idaTSNSimulator

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Chapter 1

RTPS Configuration

The following parameters have to be configured

- For a multicast transmission reader entityIds should have the same Id even if they are in different participants!
- ∗ Therefore search an entityId, which is not used in each of the receiving participants

1.1 Overall configuration

- ∗∗.middleware.delayUnit[∗].duration = normal(xms, yms) (Distribution of the initial delay of a generated Sample before it is handled in the RTPS middleware)
- ∗∗.middleware.delayUnit[∗].durationMin = xms (The minimum initial delay of a generated Sample before it is handled in the RTPS middleware)
- ∗∗.middleware.delayUnit[∗].durationMax = xms (The maximum initial delay of a generated Sample before it is handled in the RTPS middleware)
- ∗∗.middleware.shaperEnabled = true (Shaping over all outgoing messages of an RTPS middleware component)
- ∗∗.middleware.shapingDuration = 10us (Shaping duration over all outgoing messages of an RTPS middleware component)
- ∗∗.middleware.writer[∗].history = 10 (The history size of a writer entity)
- ∗∗.middleware.reader[∗].history = 10 (The history size of a reader entity)

1.2 Endpoint specific

- ∗∗.Endpoint.middleware.participantId = x (globally unique participant Id)
- ∗∗.Endpoint.numMwStreams = x (The number of middleware writers)
- ∗∗.Endpoint.numMwSinks = x (The number of middleware readers)

1.3 Stream specific

- ∗∗.Endpoint.sampleGenerator[<>].sampleSize = normal(xB,yB) (The size distribution of a sample)
- ∗∗.Endpoint.sampleGenerator[<>].sampleSizeMin = xB (The minimum size of a sample)
- ∗∗.Endpoint.sampleGenerator[<>].sampleSizeMax = xB (The maximum size of a sample)
- ∗∗.Endpoint.sampleGenerator[<>].period = normal(xs,ys) (The period distribution of a sample i.e. the distance between two consecutive sample generations)
- ∗∗.Endpoint.sampleGenerator[<>].periodMin = xs (The minimum period)
- ∗∗.Endpoint.sampleGenerator[<>].periodMax = xs (The maximum period)
- ∗∗.Endpoint.sampleGenerator[<>].globalStreamId = <> (The unique global stream Id)

1.4 Wrtier specific

- ∗∗.Endpoint.middleware.writer[<>].globalStreamId = <> (The unique global stream ID of the writer corresponding to the connected generator)
- ∗∗.Endpoint.middleware.writer[<>].streamEthernetPriority = <> (The Ethernet priority)
- ∗∗.Endpoint.middleware.writer[<>].sourceMac = <> (The own egress port to send the messages out)
- ∗∗.Endpoint.middleware.writer[<>].entityId = <> (The own entity Id which has to be unique for the participant)
- ∗∗.Endpoint.middleware.writer[<>].destinationMac = <> (The remote (ingress) port MAC adress to send the messages to)
- ∗∗.Endpoint.middleware.writer[<>].destinationEntityId = <> (The remote entity Id – Note that for multicast all readers have to be configured with this adress)
- ∗∗.Endpoint.middleware.writer[<>].fragmentSize = <> (The fragment size)
- ∗∗.Endpoint.middleware.writer[<>].shaper.shapingDuration = <> (The frame shaping duration of the writer for its sample transmission)

1.5 Reader specific

- ∗∗.Endpoint.middleware.reader[<>].entityId = X (The readers entityId which has to be unique for the RTPS participant)
- ∗∗.Endpoint.middleware.reader[<>].sourceMac = X (The own egress prot to send the messages out – backchannel for retranmissions)

1.6 Example

Chapter 2

Hierarchical Index

2.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 3

Class Index

3.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 4

File Index

4.1 File List

Here is a list of all files with brief descriptions:

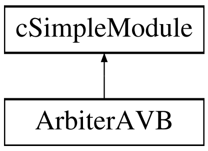
Chapter 5

Class Documentation

5.1 ArbiterAVB Class Reference

```
#include <ArbiterAVB.h>
```

Inheritance diagram for ArbiterAVB:



Public Member Functions

- ArbiterAVB ()
- virtual ∼ArbiterAVB ()
- void initialize ()
- void handleMessage (cMessage ∗message)

Private Member Functions

- void calculateTransmissionSpeed ()
- void initializeAVBClassInformation ()
- void loadAVBClassInformationFromFile ()
- void dealWithInternalMessage (cMessage ∗message)
- void dealWithExternalMessage (cMessage ∗message)
- EthernetFrame ∗ checkAndCastEthernetFrame (cMessage ∗message)
- BufferControlMessage ∗ checkAndCastBufferControlMessage (cMessage ∗message)
- void dealWithEthernetFrame (cMessage ∗message)
- void dealWithControlMessage (cMessage ∗controlMessage)
- void controlArbitrationBufferStatusList (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- void prepareClassInformations (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- void calculateClassInformationCredits ()
- void calculateCredits (int priority)
- int calculateCreditValues (int priority)

- std::vector< ethernetHeaderInformation ∗ > prepareBufferStatusList (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- int arbitrateBufferStatusList (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- void sendBufferAuthorizedBuffer (int authorizedBuffer)
- void sendBufferRequest ()
- simtime_t calculateTransmissionDelay (EthernetFrame ∗ethernetFrame)
- void setRechargeTime ()
- void settriggerDelayEnd (simtime_t transmissionPathDelay)
- void settriggerCreditRecharged (simtime_t calculatedRechargeTime, int priority)
- simtime_t calculatedRechargeTime (int priority)
- void sendFrameOut ()
- void updateClassInformationsStatus (int authorizedBuffer)
- void collectCreditsStatistics (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- void debugStatus ()
- void debugStatusInitialization ()

Private Attributes

- std::vector< ethernetHeaderInformation ∗ > currentBufferStatusList
- int numberPriorities
- cModule ∗ parentModul
- cGate ∗ parentGateOut
- cChannel ∗ parentChannelOut
- double channelTransmissionRate
- int egressPortIndex
- int macAddress
- configVector avbTableVector
- cOutVector creditValueStatisticStreamA
- cOutVector creditValueStatisticStreamB
- csvVector config
- std::string configFile
- bool arbiterIsBusy
- EthernetFrame ∗ ethernetFrameWaitForSend
- cMessage ∗ triggerSelf = new cMessage()
- std::vector< arbiterAVBClass ∗ > classInformations

5.1.1 Detailed Description

ArbiterAVB is an arbiter which arbitrate the stored Frames in BuffersModule. Arbiter will select based on the CBS algorithm the next sending Frame and store it for the length of the transmission delay

5.1.2 Constructor & Destructor Documentation

5.1.2.1 ArbiterAVB()

```
ArbiterAVB::ArbiterAVB ( )
```

Constructor ArbiterAVB, nothing to do here

5.1.2.2 ∼ArbiterAVB()

```
ArbiterAVB::∼ArbiterAVB ( )  [virtual]
```

Destructor ArbiterAVB, nothing to do here

5.1.3 Member Function Documentation

5.1.3.1 arbitrateBufferStatusList()

```
int ArbiterAVB::arbitrateBufferStatusList (
             std::vector< ethernetHeaderInformation * > BufferStatusList )  [private]
```

Arbiter which choose out of the Buffer Status List the current winner for next transmission

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation∗>

5.1.3.2 calculateClassInformationCredits()

```
void ArbiterAVB::calculateClassInformationCredits ( )  [private]
```

choose for which priority the credits have to be updated

5.1.3.3 calculateCredits()

```
void ArbiterAVB::calculateCredits (
             int priority )  [private]
```

calculate the total credit values of that priority

Parameters

priority	

5.1.3.4 calculateCreditValues()

```
int ArbiterAVB::calculateCreditValues (
             int priority )  [private]
```

calculate the current credit value based on the time difference of sending the frame

Parameters

priority	

5.1.3.5 calculatedRechargeTime()

```
simtime_t ArbiterAVB::calculatedRechargeTime (
            int priority )  [private]
```

calculated recharge Time

Parameters

priority	

Returns

simtime_t

5.1.3.6 calculateTransmissionDelay()

```
simtime_t ArbiterAVB::calculateTransmissionDelay (
            EthernetFrame * ethernetFrame )  [private]
```

