QS-XCAST: A QoS Aware XCAST Implementation

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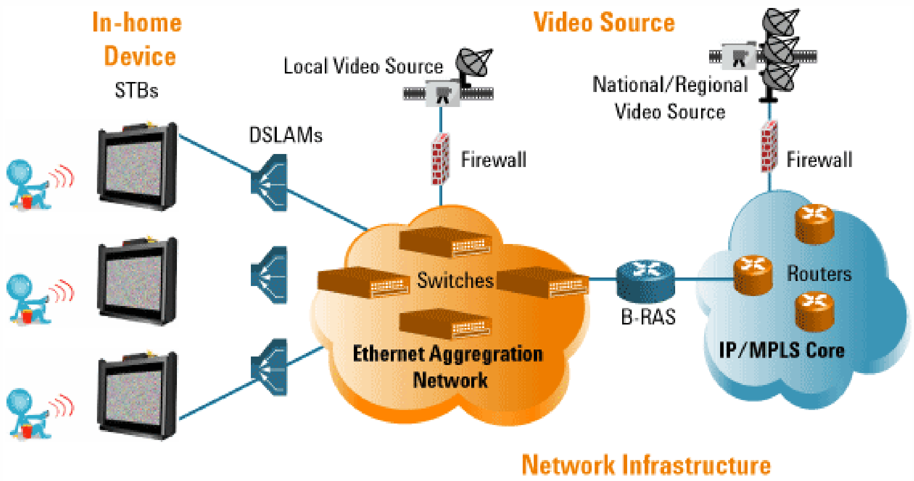
Introduction

- Multipoint communication
  - One source to many receivers
  - Application areas
  - Protocols
    - Multiple unicast, Multicast,
- Multicast
  - IP Multicast
  - Application Layer Multicast (ALM)

Multipoint Communication

APPLICATION AREAS:

1. Videoconferencing



2. IP Television

- Can be simplified using Multicast technology
- Multicast: Bandwidth efficiency
- Multicast deployment in global scope is challenging
- XCAST was proposed

XCAST

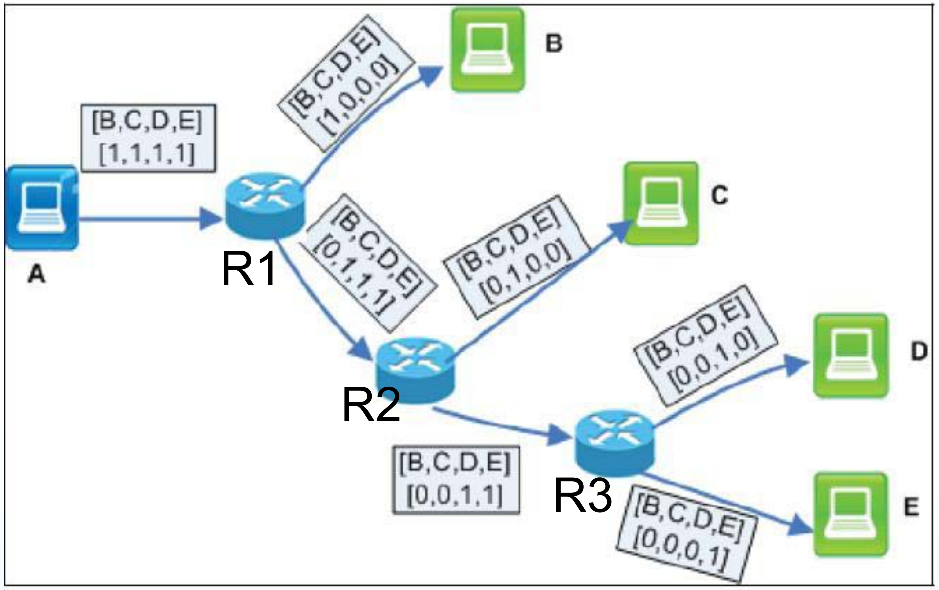
- XCAST: (Specifications in RFC 5058)
  - explicit multiunicast
  - List of destinations embedded in IP header
  - Routing - unicast route tables
  - Not yet fully investigated

Source	Destinations	Data
Node A	Dst1, Dst2,.....DstN	

<u>Complementary to IP multicast model:</u>

- IP multicast:
  - Scales with the number of receivers
- XCAST:
  - Scales with the number of groups
  - No per-session signaling and state information

XCAST



A – Sender.
B,C,D,E - Receivers

Packet from A:
Embeds ALL destinations
Has a bitmap

<u>Router Operations:</u>

- Table lookup for next-hops
- Grouping of destinations
- Packet replication
- Updating of the bitmaps
- Forwarding of packet copies

Motivation

- Need to deploy XCAST6 in real-world.
  - Existing routers are not XCAST-aware
  - Using Testbeds: Scale can be limited by time and resources available.
  - No Significant research on XCAST QoS
  - Existing simulators do not have XCAST routing model
- XCAST Simulation models are needed:
  - XCAST header is already complex
  - Alternative way to make XCAST QoS aware
  - Differentiated Architecture provides an option.

