SOI-Asia, Feb. 4 – Feb. 12, 2008

WIDE

Toward IP Multicast Deployment

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Second Day

- IP multicast communication architecture
  - Communication protocols
    - PIM-SM, MSDP, MBGP, Embedded RP
    - Source-Specific Multicast (SSM)
    - IGMPv3, MLDv2, LW-IGMPv3/LW-MLDv2
    - Automatic multicast tunnel (AMT)
  - Infrastructure protection

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PIM-SM

- Protocol Independent Multicast Routing Protocol – Sparse Mode (PIM-SM)
  - PIM-SMv2 standard protocol defined in [RFC4601]
  - Explicit-join type routing protocol
  - Components
    - Bootstrap router (BSR) [RFC5059]
    - Rendezvous Point router (RP)
    - Designated router (DR)
    - PIM Multicast Border Router (PMBR)
    - (IGMP/MLD querier)
      - Router that has lower IP address becomes querier

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PIM Messages

- PIM has own IP protocol number, 103
  - IP + PIM message (not with UDP, IGMP, etc.)
- ALL-PIM-ROUTERS address
  - 224.0.0.13 for IPv4 and ff02::d for IPv6
- Types
  - 0 = Hello Multicast to ALL-PIM-ROUTERS
  - 1= Register Unicast to RP
  - 2= Register-Stop Unicast to source of Register packet
  - 3 = Join/Prune Multicast to ALL-PIM-ROUTERS
  - 4 = Bootstrap Multicast to ALL-PIM-ROUTERS
  - 5 = Assert Multicast to ALL-PIM-ROUTERS
  - 6 = Graft (used in PIM-DM only) Unicast to RPF'(S)
  - 7 = Graft-Ack (used in PIM-DM only) Unicast to source of Graft packet
  - 8 = Candidate-RP-Advertisement

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Rendezvous Point Router (RP)

- RP is a core router that becomes a root of multicast routing tree
- Each RP defines group prefix the RP supports
- Sender's data is encapsulated and transmitted to RP
- Receiver's join is forwarded toward RP
- RP resolves data senders' addresses and join requests sent by receivers

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Shared Tree

- Concept
  - Routing tree is rooted at a core router (or RP)
  - Join messages from receivers for a group are sent towards the RP
  - Data from senders is sent to the RP so that receivers can discover who the senders are and start to receive traffic destined for the group.
  - Shared tree (or RPT) is created multicast address prefix
  - Enable (*,G) join/leave
  - Source address discovery

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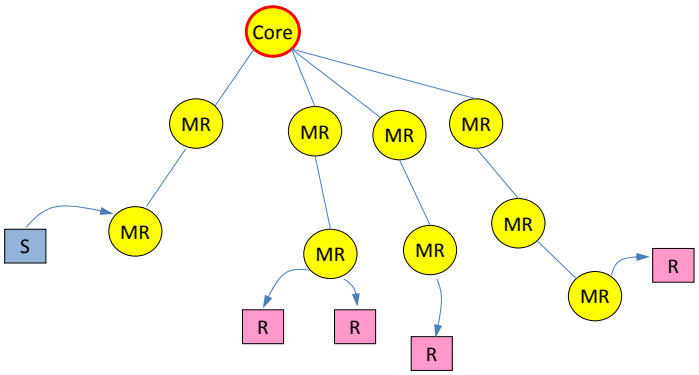
Shared Tree Concept



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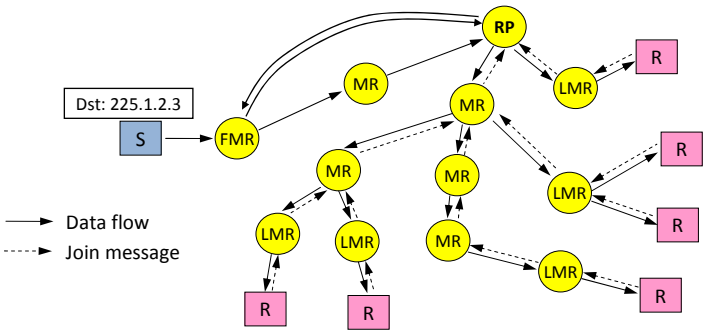
Rendezvous Point Tree