Calculate based on Ethernet frame length transmission delay

Parameters

ethernetFrame	

Returns

simtime_t

5.1.3.7 calculateTransmissionSpeed()

```
void ArbiterAVB::calculateTransmissionSpeed ( )  [private]
```

Calculate Transmission seed of channel SafeGuard prevent for choose nullpointer as channel

5.1.3.8 checkAndCastBufferControlMessage()

```
BufferControlMessage * ArbiterAVB::checkAndCastBufferControlMessage (
            cMessage * message )  [private]
```

check if message is an BufferControlMessage and return it

Parameters

message	

Returns

BufferControlMessage∗

5.1.3.9 checkAndCastEthernetFrame()

```
EthernetFrame * ArbiterAVB::checkAndCastEthernetFrame (
            cMessage * message )  [private]
```

check if message is an Ethernet Frame and return it

Parameters

message	this is a comment about the input variable

Returns

pointer to EthernetFrame

5.1.3.10 collectCreditsStatistics()

```
void ArbiterAVB::collectCreditsStatistics (
            std::vector< ethernetHeaderInformation * > BufferStatusList )  [private]
```

This function record Credit Values to cOutVector structures If more than two Priorities exist AVB will work and than statistics are collected. Just Stream A and Stream B are collected, BE is ignored

Parameters

BufferStatusList	with informations about AVB Arbiter

5.1.3.11 controlArbitrationBufferStatusList()

```
void ArbiterAVB::controlArbitrationBufferStatusList (
             std::vector< ethernetHeaderInformation * > BufferStatusList )  [private]
```

control the arbitration steps. First prepare the bufferList and calculate the credits(recharging if nessecary). Based on new credit value arbitrate and collect statistics. Last but not least the arbitration result is send to BuffersMoudles.

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation*>

5.1.3.12 dealWithControlMessage()

```
void ArbiterAVB::dealWithControlMessage (
             cMessage * controlMessage )  [private]
```

Select which type of Control Message is received

Parameters

controlMessage	

5.1.3.13 dealWithEthernetFrame()

```
void ArbiterAVB::dealWithEthernetFrame (
             cMessage * message )  [private]
```

deal with incoming Ethernet Frames

Parameters

message	

5.1.3.14 dealWithExternalMessage()

```
void ArbiterAVB::dealWithExternalMessage (
             cMessage * message )  [private]
```

deal with incoming external Messages like Control Messages or Ethernet Frames

Parameters

message	incomming external message

5.1.3.15 dealWithInternalMessage()

```
void ArbiterAVB::dealWithInternalMessage (
            cMessage * message )  [private]
```

Deals with internal messages and process timer timeouts. Timer trigger start of transmission to next router

Parameters

message	incoming message

5.1.3.16 debugStatus()

```
void ArbiterAVB::debugStatus ( )  [private]
```

shows the credit values and current status of priorities

5.1.3.17 debugStatusInitialization()

```
void ArbiterAVB::debugStatusInitialization ( )  [private]
```

shows the status of Arbiter initializations class

5.1.3.18 handleMessage()

```
void ArbiterAVB::handleMessage (
            cMessage * message )
```

Classification of incoming messages into internal and external sources

5.1.3.19 initialize()

```
void ArbiterAVB::initialize ( )
```

Initialize Arbiter and load informations form Parent Start calculation of transmission speed

5.1.3.20 initializeAVBClassInformation()

```
void ArbiterAVB::initializeAVBClassInformation ( )  [private]
```

Calculate Transmission seed of channel SafeGuard prevent for choose nullpointer as channel

5.1.3.21 loadAVBClassInformationFromFile()

```
void ArbiterAVB::loadAVBClassInformationFromFile ( )  [private]
```

load Class information from AVB configuration file

5.1.3.22 prepareBufferStatusList()

```
std::vector< ethernetHeaderInformation * > ArbiterAVB::prepareBufferStatusList (
             std::vector< ethernetHeaderInformation * > BufferStatusList )  [private]
```

Arbiter which choose out of the Buffer Status List the current winner for next transmission

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation∗>

5.1.3.23 prepareClassInformations()

```
void ArbiterAVB::prepareClassInformations (
             std::vector< ethernetHeaderInformation * > BufferStatusList )  [private]
```

checks if new Frames arrived in BufferModule

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation∗>

5.1.3.24 sendBufferAuthorizedBuffer()

```
void ArbiterAVB::sendBufferAuthorizedBuffer (
             int authorizedBuffer )  [private]
```

Send Buffer the result of arbitration, send the authorized Buffer to transmit next frame

Parameters

authorizedBuffer	

5.1.3.25 sendBufferRequest()

```
void ArbiterAVB::sendBufferRequest ( )  [private]
```

Send a Request for Buffer to answer the current Buffer Status

5.1.3.26 sendFrameOut()

```
void ArbiterAVB::sendFrameOut ( )  [private]
```

send Frame out after Transmission time Delay is past

5.1.3.27 setRechargeTime()

```
void ArbiterAVB::setRechargeTime ( )  [private]
```

start recharge calculation of each priority with negative credit value

5.1.3.28 settriggerCreditRecharged()

```
void ArbiterAVB::settriggerCreditRecharged (
             simtime_t calculatedRechargeTime,
             int priority )  [private]
```

set the trigger for credit recharge of one priotity

Parameters

calculatedRechargeTime,priority	

5.1.3.29 settriggerDelayEnd()

```
void ArbiterAVB::settriggerDelayEnd (
             simtime_t transmissionPathDelay )  [private]
```

set the trigger for sending frame out

Parameters

transmissionPathDelay	

5.1.3.30 updateClassInformationsStatus()

```
void ArbiterAVB::updateClassInformationsStatus (
             int authorizedBuffer )  [private]
```

update class information status of each priority

Parameters

authorizedBuffer	

5.1.4 Member Data Documentation

5.1.4.1 arbiterIsBusy

```
bool ArbiterAVB::arbiterIsBusy  [private]
```

5.1.4.2 avbTableVector

```
configVector ArbiterAVB::avbTableVector  [private]
```

5.1.4.3 channelTransmissionRate

```
double ArbiterAVB::channelTransmissionRate  [private]
```

5.1.4.4 classInformations

```
std::vector<arbiterAVBClass*> ArbiterAVB::classInformations  [private]
```

5.1.4.5 config

```
csvVector ArbiterAVB::config  [private]
```

5.1.4.6 configFile

```
std::string ArbiterAVB::configFile  [private]
```

5.1.4.7 creditValueStatisticStreamA

```
cOutVector ArbiterAVB::creditValueStatisticStreamA  [private]
```

5.1.4.8 creditValueStatisticStreamB

```
cOutVector ArbiterAVB::creditValueStatisticStreamB  [private]
```

5.1.4.9 currentBufferStatusList

```
std::vector<ethernetHeaderInformation*> ArbiterAVB::currentBufferStatusList  [private]
```

5.1.4.10 egressPortIndex

```
int ArbiterAVB::egressPortIndex  [private]
```

5.1.4.11 ethernetFrameWaitForSend

```
EthernetFrame* ArbiterAVB::ethernetFrameWaitForSend  [private]
```

5.1.4.12 macAddress

```
int ArbiterAVB::macAddress  [private]
```

5.1.4.13 numberPriorities

```
int ArbiterAVB::numberPriorities  [private]
```

5.1.4.14 parentChannelOut

```
cChannel* ArbiterAVB::parentChannelOut  [private]
```

5.1.4.15 parentGateOut

```
cGate* ArbiterAVB::parentGateOut  [private]
```

5.1.4.16 parentModul

```
cModule* ArbiterAVB::parentModul  [private]
```

5.1.4.17 triggerSelf

```
cMessage* ArbiterAVB::triggerSelf = new cMessage()  [private]
```

5.2 arbiterAVBClass Struct Reference

```
#include <ArbiterAVB.h>
```

Public Attributes

- int classCreditValue
- bool classFrameWaiting
- bool classIsShaped
- int classStatus
- double sendSlope
- double idleSlope
- simtime_t lastArbitrationTimeStamp
- bool timerIsScheduled