OMNeT++

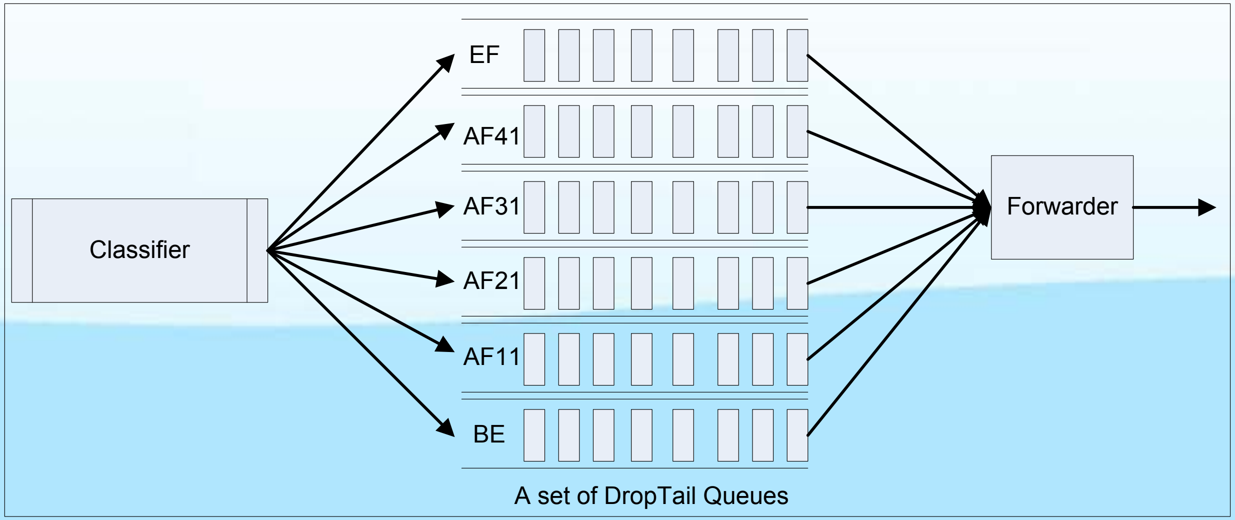
- Generic:
  - Modeling any system where the discrete event approach is suitable.
  - Communication networks, Queuing systems etc
- QoS using DiffServ Architecture:
  - Only basic Implementation exists in OMNeT++
- Enhancements:
  - Implement XCAST6
  - Extend Basic DiffServ
  - Integrate DiffServ with XCAST6

QoS Provisioning

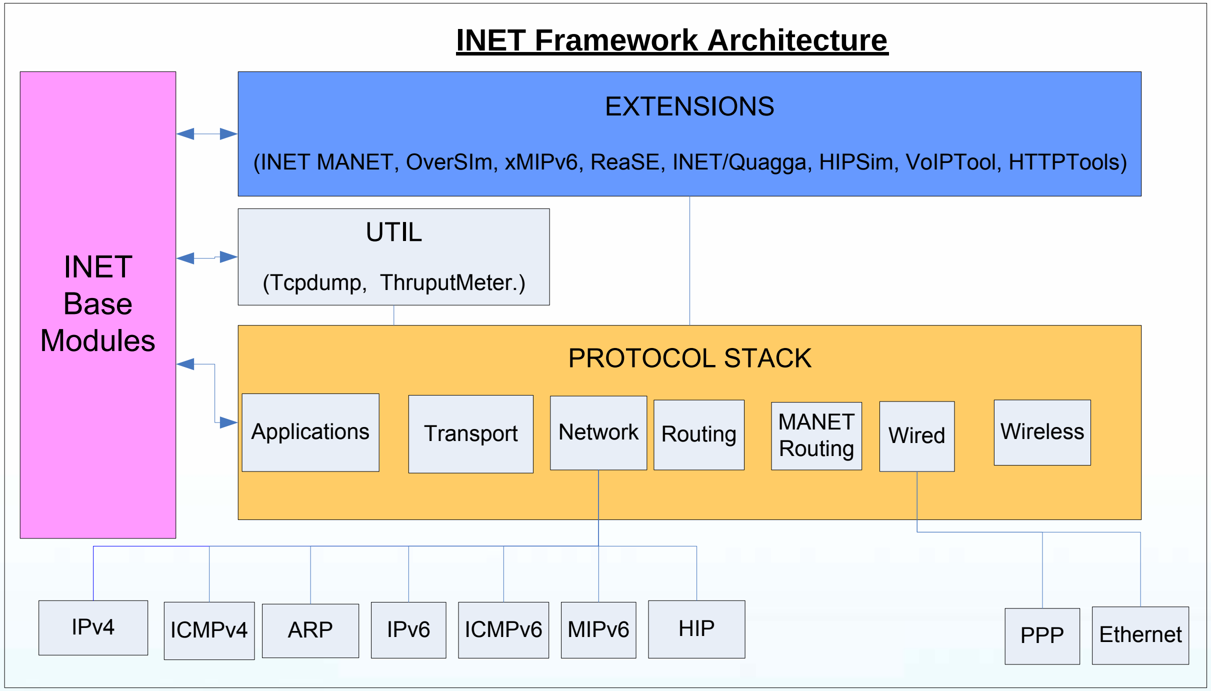
- Using DiffServ Architecture (RFC 2474, 2475)
- A defined set of building blocks
  - A small bit-pattern in IP packets (IPv4,IPv6)
  - 6-bit DS field (DSCP)
  - Forwarding treatment (Per-Hop-Behavior)
  - Classification and QoS revolve around DSCP
  - Hierarchical organization of nodes
    - (Core routers, Edge routers, End hosts)
  - Concept of domains (DiffServ domains)
  - Packet Marking
  - Admission Control