- Join messages and forwarded data along Rendezvous Point Tree (RPT)



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Shortest-Path Tree

- Concept
  - Source-based tree
  - Routing tree is constructed for each source
    - Routing tree is rooted at each source
  - Optimized tree (since the tree is coordinated with the shorted path)

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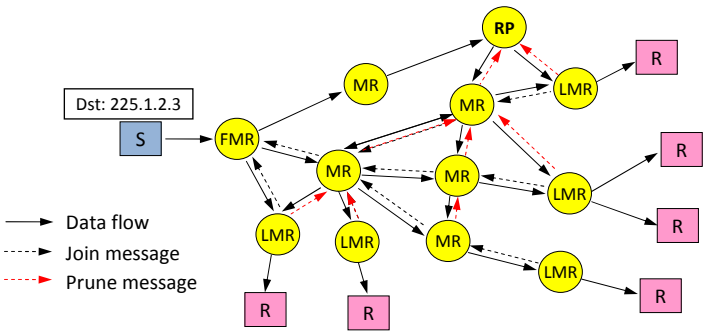
Shortest-Path Tree

- Join and prune messages and forwarded data over SPT
- PIM-SM switches from RPT to SPT



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Bi-Directional PIM

- Defined in [RFC5015]
- Not switched from RPT to SPT
  - No SSM transition
- Difference from PIM-SM's RPT
  - Register procedure does not exist

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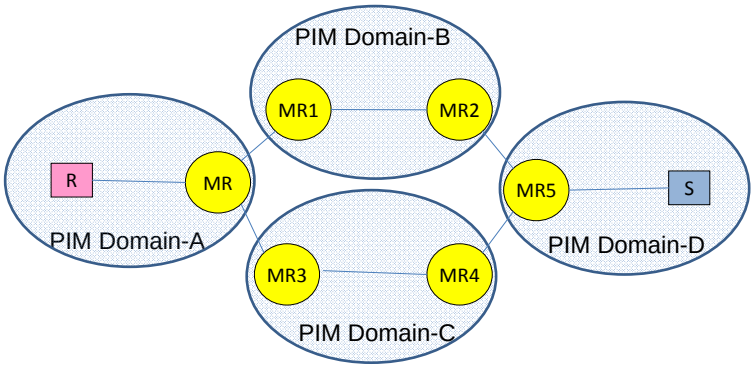
MBGP

- Multiprotocol Extensions for BGP-4 [RFC4760]
  - Implemented with MRIB



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Multicast Routing Information Base

- MRIB is used to define routing policy
  - Define incoming interface for RPF calculation

MR's unicast routing table

Destination	Next hop
S1 or S1's prefix	MR1
S2	MR1
S3	MR2

MR's multicast routing table

Destination	Next hop
S1 or S1's prefix	MR2
S2	MR1
S3	MR2

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MSDP

- Multicast Source Discovery Protocol
  - Defined in [RFC3618]
  - MSDP is a mechanism to connect multiple IPv4 PIM-SM domains together
  - Each PIM-SM domain uses its own independent RP and needs to discover sources in other PIM domains
  - MSDP creates peering relationship that is made up of a TCP connection