5.2.1 Detailed Description

General Struct for Information about Arbiter Classes

5.2.2 Member Data Documentation

5.2.2.1 classCreditValue

```
int arbiterAVBClass::classCreditValue
```

5.2.2.2 classFrameWaiting

```
bool arbiterAVBClass::classFrameWaiting
```

5.2.2.3 classIsShaped

```
bool arbiterAVBClass::classIsShaped
```

5.2.2.4 classStatus

```
int arbiterAVBClass::classStatus
```

5.2.2.5 idleSlope

```
double arbiterAVBClass::idleSlope
```

5.2.2.6 lastArbitrationTimeStamp

```
simtime_t arbiterAVBClass::lastArbitrationTimeStamp
```

5.2.2.7 sendSlope

```
double arbiterAVBClass::sendSlope
```

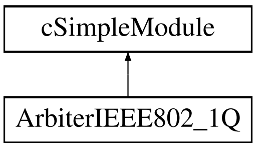
5.2.2.8 timerIsScheduled

```
bool arbiterAVBClass::timerIsScheduled
```

5.3 ArbiterIEEE802_1Q Class Reference

```
#include <ArbiterIEEE802_1Q.h>
```

Inheritance diagram for ArbiterIEEE802_1Q:



Public Member Functions

- ArbiterIEEE802_1Q ()
- virtual ∼ArbiterIEEE802_1Q ()
- void initialize ()
- void handleMessage (cMessage ∗message)

Private Member Functions

- void dealWithInternalMessage (cMessage ∗message)
- void dealWithExternalMessage (cMessage ∗message)
- void dealWithEthernetFrame (cMessage ∗frame)
- void dealWithControlMessage (cMessage ∗controlMessage)
- void controlArbitrationBufferStatusList (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- std::vector< ethernetHeaderInformation ∗ > prepareBufferStatusList (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- int arbitrateBufferStatusList (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- void sendBufferAuthorizedBuffer (int authorizedBuffer)
- void sendBufferRequest ()
- simtime_t calculateTransmissionDelay (EthernetFrame ∗ethernetFrame)
- void calculateTransmissionSpeed ()
- void settriggerDelayEnd (simtime_t transmissionPathDelay)
- void sendFrameOut ()

Private Attributes

- std::vector< ethernetHeaderInformation ∗ > currentBufferStatusList
- int numberPriorities
- cModule ∗ parentModul
- cGate ∗ parentGateOut
- cChannel ∗ parentChannelOut
- double channelTransmissionRate
- bool arbiterIsBusy
- EthernetFrame ∗ ethernetFrameWaitForSend
- cMessage ∗ triggerSelf = new cMessage()

5.3.1 Detailed Description

ArbiterIEEE802_1Q is an arbiter which arbitrate the stored frames in BuffersModule Based on the static priority non preemption algorithm frames are selected Each frame will be stored for the transmission delay inside the arbiter and after the time it is send out

5.3.2 Constructor & Destructor Documentation

5.3.2.1 ArbiterIEEE802_1Q()

```
ArbiterIEEE802_1Q::ArbiterIEEE802_1Q ( )
```

Constructor ArbiterIEEE802.1Q, nothing to do here

5.3.2.2 ∼ArbiterIEEE802_1Q()

```
ArbiterIEEE802_1Q::∼ArbiterIEEE802_1Q ( ) [virtual]
```

Destructor ArbiterIEEE802.1Q, nothing to do here

5.3.3 Member Function Documentation

5.3.3.1 arbitrateBufferStatusList()

```
int ArbiterIEEE802_1Q::arbitrateBufferStatusList (
            std::vector< ethernetHeaderInformation * > BufferStatusList ) [private]
```

Arbiter which choose the next winning Frame for next transmission out of the Buffer Status List

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation∗>

5.3.3.2 calculateTransmissionDelay()

```
simtime_t ArbiterIEEE802_1Q::calculateTransmissionDelay (
            EthernetFrame * ethernetFrame ) [private]
```

Calculate based on Ethernet frame length transmission delay

Parameters

ethernetFrame	

Returns

simtime_t

5.3.3.3 calculateTransmissionSpeed()

```
void ArbiterIEEE802_1Q::calculateTransmissionSpeed ( )  [private]
```

Calculate Transmission seed of channel SafeGuard prevent for choose nullpointer as channel

5.3.3.4 controlArbitrationBufferStatusList()

```
void ArbiterIEEE802_1Q::controlArbitrationBufferStatusList (
             std::vector< ethernetHeaderInformation * > BufferStatusList )  [private]
```

control the arbitration result and initialized recharging if nessecary

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation*>

5.3.3.5 dealWithControlMessage()

```
void ArbiterIEEE802_1Q::dealWithControlMessage (
             cMessage * controlMessage )  [private]
```

Process incoming Control Messages Check what kind of Control Message is received. Buffer Level Update or Buffer Level Response. The Buffer Level Updates are processed if Arbiter is not busy

Parameters

controlMessage	

5.3.3.6 dealWithEthernetFrame()

```
void ArbiterIEEE802_1Q::dealWithEthernetFrame (
             cMessage * frame )  [private]
```

Process incoming Etherent frames and store them. Only one Frame is allowed. Start transmission delay process chain

Parameters

frame	

5.3.3.7 dealWithExternalMessage()

```
void ArbiterIEEE802_1Q::dealWithExternalMessage (
            cMessage * message ) [private]
```

Deals with external incoming messages and check if messages was external Ethernet Frame or Control Buffer Message

Parameters

message	incoming external message

5.3.3.8 dealWithInternalMessage()

```
void ArbiterIEEE802_1Q::dealWithInternalMessage (
            cMessage * message ) [private]
```

Deals with internal messages and process timer timeouts. Timer trigger start of transmission to next router

Parameters

message	incoming message

5.3.3.9 handleMessage()

```
void ArbiterIEEE802_1Q::handleMessage (
            cMessage * message )
```

Classification of incoming messages into internal and external sources

5.3.3.10 initialize()

```
void ArbiterIEEE802_1Q::initialize ( )
```

Initialize Arbiter and load informations form Parent Start calculation of transmission speed

5.3.3.11 prepareBufferStatusList()

```
std::vector< ethernetHeaderInformation * > ArbiterIEEE802_1Q::prepareBufferStatusList (
             std::vector< ethernetHeaderInformation * > BufferStatusList )  [private]
```

prepare the ready value of BufferStatusList caused by frame length if length = 0 frame is not ready

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation∗>

5.3.3.12 sendBufferAuthorizedBuffer()

```
void ArbiterIEEE802_1Q::sendBufferAuthorizedBuffer (
             int authorizedBuffer )  [private]
```

Send Buffer the result of arbitration, send the authorized Buffer to transmit next frame

Parameters

authorizedBuffer	

5.3.3.13 sendBufferRequest()

```
void ArbiterIEEE802_1Q::sendBufferRequest ( )  [private]
```

Send a request to Buffer to check the current Buffer status fill level

5.3.3.14 sendFrameOut()

```
void ArbiterIEEE802_1Q::sendFrameOut ( )  [private]
```

send Frame out after Transmission time Delay is past

5.3.3.15 settriggerDelayEnd()

```
void ArbiterIEEE802_1Q::settriggerDelayEnd (
             simtime_t transmissionPathDelay )  [private]
```

set the trigger for sending frame out

Parameters

transmissionPathDelay	

5.3.4 Member Data Documentation

5.3.4.1 arbiterIsBusy

```
bool ArbiterIEEE802_1Q::arbiterIsBusy  [private]
```

5.3.4.2 channelTransmissionRate

```
double ArbiterIEEE802_1Q::channelTransmissionRate  [private]
```

5.3.4.3 currentBufferStatusList

```
std::vector<ethernetHeaderInformation*> ArbiterIEEE802_1Q::currentBufferStatusList  [private]
```

5.3.4.4 ethernetFrameWaitForSend

```
EthernetFrame* ArbiterIEEE802_1Q::ethernetFrameWaitForSend  [private]
```

5.3.4.5 numberPriorities

```
int ArbiterIEEE802_1Q::numberPriorities  [private]
```

5.3.4.6 parentChannelOut

```
cChannel* ArbiterIEEE802_1Q::parentChannelOut  [private]
```

5.3.4.7 parentGateOut

```
cGate* ArbiterIEEE802_1Q::parentGateOut  [private]
```