DiffServ Architecture

- Per-Hop-Behavior
  - Expedited Forwarding (EF) – RFC 2598,
  - Assured Forwarding- AF, RFC 2597.
    - (AFxy) – x - classes, y - drop precedence
  - Default (Best Effort – BE) – RFC 2474



The INET Framework



Concept:

- Modules
- Messages

Communication:

- Message passing

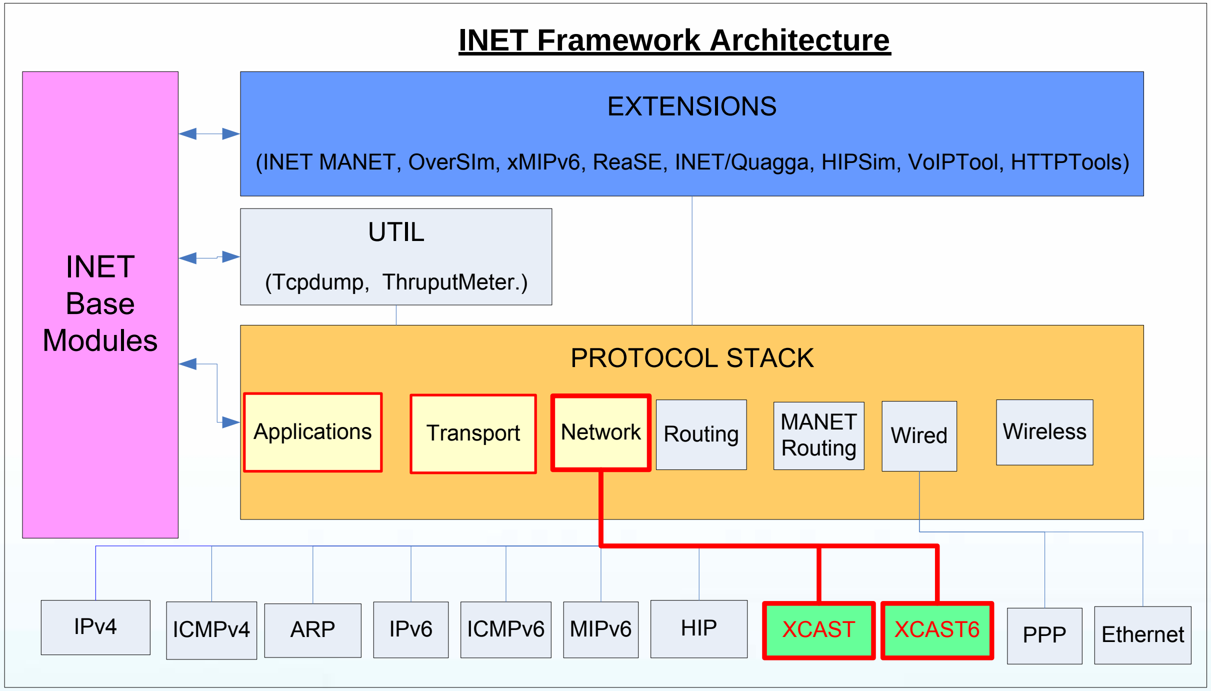
Modules:

- Protocols
- Data holders
- Extra Objects

Protocols:

- Behavior implemented in Simple modules
- Defined in C++ code
- Both wired and wireless

Implementing XCAST in OMNeT++



XCAST Protocol:

- Application layer
- Transport layer
- Network layer

Application Layer:

- Destination hosts

Transport Layer:

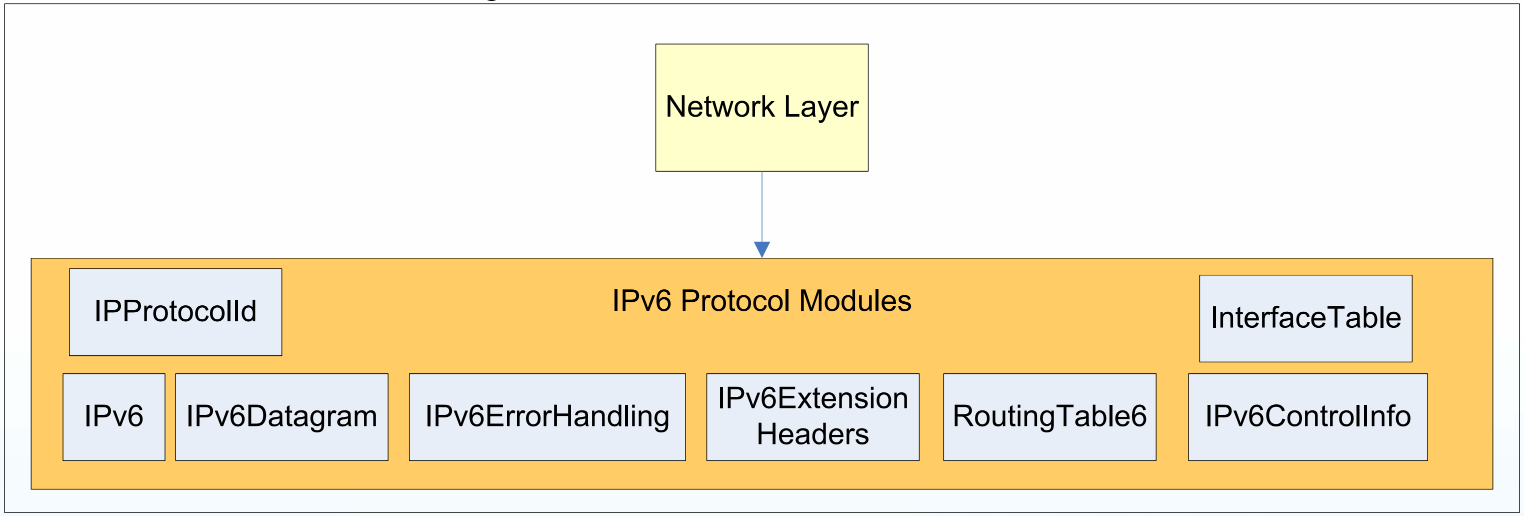
- ControlInfo
- Destinations
- Bitmap and ports