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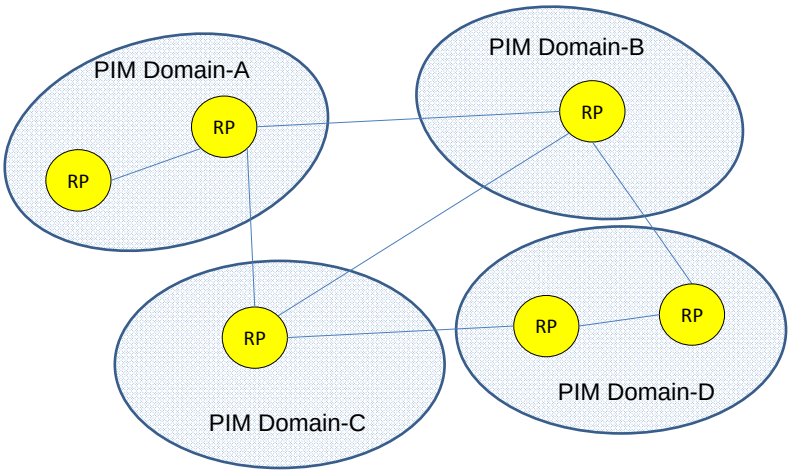
MSDP Example



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MSDP Concerns

- Periodical transmission of the large amount of SA messages transmission
  - Low scalability
  - Easy to cause DoS attacks
  - Difficult to filter out unneeded or illegal SA messages

Therefore, MSDP is not proposed for IPv6 multicast

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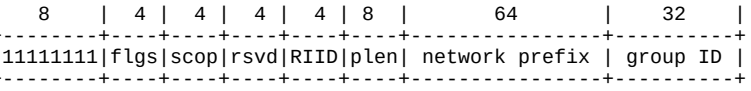
Embedded RP

- Defined in [RFC3956]
- Extension of unicast-prefix-based address (IPv6) [RFC3306]



  – plen MUST NOT be 0
- Example: If RP address is 2001:db8:1234::5 , then group address the RP supports is ff7e:0530:2001:db8:1234:5678::8000

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Source-Specific Multicast

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IP Multicast Applications

- Multimedia contents distribution
  - Real-time streaming (Live event etc.)
  - IPTV (in a broad sense)
  - E-Learning
  - Online meeting
- Resource discovery
  - SLP
  - mDNS
  - Control messages
    - E.g. OSPF Hello, PIM Hello, PIM CandRP, IGMP/MLD, ND/DAD

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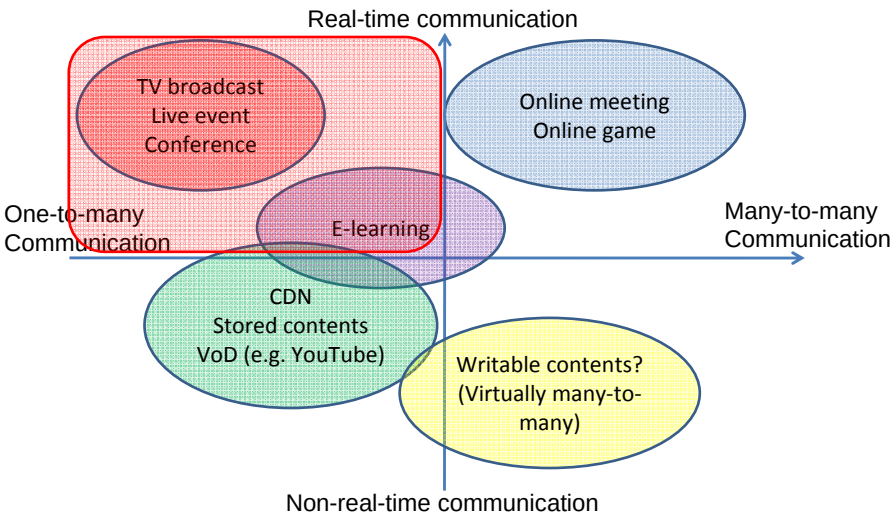
Application Category