5.3.4.8 parentModul

```
cModule* ArbiterIEEE802_1Q::parentModul  [private]
```

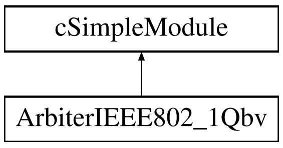
5.3.4.9 triggerSelf

```
cMessage* ArbiterIEEE802_1Q::triggerSelf = new cMessage()  [private]
```

5.4 ArbiterIEEE802_1Qbv Class Reference

```
#include <ArbiterIEEE802_1Qbv.h>
```

Inheritance diagram for ArbiterIEEE802_1Qbv:



Public Member Functions

- ArbiterIEEE802_1Qbv ()
- virtual ∼ArbiterIEEE802_1Qbv ()
- virtual void initialize (void) override
- virtual void handleMessage (cMessage ∗message) override

Private Member Functions

- simtime_t getPeriodDuration ()
- simtime_t getCriticalIntervalDuration ()
- simtime_t convertDoubleIntoTime (double valueToBeConverted)
- simtime_t calculateGuardBandDurationFromPayloadSize (int payload)
- long getPortSpeed ()
- int setEthPacketSizeFromPayload (int payload)
- std::vector< int > getCriticalClasses ()
- std::vector< bool > setUpVectorCriticalPriorities (std::vector< int > criticalPriorities)
- simtime_t getTimeOffset ()
- simtime_t calculateTimeModulo (simtime_t numeratorTime, simtime_t denominatorTime)
- int getInitialStateAndCalculateTriggerTimer (simtime_t offset)
- int getNextState (int currentState)
- void initializeTimerMessage ()
- void printInitializationConfiguration ()
- void dealWithInternalMessage (cMessage ∗message)
- void dealWithSegmentTimerMessage ()
- simtime_t getSegmentDurationFromCurrentState (int state)
- void dealWithTriggerSelf ()
- void sendFrameOut ()
- void sendBufferRequest ()
- void dealWithExternalMessage (cMessage ∗message)
- void dealWithControlMessage (cMessage ∗controlMessage)
- void controlArbitrationBufferStatusList (std::vector< ethernetHeaderInformation ∗ > bufferStatusList)
- std::vector< ethernetHeaderInformation ∗ > prepareBufferStatusList (std::vector< ethernetHeaderInformation ∗ > bufferStatusList)
- int arbitrateBufferStatusList (std::vector< ethernetHeaderInformation ∗ > bufferStatusList)
- void sendBufferAuthorizedBuffer (int authorizedBuffer)
- void dealWithEthernetFrame (cMessage ∗frame)
- simtime_t calculateTransmissionDelay (EthernetFrame ∗ethernetFrame)
- void setTriggerDelayEnd (simtime_t transmissionPathDelay)

Private Attributes

- int currentState

  the state is equal the current time segment
- int nextState

  the next state is equal to the next time segment after the current
- int maximumCriticalPayloadSize

  set by user -> defines the maximum payload number in bytes for critical priorities frames
- int maximumNoncriticalPayloadSize

  set by user -> defines the maximum payload number in bytes for noncritical priorities frames
- int numberSupportedPriorities

  number of supported priorities (= default 8 priorities)
- int switchMAC

  MAC address of the switch.
- int portIndex

  index of the EgressPort via which the frame is forwarded
- simtime_t periodDuration

  set by user -> defines the duration of the period (= default 5 ms)
- simtime_t criticalIntervalDuration

set by user -> defines the duration of the critical interval

- simtime_t criticalSendingSegmentDuration

  critical interval is split into sending and guard band segment
- simtime_t criticalGuardBandSegmentDuration

  guard band segment is as long as a critical frame needs for transmission
- simtime_t noncriticalIntervalDuration

  non critical interval duration is the time remaining from the subtraction of period and criticalInterval
- simtime_t noncriticalSendingSegmentDuration

  non critical interval duration is split into sending and guard band segment
- simtime_t noncriticalGuardBandSegmentDuration

  non critical guard band segment is as long as a non critical frame needs for transmission
- std::vector< int > criticalPriorityClasses

  integer vector which stores the critical priorities (= default ("7 6"))
- simtime_t timeOffset

  timer, which allows to start the simulation in any time segment (= default 0 -> critical timing segment)
- simtime_t triggerTimer

  timer to trigger a a self message
- cMessage ∗ segmentTriggerTimerMessage

  cMessage timer for changing states (time segments)
- cMessage ∗ triggerSelf = new cMessage()

  cMessage timer for trigger Ethernet frame transmission
- EthernetFrame ∗ ethernetFrameWaitForTransmission

  arbiter stores only one Ethernet frame which must wait for its transmission to simulate transmission rate
- std::vector< ethernetHeaderInformation ∗ > currentBufferStatusList
- std::vector< bool > isCritical

  boolean vector indicating which of the priorities is critical (= true) or not (= false)
- bool arbiterIsBusy

  variable that indicates that the arbitration is already in progress
- bool frameStoredInBuffer

5.4.1 Detailed Description

ArbiterIEEE802_1Qbv is an Arbiter() which arbitrate the stored Ethernet frames in BuffersModule. It is also known as Time Aware Shaper (TAS).

TAS is a circuit-switched arbitration. The period is divided into two intervals

1. critical interval
2. noncritical interval Each interval is also divided into the following segments: ∗.1 sending segment ∗.2 guard band segment Only Ethernet frames with critical priorities are sent in the critical interval of the sending segment. In IEEE802_1Qbv, traffic classes with priorities 6 and 7 are classified as critical (set as default). For simulation purpose it is also possible to set other classes as critical as well. The guard band segment is only as long for an Ethernet frame to complete its transmission. No Ethernet frames start their transmission in this segment. In noncritical sending segment only non critical priority classes are sent (default priority 5-0).

5.4.2 Constructor & Destructor Documentation

5.4.2.1 ArbiterIEEE802_1Qbv()

```
ArbiterIEEE802_1Qbv::ArbiterIEEE802_1Qbv ( )
```

Class constructor - nothing to do here

5.4.2.2 ∼ArbiterIEEE802_1Qbv()

```
ArbiterIEEE802_1Qbv::∼ArbiterIEEE802_1Qbv ( )  [virtual]
```

Class destructor

Cancel and delete the self messages triggerSelf and segmentTriggerTimerMessage.

5.4.3 Member Function Documentation

5.4.3.1 arbitrateBufferStatusList()

```
int ArbiterIEEE802_1Qbv::arbitrateBufferStatusList (
            std::vector< ethernetHeaderInformation * > bufferStatusList )  [private]
```

Arbitrate the ethernetHeaderInformation vector.

After the preparation of the ethernetHeaderInformation vector an Ethernet frame is selected for transmission. It is first checked at which state (time segment) the simulation is. Critical sending segment -> only Ethernet frames with critical priorities are transmit. Critical guard band segment -> no Ethernet frame are transmit. Noncritical sending segment -> only noncritical Ethernet frames (best effort) are transmit. If several messages of different noncritical or critical priorities are in the FrameBuffers, the selection is made according to static priority non preemptive.

Parameters

bufferStautsList	a vector containing pointer ethernetHeaderInformation with set boolean variable ready

Returns

integer value of the priority which specifies the FrameBuffer from which the first Ethernet frame is forwarded

5.4.3.2 calculateGuardBandDurationFromPayloadSize()

```
simtime_t ArbiterIEEE802_1Qbv::calculateGuardBandDurationFromPayloadSize (
            int payload )  [private]
```

Calculate the duration of the guard band depending on the payload size of an Ethernet frame.

The period is divided into critical and noncritical interval. Each interval itself is also divided into sending and guard band segments. The duration of the guard band segment depends on the maximum payload size of the Ethernet frame. The guard band is so long that one Ethernet frame can complete its transmission. But: no frame starts transmission in the guard band!

Parameters

payload	integer of the Ethernet frame payload size

Returns

the duration of the guard band

5.4.3.3 calculateTimeModulo()

```
simtime_t ArbiterIEEE802_1Qbv::calculateTimeModulo (
            simtime_t numeratorTime,
            simtime_t denominatorTime ) [private]
```

Calculates the time remaining after dividing two times.

This is required for setting the initial time segment with which the arbitration. It is not possible to divide simtime_t values and get the remainder. Therefore the denominator is subtracted from numerator until denominator is larger than numerator. The rest is returned.