Network Layer:

- XCAST has significant impact here
- Understanding packet structure
- Routing decisions to pass to routing protocols

Implementing XCAST in OMNeT++

- Network Layer Modules:



<u>IPv6 Class:</u>

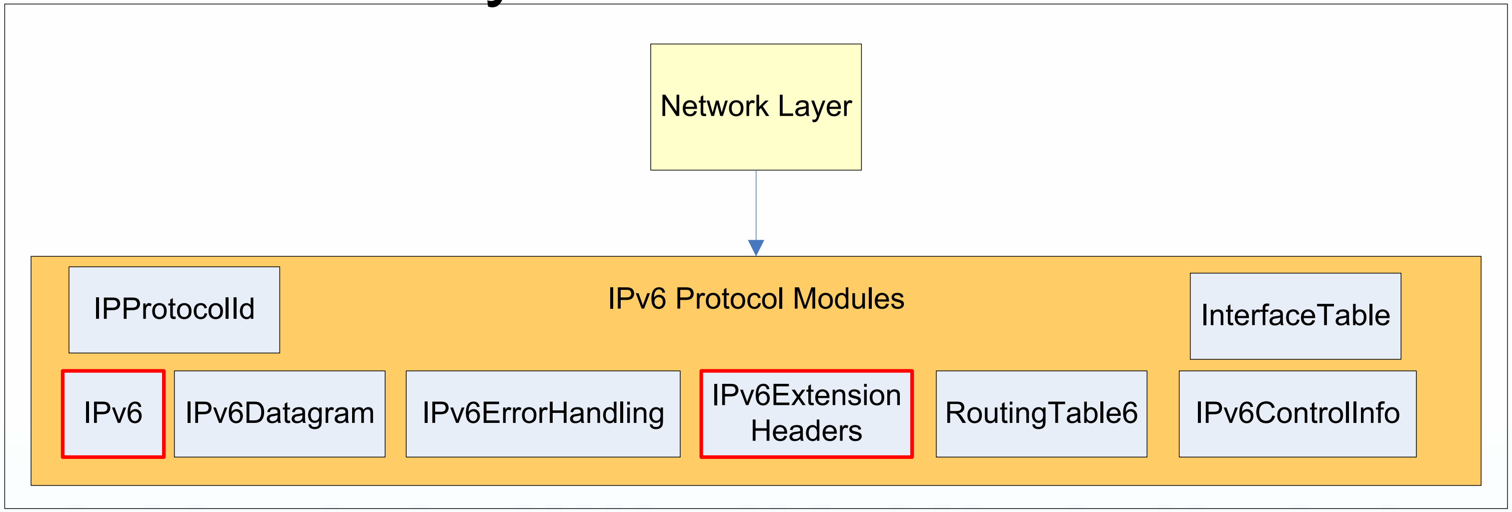
- Invokes:
  - Routing decisions made here
  - Neighbor Discovery
  - Data delivery (to Transport)
- Marked as Work In Progress

<u>IPv6 Extension Header:</u>

- Incomplete (OMNeT++ 4.1):
  - Only Class Declarations
  - Needed by XCAST6

Implementing XCAST in OMNeT++

- Network Layer Modules:

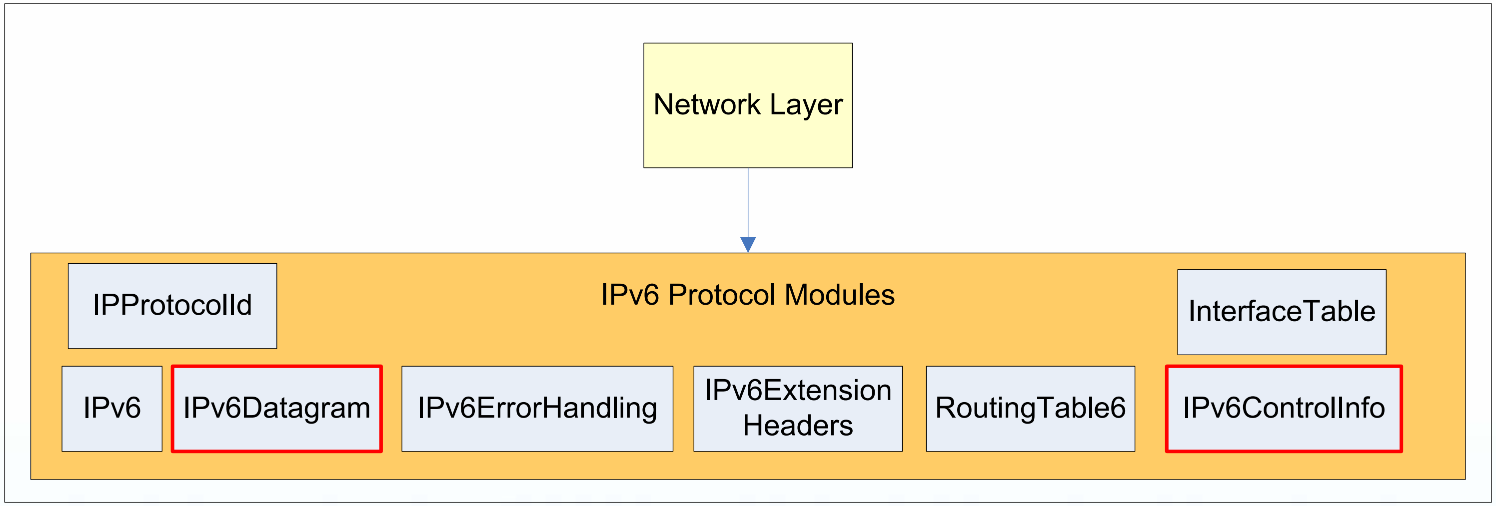


IPv6 Module:
- Destination List container:
- Bitmap container
- Redefined *handleMessage()*
- New: *routeXcastPackets()*
- XCAST Statistics:
  - Dropped packets
  - Replications

IPv6ExtensionHeader:
- Completed:
  - Routing Extension header
- Introduced:
  - List of destinations
  - XCAST Bitmap

Implementing XCAST in OMNeT++

- Network Layer Modules:



IPv6ControlInfo:

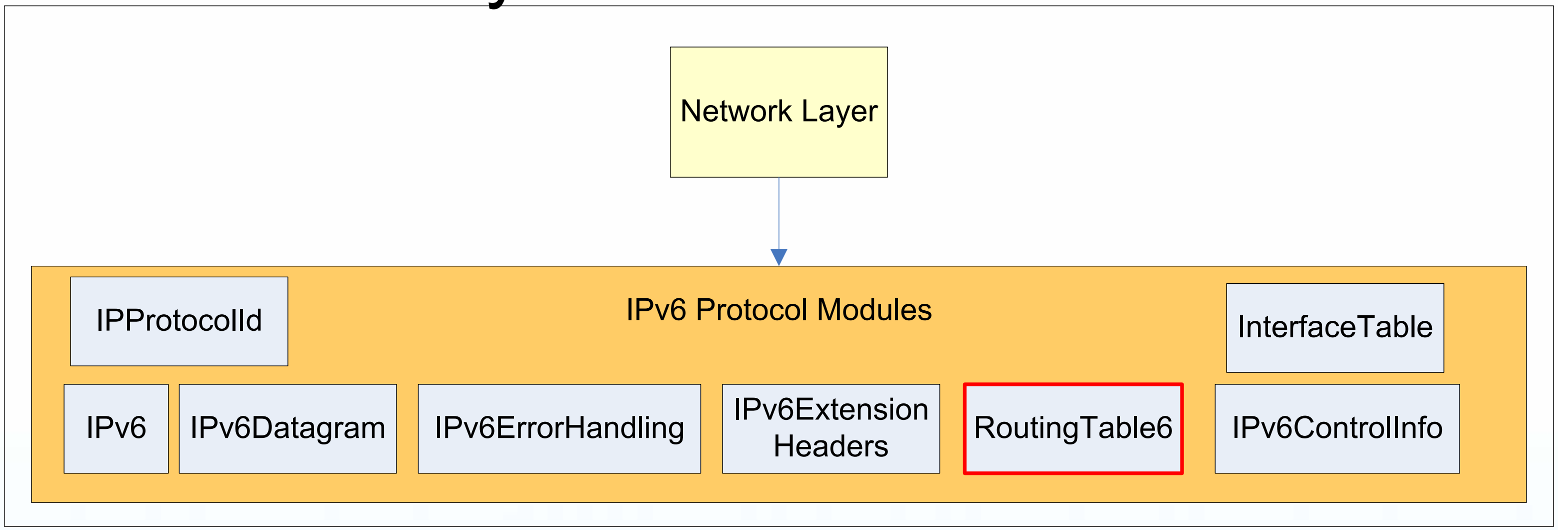
- Currently support single address:
- For XCAST6 Support:
  - List of destinations
  - Bitmap container
  - Traffic class holder

IPv6Datagram:

- Methods to handle:
  - Routing Extension header
  - Traffic Class
  - New IPv6ControlInfo