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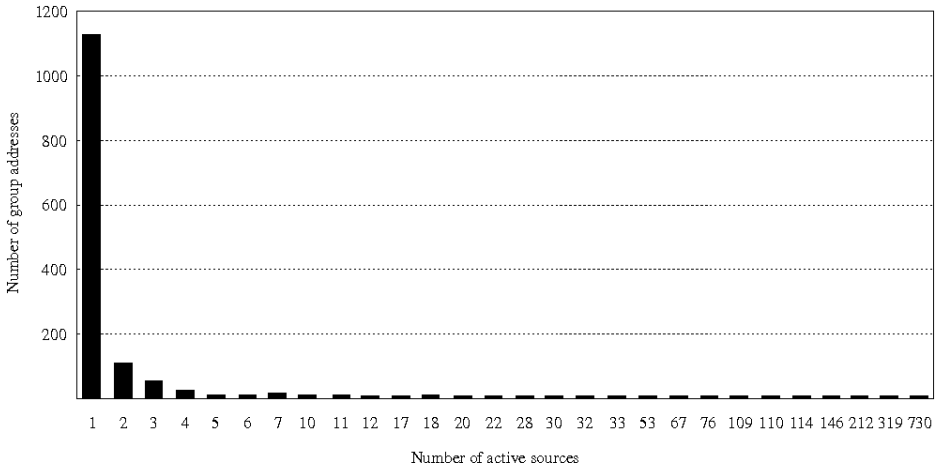
Statistical Trend



Measured from Feb. 28, 2004 to Mar. 13, 2004 on an APAN B.B. router

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Current Multicast State

- http://www.multicasttech.com/status/

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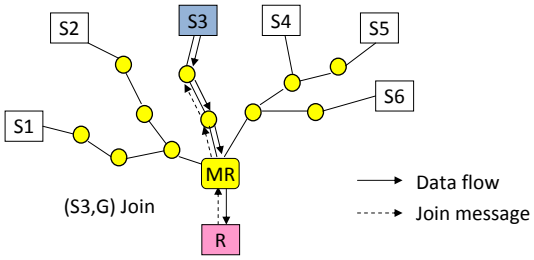
Source-Specific Multicast (SSM)

- Host specifies (S,G) addresses to join/leave a session
- No Rendezvous Point router (RP)
- Simple tree coordination
  - Known as a deployable multicast communication model



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SSM Concept

- Communication model
  - One-to-many communication is the assumption
  - Data receiver specifies (S,G) address pair to join the multicast channel
- Advantages
  - RP and RPT are not needed
    - Source address discovery function (done by RP) is eliminated from routing protocol
    - Routing scalability problem would be reduced from the current routing protocol
  - PIM-SM routing state is simplified

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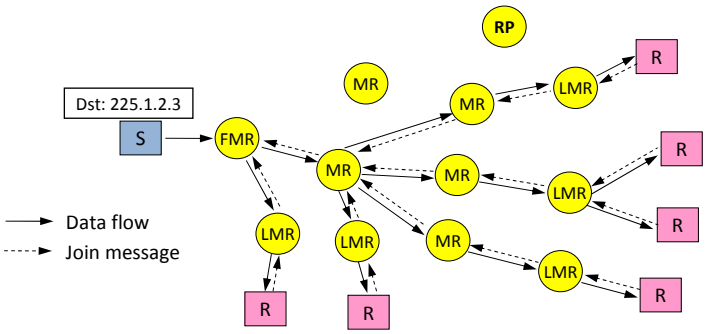
SSM Routing Tree

- SSM routing tree is simply constructed



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SSM Issues

- Host-side issues
  - Many procedures that have been done by router should be taken care on data senders and receivers
    - Source discovery function (on receiver side) or source announcement function (on sender side)
    - Data receiver must notify source and multicast address pair (i.e. (S,G)) to routers whenever the receiver requests join or leave

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SSM Issues

- Router-side issues
  - Many procedures that have been done by router are eliminated, but router needs to support new communication architecture
    - When data receiver notifies source and multicast address pair (i.e. (S,G)), the router must construct the shortest routing tree directly
  - Receiver-based attack will be appeared
    - It is not common in ASM (explained later)