Parameters

numeratorTime	simtime_t which is to divided
denominatorTime	simtime_t to be divided with

Returns

the rest of the division

5.4.3.4 calculateTransmissionDelay()

```
simtime_t ArbiterIEEE802_1Qbv::calculateTransmissionDelay (
            EthernetFrame * ethernetFrame ) [private]
```

Calculate the transmission time of the Ethernet frame.

To set up a timer message that simulates the transmission time of the Ethernet frame it must first be calculated. This requires the Ethernet frame payload length and the port speed. (Port speed is obtained from getPortSpeed()).

Parameters

ethernetFrame	pointer of an EthernetFrame message

Returns

the transmission time of the Ethernet frame

5.4.3.5 controlArbitrationBufferStatusList()

```
void ArbiterIEEE802_1Qbv::controlArbitrationBufferStatusList (
            std::vector< ethernetHeaderInformation * > bufferStatusList )  [private]
```

Control the arbitration of the received ethernetHeaderInformation vector from the BufferControlMessage.

With the received ethernetHeaderInformation vector the arbitration phase starts. The ethernetHeaderInformation vector contains for each FrameBuffer in BuffersModule the payload of the first Ethernet frame in the FrameBuffer as well as the priority of the the corresponding buffer. The arbitration phase is divided in two parts: prepareBuffer←StatusList(...) and arbitrateBufferStatusList

Parameters

bufferStatusList	a vector containing pointer ethernetHeaderInformation

5.4.3.6 convertDoubleIntoTime()

```
simtime_t ArbiterIEEE802_1Qbv::convertDoubleIntoTime (
            double valueToBeConverted )  [private]
```

Convert a double value into simtime_t

Time values are entered as double values. Double has to be converted into time values to work with simttime_t.

Parameters

valueToBeConverted	a double value which has to be converted

Returns

converted simtime_t value

5.4.3.7 dealWithControlMessage()

```
void ArbiterIEEE802_1Qbv::dealWithControlMessage (
            cMessage * controlMessage )  [private]
```

Deal with the external message BufferControlMessage.

Arriving external message is a BufferControlMessage. BufferControlMessages are messages to control the BuffersModule(). There are two different flags that the Arbiter() must handle. BUFFER_CONTROL_UPDATE is a update message. It always arrives if a Ethernet frame with new priority is stored into a FrameBuffer(). BUFFE↩ R_LEVEL_RESPONSE is the answer of the BUFFER_LEVEL_REQUEST. First the Arbiter sends a request to the BuffersModule() to get the fill level of the FrameBuffers(). Than the BuffersModule answers with the BUFFER_LE↩ VEL_RESPONSE containing a ethernetHeaderInformation vector.

Parameters

controlMessage	cMessage pointer to a BufferControlMessage

5.4.3.8 dealWithEthernetFrame()

```
void ArbiterIEEE802_1Qbv::dealWithEthernetFrame (
             cMessage * frame )  [private]
```

Deal with external message Ethernet frame.

Arriving external message is an Ethernet frame. The frame is temporarily stored in variable ethernetFrameWaitFor↩ Transmission until the transmission time is over. For simulation the transmission time a timer message TriggerSelf is scheduled.

Parameters

frame	cMessage pointer of an Ethernet Frame

5.4.3.9 dealWithExternalMessage()

```
void ArbiterIEEE802_1Qbv::dealWithExternalMessage (
             cMessage * message )  [private]
```

Deal with external message (Ethernet frame and BufferControlMessage)

The arbiter has to deal with internal (self) messages and external (BufferControlMessage and Ethernet frame) messages. BufferControlMessages are messages to control the BuffersModule(). The arriving Ethernet frame is the message that was selected by the arbitration and is now forwarded.

Parameters

message	cMessage pointer to arriving external message

5.4.3.10 dealWithInternalMessage()

```
void ArbiterIEEE802_1Qbv::dealWithInternalMessage (
            cMessage * message )  [private]
```

Deal with internal messages (self messages).

The arbiter has to deal with internal (self) messages and external (bufferControl and Ethernet frame) messages. The internal messages simulates timer functions. Two internal messages must be distinguished. The segmentTrigger↩ TimerMessage triggers always a self message after changing the state. The triggerSelf self message simulates the transmission of an Ethernet frame. It is triggered when the transmission time has expired and the Ethernet frame is transmit.

Parameters

message	pointer to a self message, segmentTriggerTimerMessage or triggerSelf

5.4.3.11 dealWithSegmentTimerMessage()

```
void ArbiterIEEE802_1Qbv::dealWithSegmentTimerMessage ( )  [private]
```

Deal with internal message segmentTriggerTimerMessage.

A segmentTriggerTimerMessage is arrived. It indicates the finishing of a time segment. The current state is updated as well as the next state. The segmentTriggerTimerMessage is updated and scheduled.

5.4.3.12 dealWithTriggerSelf()

```
void ArbiterIEEE802_1Qbv::dealWithTriggerSelf ( )  [private]
```

Deal with internal message triggerSelf.

A triggerSelf message is arrived. It simulates the transmission time of the Ethernet frame. Its arriving indicates that the transmission time of the stored Ethernet Frame is finished.

5.4.3.13 getCriticalClasses()

```
std::vector< int > ArbiterIEEE802_1Qbv::getCriticalClasses ( )  [private]
```

Get the critical priority classes.

To transmit Ethernet frames in critical sending segment critical class priorities has to be set. Per default 7 and 6 are critical priorities. They are set as string in .ini file. They are converted as integer and stored into a integer vector.

Returns

an integer vector containing the critical priorities

5.4.3.14 getCriticalIntervalDuration()

```
simtime_t ArbiterIEEE802_1Qbv::getCriticalIntervalDuration ( )  [private]
```

Get the duration of the critical interval

The period is divided into critical and noncritical interval. The duration of the critical interval has to be set by the user. Per default it is set to 3 ms.

Returns

the duration of the critical interval

5.4.3.15 getInitialStateAndCalculateTriggerTimer()

```
int ArbiterIEEE802_1Qbv::getInitialStateAndCalculateTriggerTimer (
             simtime_t offset )  [private]
```

Get the state (time segment) with which the arbitration starts.

Depending on the time offset the initial state is set. If no time offset state is set (=0) the initial state is always the critical sending segment.

Returns

integer value of the initial state.

5.4.3.16 getNextState()

```
int ArbiterIEEE802_1Qbv::getNextState (
             int currentState )  [private]
```

Get the next state of the current state.

There are four states. The state transitions are fixed. From Critical sending to critical guard band to noncritical sending to noncritical guard band back to critical sending. For a correct arbitration, the next state must be set from the current state.

Parameters

currentState	integer value of the current state (time segment)

Returns

integer value of the next state (time segment)

5.4.3.17 getPeriodDuration()

```
simtime_t ArbiterIEEE802_1Qbv::getPeriodDuration ( )  [private]
```

Get the duration of the period

The period duration is set by the user in .ini file and defines the the time length of a single arbitration run. Per default it is set to 5 ms.

Returns

the duration of the period

5.4.3.18 getPortSpeed()

```
long ArbiterIEEE802_1Qbv::getPortSpeed ( )  [private]
```

Calculate the Port speed and get the value.

For calculating the duration of the guard band the port speed is required. The guard band is as long as the transmission of an Ethernet frame. The Transmission is calculated by packetSize (in bit) divided by port speed.

Returns

the port speed

5.4.3.19 getSegmentDurationFromCurrentState()

```
simtime_t ArbiterIEEE802_1Qbv::getSegmentDurationFromCurrentState (
             int state )  [private]
```

Get the duration time of the segment from the current state

To schedule the segmentTriggerTimerMessage the duration of the current state is required.

Parameters

state	integer value of the state from which the duration time is required

Returns

the time of the state (time segment)

5.4.3.20 getTimeOffset()

```
simtime_t ArbiterIEEE802_1Qbv::getTimeOffset ( )  [private]
```

Gets the time offset.

If the time offset is not set, the arbitration always starts in the critical sending segment. To start in another segment the offset is used. This can be set larger than the period but does not change the timing of the arbitration. Arbitration always starts at time 0.

