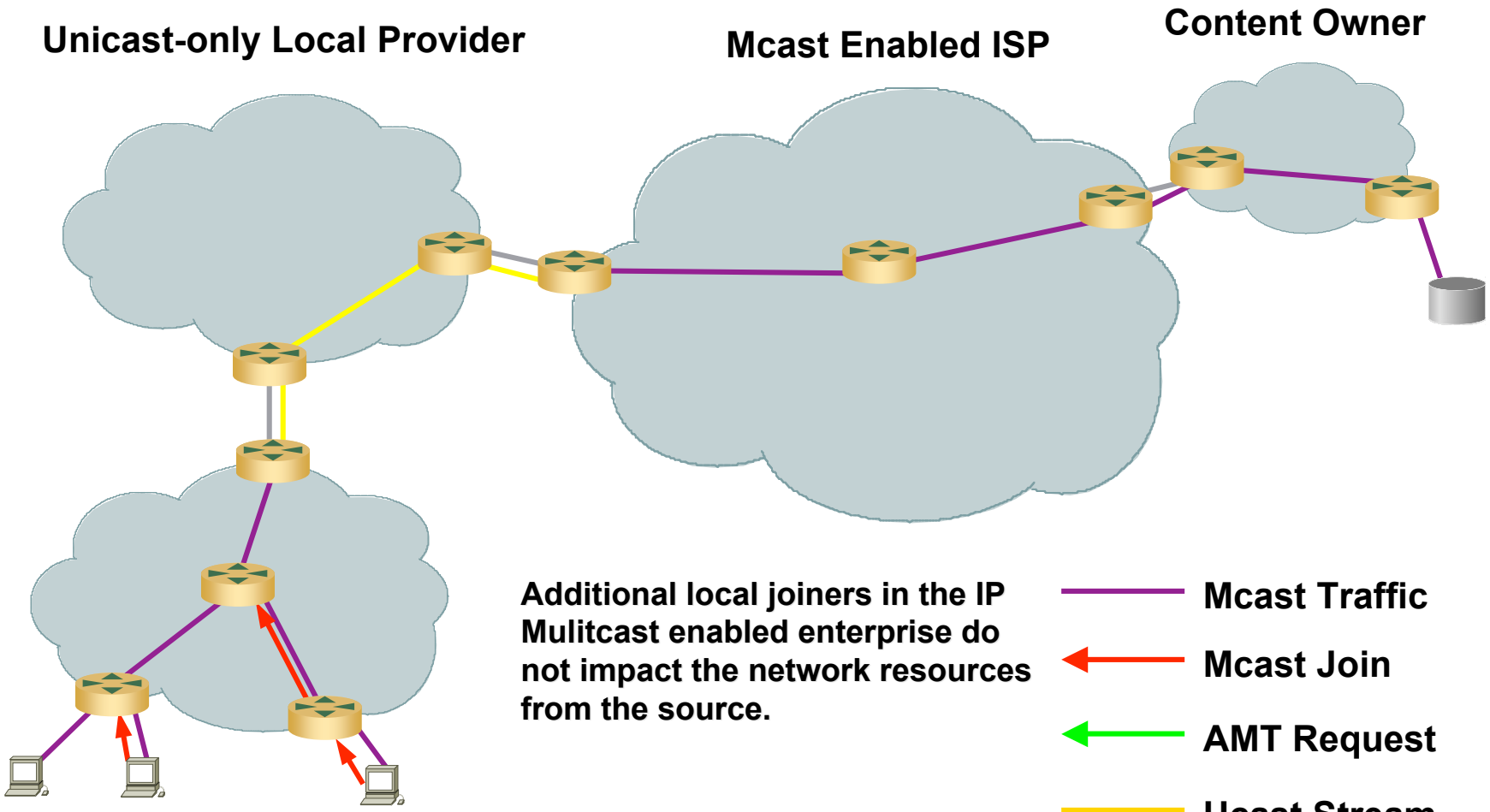
AMT
Connecting Multicast Islands



The AMT Gateway decapsulates the data and forwards the packets natively along the IP Multicast distribution tree within the enterprise network.

- Mcast Traffic
- Mcast Join
- AMT Request
- Ucast Stream

AMT
Connecting Multicast Islands



Current AMT status

- Cisco development in DCOS
- Public reference implementation
  - Cisco Research grant to UCSB/UTDallas
    - Relay/Gateway - Linux/FreeBSD
    - Gateway - VLC (Mac, Win), Linksys
    - Java Applet wrapper for web-embedded AMT content

AMT Deployment Trial

- NETNOD - MIX in Sweden
  - Radio and IPTV content customers
- ISC.org
  - Global mcast mix network
- SDP extensions for AMT anycast address and timer
  - IETF 71
- Other trial locations welcome
  - Contact me

Thank you!

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