Implementing XCAST in OMNeT++

- Network Layer Modules:



<u>IPv6FlatNetworkConfigurator:</u>

- All host in same network
- No support for subnets
- Our approach:
  - NETCONF-style XML file for
  - IP addresses & Routing

<u>RoutingTable6:</u>

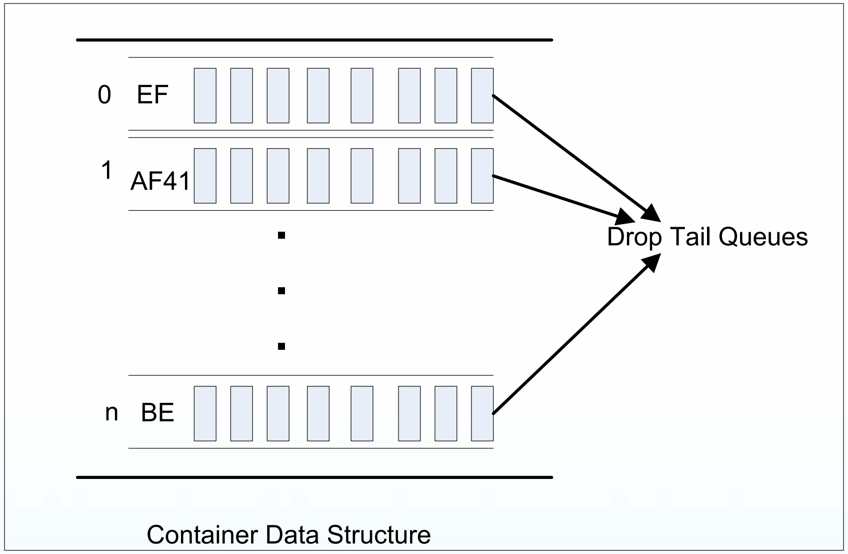
- Added: NETCONF XML processing
- Initialization stage 3 invokes:
  - *parseXMLConfigFileForStaticRoutes()*
    - *addDefaultRoute()*
    - *addStaticRoute()*

Implementing XCAST in OMNeT++

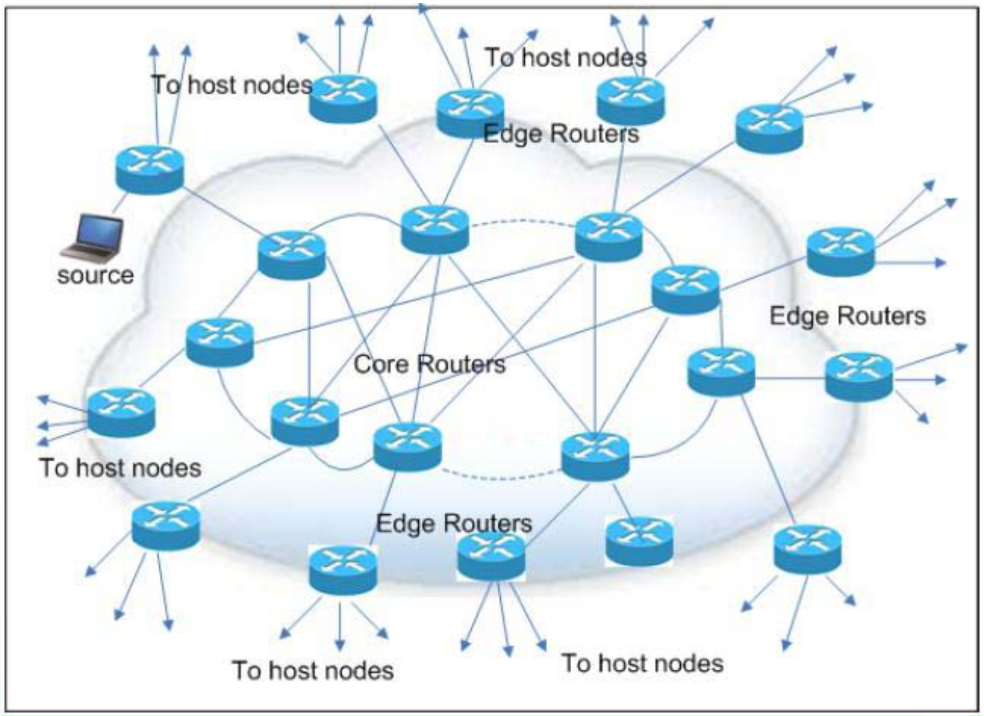
- Transport Layer
  - *UDPControlInfo*
    - Destination: ALL_XCAST_NODES (*"ff0e::114"*)
    - *UDPControlInfo and IPv6ControlInfo* exchange information across protocol layers
- Application Layer
  - XCAST6 Model application
    - Based on UDPBasicAPP
    - Selects a group and sends data to ALL members
- Statistics Collection
  - Dropped packets
  - Propagation delay
  - Number of replications etc

XCAST-DiffServ Integration

- DiffServ QoS tasks:
  - Classification,
  - Marking and
  - Shaping
- XCASTQoSClassifier
  - Inherits from *IQoSClassifier* Base Class
  - Implements 14 PHBs
  - Works with *DropTailQoSQueue*