Returns

the time offset

5.4.3.21 handleMessage()

```
void ArbiterIEEE802_1Qbv::handleMessage (
            cMessage * message )  [override], [virtual]
```

Handle arriving messages - internal and external messages

There are two types of messages to handle. Internal messages are self messages that simulates time triggers. TAS two time trigger are required. The first one is the segmentTriggerTimerMessage. It is always triggered when the duration of a time segment is up. The second one is triggerSelf. It simulates the transmission delay from an Ethernet frame. There are also two types of external messages to handle. An arriving Ethernet frame is temporarily stored until its transmission delay is up. Than it is transmit to the next module. A BufferControlMessage contains information about the fill level of the FrameBuffers() in BufferModule().

5.4.3.22 initialize()

```
void ArbiterIEEE802_1Qbv::initialize (
            void )  [override], [virtual]
```

Initialize the time aware shaper (TAS).

For the initialization: Get the period and critical interval duration. Get the maximum payload size of critical and noncritical Ethernet frames. Calculate the guard band and sending segments. Set up the segmentTriggerTimer↩
Message to simulate the time states of TAS. Get the current state and the next state of TAS.

5.4.3.23 initializeTimerMessage()

```
void ArbiterIEEE802_1Qbv::initializeTimerMessage ( )  [private]
```

Initialize the timer message segmentTriggerTimerMessage to control the Arbitration.

To change the state under correct timing conditions a self message segmentTriggerTimerMessage is initialized. It is always sent, if the duration of a segment is finished.

5.4.3.24 prepareBufferStatusList()

```
std::vector< ethernetHeaderInformation * > ArbiterIEEE802_1Qbv::prepareBufferStatusList (
            std::vector< ethernetHeaderInformation * > bufferStatusList )  [private]
```

Preparation of the ethernetHeaderInformation vector for arbitration.

EthernetHeaderInformation is a struct containing the priority of a FrameBuffer() and the payload size of the first Ethernet frame in a FrameBuffer(). If no Ethernet frame is stored in a FrameBuffer() it is indicated with a payload size 0. If an Ethernet frame is in the buffer (payload size $>$ 0), the boolean variable is ready from EthernetHeader↩
Information is set true.

Parameters

bufferStatusList	a vector containing pointer ethernetHeaderInformation

Returns

a vector containing pointer ethernetHeaderInformation with set boolean variable ready

5.4.3.25 printInitializationConfiguration()

```
void ArbiterIEEE802_1Qbv::printInitializationConfiguration ( )  [private]
```

Print all initialization configuartions.

Print the period duration, the critical interval duaration, non critical interval duration, the critical sending and guard band segment duration as well as the noncritical sending and guard band segment duration. It is also the initial state and the current state printed.

5.4.3.26 sendBufferAuthorizedBuffer()

```
void ArbiterIEEE802_1Qbv::sendBufferAuthorizedBuffer (
            int authorizedBuffer )  [private]
```

Send a authorization BufferControlMessage to BuffersModule.

By arbitration the priority of the FrameBuffer is selected that transmit its Ethernet frame. This is told to the BuffersModule() via BufferControlMessage with the flag SEND_AUTHORISATION.

Parameters

authorizedBuffer	integer value of the FrameBuffers priority

5.4.3.27 sendBufferRequest()

```
void ArbiterIEEE802_1Qbv::sendBufferRequest ( )  [private]
```

Send a request to the buffer to get information about stored Ethernet frames in buffer.

After finishing the transmission of the waiting Ethernet frame a new Ethernet frame can start its transmission. To get the information about stored Ethernet frames in the buffer a BufferControlMessage with the flag BUFFER_C↩
ONTROL_REQUEST is transmit to the BuffersModule().

5.4.3.28 sendFrameOut()

```
void ArbiterIEEE802_1Qbv::sendFrameOut ( )  [private]
```

Transmit the Ethernet frames that waits for its transmission

A triggerSelf message is arrived. It indicates that the transmission time of the Ethernet frame is finished. Now the frame is sent.

5.4.3.29 setEthPacketSizeFromPayload()

```
int ArbiterIEEE802_1Qbv::setEthPacketSizeFromPayload (
             int payload )  [private]
```

Set the packet size of an Ethernet frame.

From the payload the packet size of an Ethernet frame is set. The frame overhead (22 byte), packet overhead (8 byte) and interpacket gap (12 byte) are added to the payload. It is required for calculating the transmission duration of an Ethernet frame.

Returns

the packet size of an Ethernet frame in byte depending on the payload

5.4.3.30 setTriggerDelayEnd()

```
void ArbiterIEEE802_1Qbv::setTriggerDelayEnd (
             simtime_t transmissionPathDelay )  [private]
```

Set up timer message TriggerSelf

To simulate the transmission time of the Ethernet frame an self message TriggerSelf is set up. It is scheduledAt the above calculated transmission time.

Parameters

transmissionPathDelay	the transmission time of the Ethernet frame from one module to the next hop

5.4.3.31 setUpVectorCriticalPriorities()

```
std::vector< bool > ArbiterIEEE802_1Qbv::setUpVectorCriticalPriorities (
             std::vector< int > criticalPriorities )  [private]
```

Set up a boolean vector for all supported priorities to indicate their criticality.

For arbitration it is essential to know which priority is critical and which is not. Therefore a boolean vector is implemented. It contains for each priority an entry. True indicates that the priority is critical and false that it is noncritical.

Parameters

criticalPriorities	integer vector containing the critical priorities

Returns

boolean vector indicating which of the priorities is critical (= true) or not (= false)

5.4.4 Member Data Documentation

5.4.4.1 arbiterIsBusy

```
bool ArbiterIEEE802_1Qbv::arbiterIsBusy  [private]
```

variable that indicates that the arbitration is already in progress

5.4.4.2 criticalGuardBandSegmentDuration

```
simtime_t ArbiterIEEE802_1Qbv::criticalGuardBandSegmentDuration  [private]
```

guard band segment is as long as a critical frame needs for transmission

5.4.4.3 criticalIntervalDuration

```
simtime_t ArbiterIEEE802_1Qbv::criticalIntervalDuration  [private]
```

set by user -> defines the duration of the critical interval

5.4.4.4 criticalPriorityClasses

```
std::vector<int> ArbiterIEEE802_1Qbv::criticalPriorityClasses  [private]
```

integer vector which stores the critical priorities (= default ("7 6"))

5.4.4.5 criticalSendingSegmentDuration

```
simtime_t ArbiterIEEE802_1Qbv::criticalSendingSegmentDuration  [private]
```

critical interval is split into sending and guard band segment

5.4.4.6 currentBufferStatusList

```
std::vector<ethernetHeaderInformation*> ArbiterIEEE802_1Qbv::currentBufferStatusList  [private]
```

5.4.4.7 currentState

```
int ArbiterIEEE802_1Qbv::currentState  [private]
```

the state is equal the current time segment

5.4.4.8 ethernetFrameWaitForTransmission

```
EthernetFrame* ArbiterIEEE802_1Qbv::ethernetFrameWaitForTransmission  [private]
```

arbiter stores only one Ethernet frame which must wait for its transmission to simulate transmission rate

5.4.4.9 frameStoredInBuffer

```
bool ArbiterIEEE802_1Qbv::frameStoredInBuffer  [private]
```

5.4.4.10 isCritical

```
std::vector<bool> ArbiterIEEE802_1Qbv::isCritical  [private]
```

boolean vector indicating which of the priorities is critical (= true) or not (= false)

5.4.4.11 maximumCriticalPayloadSize

```
int ArbiterIEEE802_1Qbv::maximumCriticalPayloadSize  [private]
```

set by user -> defines the maximum payload number in bytes for critical priorities frames

5.4.4.12 maximumNoncriticalPayloadSize

```
int ArbiterIEEE802_1Qbv::maximumNoncriticalPayloadSize  [private]
```

set by user -> defines the maximum payload number in bytes for noncritical priorities frames

5.4.4.13 nextState

```
int ArbiterIEEE802_1Qbv::nextState  [private]
```

the next state is equal to the next time segment after the current

5.4.4.14 noncriticalGuardBandSegmentDuration

```
simtime_t ArbiterIEEE802_1Qbv::noncriticalGuardBandSegmentDuration  [private]
```

non critical guard band segment is as long as a non critical frame needs for transmission

5.4.4.15 noncriticalIntervalDuration

```
simtime_t ArbiterIEEE802_1Qbv::noncriticalIntervalDuration  [private]
```

non critical interval duration is the time remaining from the subtraction of period and criticalInterval

5.4.4.16 noncriticalSendingSegmentDuration

```
simtime_t ArbiterIEEE802_1Qbv::noncriticalSendingSegmentDuration  [private]
```

non critical interval duration is split into sending and guard band segment

5.4.4.17 numberSupportedPriorities

```
int ArbiterIEEE802_1Qbv::numberSupportedPriorities  [private]
```

number of supported priorities (= default 8 priorities)

5.4.4.18 periodDuration

```
simtime_t ArbiterIEEE802_1Qbv::periodDuration  [private]
```

set by user -> defines the duration of the period (= default 5 ms)

5.4.4.19 portIndex

```
int ArbiterIEEE802_1Qbv::portIndex  [private]
```

index of the EgressPort via which the frame is forwarded

5.4.4.20 segmentTriggerTimerMessage

```
cMessage* ArbiterIEEE802_1Qbv::segmentTriggerTimerMessage  [private]
```

cMessage timer for changing states (time segments)

5.4.4.21 switchMAC

```
int ArbiterIEEE802_1Qbv::switchMAC  [private]
```

MAC address of the switch.