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Required Protocols

- IGMPv3 for IPv4 SSM
  - Defined in [RFC3376]
- MLDv2 for IPv6 SSM
  - Defined in [RFC3810]
- Currently these lightweight protocols have been proposed
  - Draft-ietf-mboned-lightweight-igmpv3-mldv2-02.txt

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Filter Mode

- INCLUDE mode
  - If the requested filter mode is INCLUDE *and* the requested source list is empty, then the entry corresponding to the requested interface and multicast address is deleted if present. If no such entry is present, the request is ignored.
- EXCLUDE mode
  - If the requested filter mode is EXCLUDE *or* the requested source list is non-empty, then the entry corresponding to the requested interface and multicast address, if present, is changed to contain the requested filter mode and source list. If no such entry is present, a new entry is created, using the parameters specified in the request.

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Socket State and Interface State

- Socket State
  - (interface, multicast-address, filter-mode, source-list)
- Interface State
  - (multicast-address, filter-mode, source-list)
- Combinations of interface state and socket state
  - States of independent applications are managed by hosts
  - Operating system requirements
    - Integrate all socket states all application have
    - Report current interface state that is calculated by integrated soket state to the upstream router (INCLUDE, EXCLUDE, TO_IN, TO_EX)

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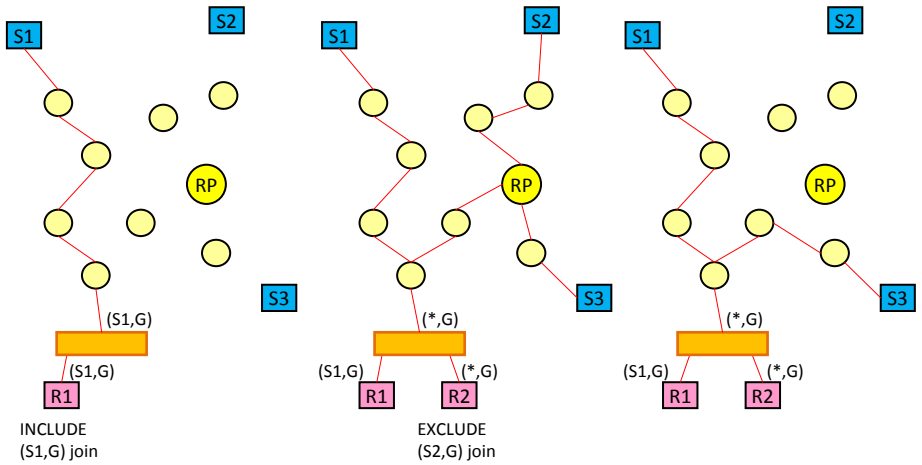
IGMPv3/MLDv2

- Support SSM
  - (S,G) join/leave
  - Aka, INCLUDE (S,G) join/leave
- Support source filtering function
  - (*,G) join with “non-interesting” source
  - Aka, EXCLUDE (S,G) join/leave
- Support MSF APIs
  - Basic APIs
    - (S,G) join/leave
  - Advanced APIs
    - (S*n*,G) join/leave

Problems in Full Version Protocols

- Implementation complexity
  - State transition between INCLUDE and EXCLUDE modes is complex
- Low scalability
  - State transition between INCLUDE and EXCLUDE modes leads inefficient procedures
    - Switch needs to forward all data whenever the downstream host requests EXCLUDE mode join
- Routing tree fallback
  - SPT back to RPT
    - Router needs to maintain RPT whenever the downstream host requests EXCLUDE mode join

State Transition



LW-IGMPv3/LW-MLDv2

- Goal
  - Define simplified IGMPv3/MLDv2 to facilitate further SSM deployment
- Approach
  - Remove an EXCLUDE filter-mode operation from a host (except (*,G) join)
  - Remove EXCLUDE filter-mode on routers
  - Simplify an INCLUDE filter-mode operation
  - Several record types for IGMP/MLD report are eliminated
  - Keep compatibility with the full version