Simulation



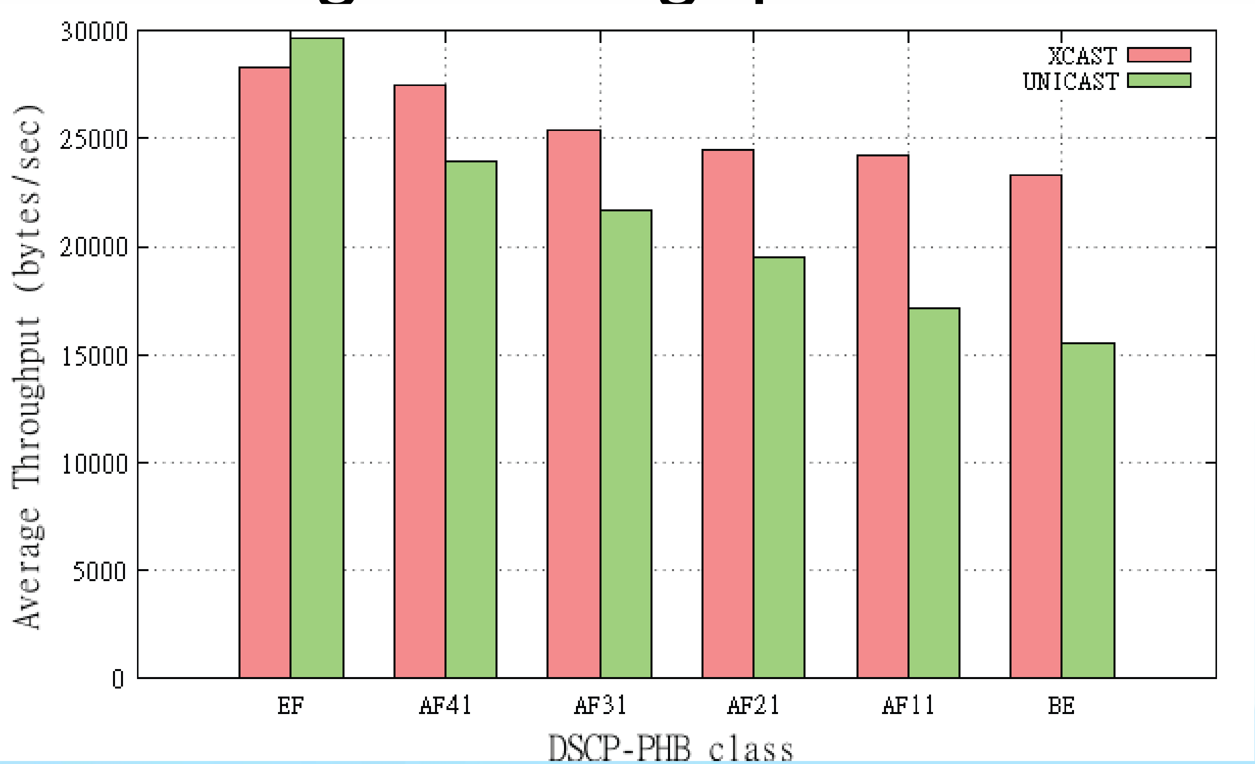
- IPTV network
- Hierarchically
- Core routers– Provider network,
- Edge routers – Connecting clients

- IPTV Plans (For pricing & QoS)
  - Platinum - EF
  - Gold - AF41
  - Sliver - AF31
  - Bronze - AF21
  - Delux - AF11
  - Economy - BE