5.4.4.22 timeOffset

```
simtime_t ArbiterIEEE802_1Qbv::timeOffset  [private]
```

timer, which allows to start the simulation in any time segment (= default 0 -> critical timing segment)

5.4.4.23 triggerSelf

```
cMessage* ArbiterIEEE802_1Qbv::triggerSelf = new cMessage()  [private]
```

cMessage timer for trigger Ethernet frame transmission

5.4.4.24 triggerTimer

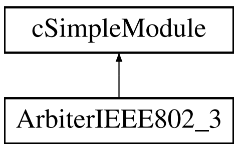
```
simtime_t ArbiterIEEE802_1Qbv::triggerTimer  [private]
```

timer to trigger a a self message

5.5 ArbiterIEEE802_3 Class Reference

```
#include <ArbiterIEEE802_3.h>
```

Inheritance diagram for ArbiterIEEE802_3:



Public Member Functions

- ArbiterIEEE802_3 ()
- virtual ∼ArbiterIEEE802_3 ()
- void initialize ()
- void handleMessage (cMessage ∗message)

Private Member Functions

- void dealWithInternalMessage (cMessage ∗message)
- void dealWithExternalMessage (cMessage ∗message)
- void dealWithEthernetFrame (cMessage ∗frame)
- void dealWithControlMessage (cMessage ∗controlMessage)
- std::vector< ethernetHeaderInformation ∗ > prepareBufferStatusList (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- void controlArbitrationBufferStatusList (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- int arbitrateBufferStatusList (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)
- void sendBufferAuthorizedBuffer (int authorizedBuffer)
- void sendBufferRequest ()
- simtime_t calculateTransmissionDelay (EthernetFrame ∗ethernetFrame)
- void calculateTransmissionSpeed ()
- void settriggerDelayEnd (simtime_t transmissionPathDelay)
- void sendFrameOut ()
- void debugStatusInitialization (std::vector< ethernetHeaderInformation ∗ > BufferStatusList)

Private Attributes

- std::vector< ethernetHeaderInformation ∗ > currentBufferStatusList
- int numberPriorities
- cModule ∗ parentModul
- cGate ∗ parentGateOut
- cChannel ∗ parentChannelOut
- double channelTransmissionRate
- bool arbiterIsBusy
- EthernetFrame ∗ ethernetFrameWaitForSend
- cMessage ∗ triggerSelf = new cMessage()
- int rememberLastWinner

5.5.1 Constructor & Destructor Documentation

5.5.1.1 ArbiterIEEE802_3()

```
ArbiterIEEE802_3::ArbiterIEEE802_3 ( )
```

Constructor ArbiterIEEE802.1Q, nothing to do here

5.5.1.2 ∼ArbiterIEEE802_3()

```
ArbiterIEEE802_3::∼ArbiterIEEE802_3 ( )  [virtual]
```

Destructor ArbiterIEEE802.1Q, nothing to do here

5.5.2 Member Function Documentation

5.5.2.1 arbitrateBufferStatusList()

```
int ArbiterIEEE802_3::arbitrateBufferStatusList (
              std::vector< ethernetHeaderInformation ∗ > BufferStatusList )  [private]
```

Arbiter which choose the next winning Frame for next transmission out of the Buffer Status List

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation∗>

5.5.2.2 calculateTransmissionDelay()

```
simtime_t ArbiterIEEE802_3::calculateTransmissionDelay (
            EthernetFrame * ethernetFrame )  [private]
```

Calculate based on Ethernet frame length transmission delay

Parameters

ethernetFrame	

Returns

simtime_t

5.5.2.3 calculateTransmissionSpeed()

```
void ArbiterIEEE802_3::calculateTransmissionSpeed ( )  [private]
```

Calculate Transmission seed of channel SafeGuard prevent for choose nullpointer as channel

5.5.2.4 controlArbitrationBufferStatusList()

```
void ArbiterIEEE802_3::controlArbitrationBufferStatusList (
            std::vector< ethernetHeaderInformation * > BufferStatusList )  [private]
```

This function controls the arbiter and call the steps which are necessary to prepare and arbitrate frames

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation*>

5.5.2.5 dealWithControlMessage()

```
void ArbiterIEEE802_3::dealWithControlMessage (
            cMessage * controlMessage )  [private]
```

Process incoming Control Messages Check what kind of Control Message is received. Buffer Level Update or Buffer Level Response. The Buffer Level Updates are processed if Arbiter is not busy

Parameters

controlMessage	

5.5.2.6 dealWithEthernetFrame()

```
void ArbiterIEEE802_3::dealWithEthernetFrame (
            cMessage * frame )  [private]
```

Process incoming Etherent frames and store them. Only one Frame is allowed. Start transmission delay process chain

Parameters

frame	

5.5.2.7 dealWithExternalMessage()

```
void ArbiterIEEE802_3::dealWithExternalMessage (
            cMessage * message )  [private]
```

Deals with external incoming messages and check if messages was external Ethernet Frame or Control Buffer Message

Parameters

message	incoming external message

5.5.2.8 dealWithInternalMessage()

```
void ArbiterIEEE802_3::dealWithInternalMessage (
            cMessage * message )  [private]
```

Deals with internal messages and process timer timeouts. Timer trigger start of transmission to next router

Parameters

message	incoming message

5.5.2.9 debugStatusInitialization()

```
void ArbiterIEEE802_3::debugStatusInitialization (
            std::vector< ethernetHeaderInformation * > BufferStatusList )  [private]
```

5.5.2.10 handleMessage()

```
void ArbiterIEEE802_3::handleMessage (
            cMessage * message )
```

Classification of incoming messages into internal and external sources

5.5.2.11 initialize()

```
void ArbiterIEEE802_3::initialize (
            void )
```

Initialize Arbiter and load informations form Parent Start calculation of transmission speed

5.5.2.12 prepareBufferStatusList()

```
std::vector< ethernetHeaderInformation * > ArbiterIEEE802_3::prepareBufferStatusList (
            std::vector< ethernetHeaderInformation * > BufferStatusList ) [private]
```

prepare the ready value of BufferStatusList caused by frame length if length = 0 frame is not ready

Parameters

BufferStatusList	is std::vector<ethernetHeaderInformation*>

5.5.2.13 sendBufferAuthorizedBuffer()

```
void ArbiterIEEE802_3::sendBufferAuthorizedBuffer (
            int authorizedBuffer ) [private]
```

Send Buffer the result of arbitration, send the authorized Buffer to transmit next frame

Parameters

authorizedBuffer	

5.5.2.14 sendBufferRequest()

```
void ArbiterIEEE802_3::sendBufferRequest ( ) [private]
```

Send a request to Buffer to check the current Buffer status fill level

5.5.2.15 sendFrameOut()

```
void ArbiterIEEE802_3::sendFrameOut ( )  [private]
```

send Frame out after Transmission time Delay is past

5.5.2.16 settriggerDelayEnd()

```
void ArbiterIEEE802_3::settriggerDelayEnd (
             simtime_t transmissionPathDelay )  [private]
```

set the trigger for sending frame out

Parameters

transmissionPathDelay	

5.5.3 Member Data Documentation

5.5.3.1 arbiterIsBusy

```
bool ArbiterIEEE802_3::arbiterIsBusy  [private]
```

5.5.3.2 channelTransmissionRate

```
double ArbiterIEEE802_3::channelTransmissionRate  [private]
```