AMT

- Automatic IP Multicast Without Explicit Tunnels (AMT)
  - draft-ietf-mboned-auto-multicast-08.txt
- AMT is very similar to that used by "6to4" [RFC3056], [RFC3068] to get automatic IPv6 connectivity
- UDP based tunnel
- Data and control messages can be transmitted

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AMT Components

- AMT Pseudo-Interface
- AMT Gateway
- AMT Site
- AMT Relay Router
- AMT Relay Anycast Prefix
- AMT Relay Anycast Address
- AMT Subnet Anycast Prefix
- AMT Gateway Anycast Address

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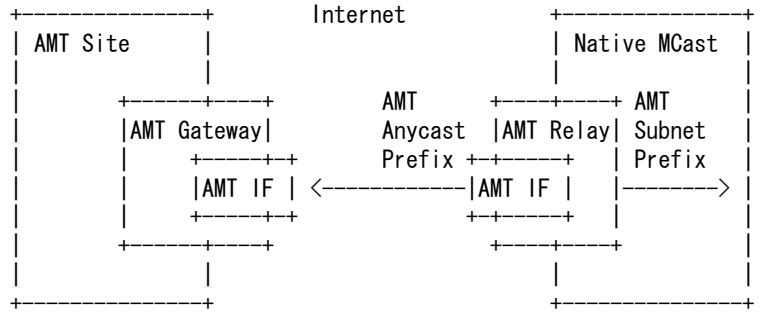
AMT Connection



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Multicast Security

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Multicast Security

- Three items
  - Contents protection
    - Multicast AAA – MBONED WG
    - Group key infrastructure – MSEC WG
  - Infrastructure protection
    - Sender-based and receiver-based attacks – MBONED WG
  - Privacy
    - Sender privacy is probably not needed
    - Receiver privacy

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Infrastructure Protection

- Sender-based attack
- Receiver-based attack

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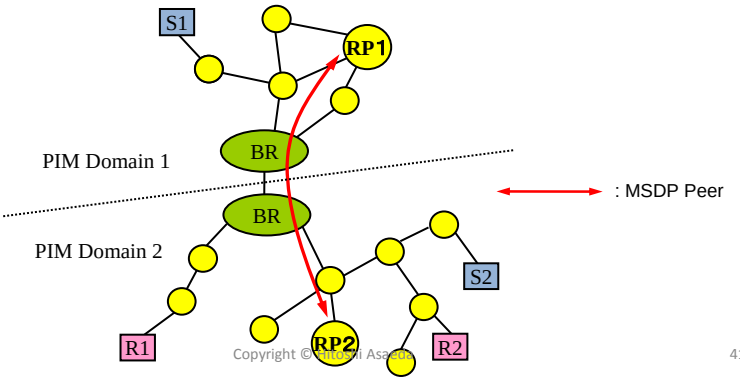
Sender-Based Attack

- Malicious sender can collapse networks
  - A large amount of PIM register messages attacks the RP
  - MSDP SA messages are easily flooded in MSDP peers
  - SSM is relatively robust for source-based attack



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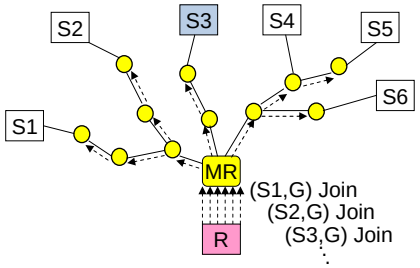
Receiver-Based Attack

- Malicious receiver can collapse networks
  - SSM is weak for receiver-based attack because of no source validation mechanism
  - ASM is relatively robust because RP can recognize active senders



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That’s all for today

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