- Metrics
  - Throughput
  - Average per hop delay

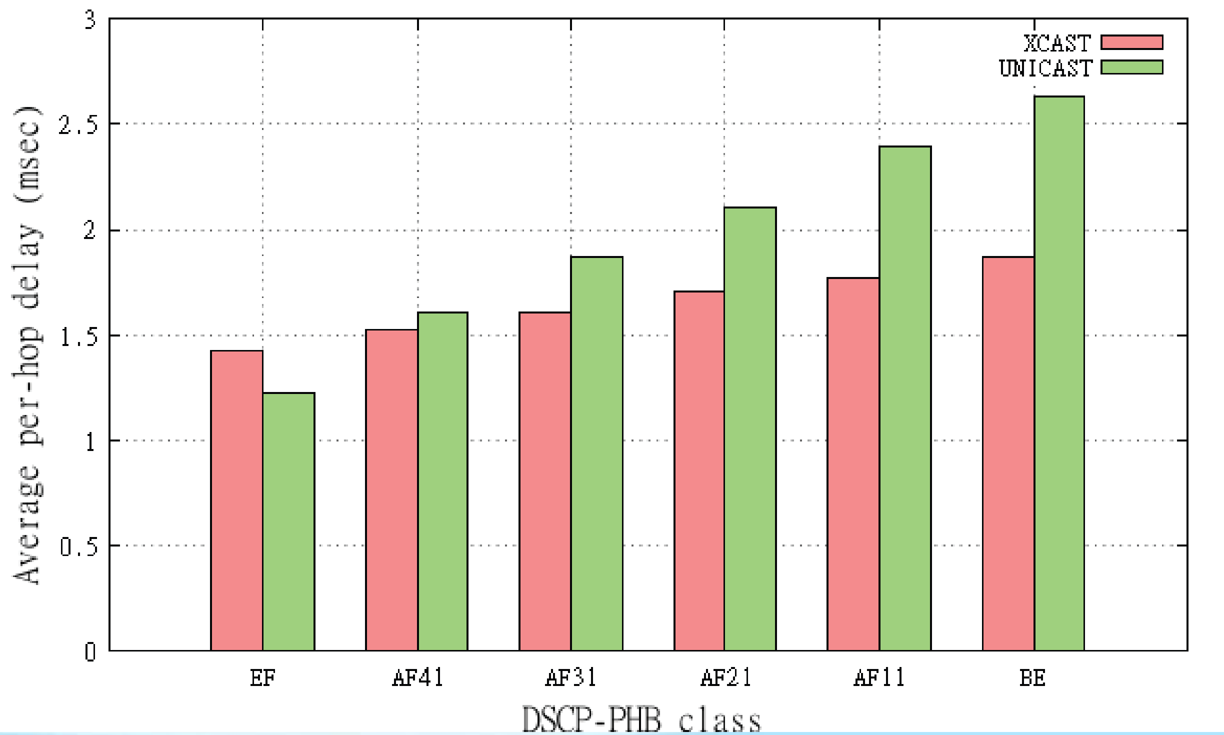
Performance Evaluation

- Average Throughput



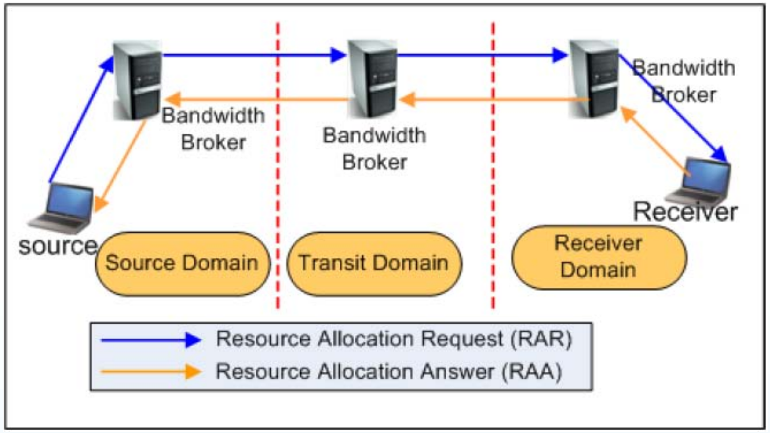
Performance Evaluation

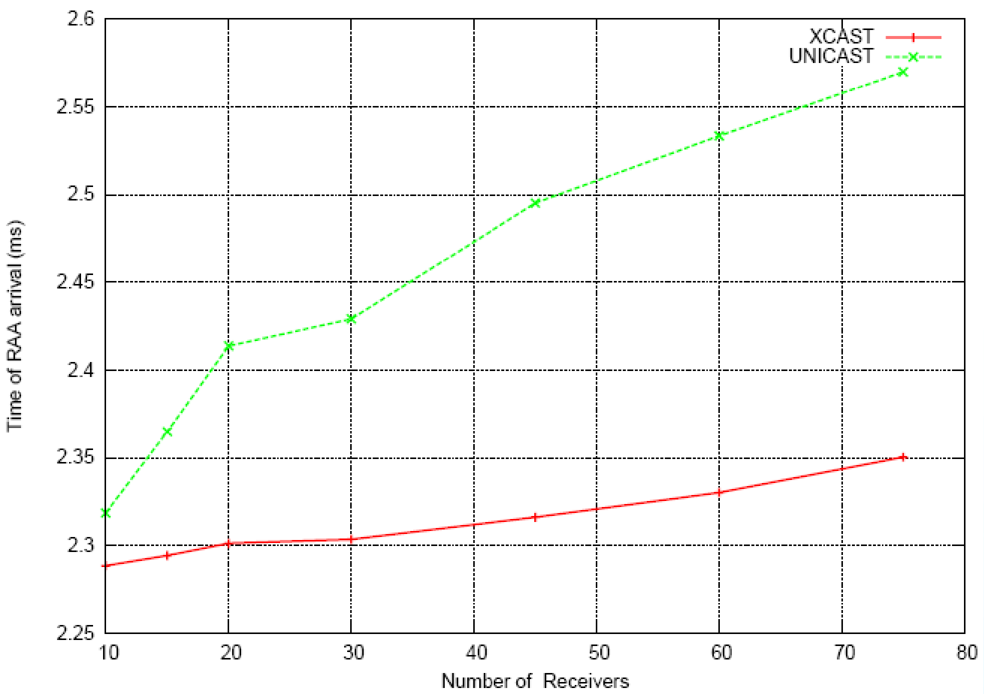
- Average per-hop delay



Performance Evaluation

- Multiple DiffServ Domain





Conclusion and Future Work

- This work:
  - Shows how to implement XCAST6 in OMNeT++
  - Shows XCAST6 QoS provisioning using DiffServ Architecture
  - Focuses on key classes of INET Framework
  - We hope it opens up XCAST QoS research.
  - Source code available in Sourceforge.
- Future Work:
  - To investigate Challenges in XCAST QoS provisioning using DiffServ Architecture.