5.5.3.3 currentBufferStatusList

```
std::vector<ethernetHeaderInformation*> ArbiterIEEE802_3::currentBufferStatusList  [private]
```

5.5.3.4 ethernetFrameWaitForSend

```
EthernetFrame* ArbiterIEEE802_3::ethernetFrameWaitForSend  [private]
```

5.5.3.5 numberPriorities

```
int ArbiterIEEE802_3::numberPriorities  [private]
```

5.5.3.6 parentChannelOut

```
cChannel* ArbiterIEEE802_3::parentChannelOut  [private]
```

5.5.3.7 parentGateOut

```
cGate* ArbiterIEEE802_3::parentGateOut  [private]
```

5.5.3.8 parentModul

```
cModule* ArbiterIEEE802_3::parentModul  [private]
```

5.5.3.9 rememberLastWinner

```
int ArbiterIEEE802_3::rememberLastWinner  [private]
```

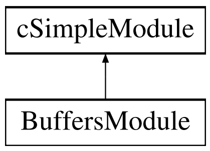
5.5.3.10 triggerSelf

```
cMessage* ArbiterIEEE802_3::triggerSelf = new cMessage()  [private]
```

5.6 BuffersModule Class Reference

```
#include <BuffersModule.h>
```

Inheritance diagram for BuffersModule:



Public Member Functions

- BuffersModule ()
- virtual ∼BuffersModule ()
- virtual void finish () override
- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override

Private Member Functions

- void setInitinalUserInputs ()
- int getNumberSupportedPriorities ()
- int getMaximumBufferSize ()
- void setUpFrameBuffers ()
- void dealWithExternalMessage (cMessage ∗message)
- bool isMessageControlMessage (cMessage ∗message)
- void dealWithBufferControl (cMessage ∗message)
- void dealWithEthernetFrame (cMessage ∗message)
- BufferControlMessage ∗ castMessageIntoBufferControlMessage (cMessage ∗message)
- int getBufferControlInstruction (BufferControlMessage ∗controlMessage)
- void handleBufferControlInstruction (int instruction, BufferControlMessage ∗controlMessage)
- void bufferControlLevelRequest ()
- void sendEthernetFrameFromBuffer (BufferControlMessage ∗controlMessage)
- void triggerUpdateMessageNewPriorityArrival ()
- EthernetFrame ∗ castMessageIntoEthernetFrame (cMessage ∗message)
- bool isFristArrivingFrameWithPriority (int priority)
- void storeEthernetFrameInBuffer (int priority, EthernetFrame ∗ethernetFrame)
- std::vector< ethernetHeaderInformation ∗ > setUpBufferInformation ()
- ethernetHeaderInformation ∗ getFrameBufferInformation (int priority)
- void sendBufferControlMessage (std::vector< ethernetHeaderInformation ∗ > bufferInformation, message↩ InformationConstant status)
- void deleteFramesInBuffers ()
- void deleteBuffers ()

Private Attributes

- int numberSupportedPriorities
- std::vector< FrameBuffer ∗ > frameBuffers
- int maximumBufferSize

5.6.1 Detailed Description

BuffersModule() is part of the EgressPort() as well as the interface Arbiter() and interface Classifier(). The BuffersModule() consists several FrameBuffers. The number of FrameBuffers() in BufferModule() depends on the number of supported priorities. For each priority a FrameBuffer() is created.

An incoming Ethernet frame is stored into the FrameBuffer() with the same priority depending on its priority. When an Ethernet frame appears the first time, BuffersModule() sends a control message with status BUFFER_LEVEL↩ _UPDATE to the Arbiter(). The Arbiter() then starts the arbitration and informs via control Message SEND_AUT↩ HORISATION the BuffersModule() which frame to be send.

5.6.2 Constructor & Destructor Documentation

5.6.2.1 BuffersModule()

```
BuffersModule::BuffersModule ( )
```

Constructor BuffersModule, nothing to do here

5.6.2.2 ∼BuffersModule()

```
BuffersModule::∼BuffersModule ( )  [virtual]
```

Destructor BuffersModule, delete every stored Ethernet frame and every generated FrameBuffer.

5.6.3 Member Function Documentation

5.6.3.1 bufferControlLevelRequest()

```
void BuffersModule::bufferControlLevelRequest ( )  [private]
```

Response of BUFFER_CONTROL_REQUEST from Arbiter

5.6.3.2 castMessageIntoBufferControlMessage()

```
BufferControlMessage ∗ BuffersModule::castMessageIntoBufferControlMessage (
             cMessage ∗ message )  [private]
```

Cast cMessage into a BufferControlMessage.

Incoming external message is cast into a BufferControlMessage. It is also checked if the message exits, otherwise an error is thrown.

Parameters

message	Pointer to cMessage that will be cast into BufferControlMessage

Returns

The pointer to the cast BufferControlMessage

5.6.3.3 castMessageIntoEthernetFrame()

```
EthernetFrame * BuffersModule::castMessageIntoEthernetFrame (
            cMessage * message )  [private]
```

Cast cMessage into an EthernetFrame.

Incoming external message is cast into an EthernetFrame. It is also checked if the message exits, otherwise an error is thrown.

Parameters

message	Pointer to cMessage that will be cast into an EthernetFrame

Returns

The pointer to the cast EthernetFrame

5.6.3.4 dealWithBufferControl()

```
void BuffersModule::dealWithBufferControl (
            cMessage * message )  [private]
```

Deal with new arrived message as BufferControlMessage.

New arrived message is a BufferControlMessage from the arbiter. Cast the cMessage into a BufferControlMessage, get the control instruction from the arbiter and handle this.

Parameters

message	Pointer to type cMessage, is a BufferControlMessage

5.6.3.5 dealWithEthernetFrame()

```
void BuffersModule::dealWithEthernetFrame (
            cMessage * message )  [private]
```

Deal with new arrived message as EthernetFrame.

New arrived message is an EthernetFrame. Cast cMessage into an EthernetFrame. Get the priority and checked whether Ethernet frames with the same priority are already stored in buffer. Store the arrived Ethernet frame in the buffer and trigger an update message to the Arbiter if the buffer is empty.

Parameters

message	Pointer to type cMessage, is an EthernetFrame

5.6.3.6 dealWithExternalMessage()

```
void BuffersModule::dealWithExternalMessage (
            cMessage * message )  [private]
```

Deal with an external incoming message

BuffersModule has only to deal with external messages. It has to distinguished two types of external messages. The first message type is the EthernetFrame and the second one the BufferControlMessage.

Parameters

message	Pointer to type cMessage, can be EthernetFrame or BufferControlMessage

5.6.3.7 deleteBuffers()

```
void BuffersModule::deleteBuffers ( )  [private]
```

Delete every remaining FrameBuffer for every priority.

After call finish or the class destructor clean up the memory. Every remaining FrameBuffer has to be deleted to avoid warnings and errors.

5.6.3.8 deleteFramesInBuffers()

```
void BuffersModule::deleteFramesInBuffers ( )  [private]
```

Delete every remaining frame in the buffers after finishing the program

After call finish or the class destructor clean up the memory. Every remaining frame in the buffers has to be deleted to avoid warnings and errors.

5.6.3.9 finish()

```
void BuffersModule::finish ( )  [override], [virtual]
```

Called after finishing the simulation. Delete every stored Ethernet frame in the buffer.

5.6.3.10 getBufferControlInstruction()

```
int BuffersModule::getBufferControlInstruction (
            BufferControlMessage * controlMessage )  [private]
```

Get the control instructions for BuffersModule from BufferControlMessage

BufferControlMessages are messages between arbiter and BuffersModule. There a two instructions from arbiter that the BuffersModule has to handle.

Parameters

controlMessage	Pointer to BufferControlMessage containing instructions

Returns

an integer from enum messageInformationConstant indicating the instruction how to deal with the message

5.6.3.11 getFrameBufferInformation()

```
ethernetHeaderInformation * BuffersModule::getFrameBufferInformation (
            int priority )  [private]
```

Get the information of one buffer.

Relevant information are the priority of the buffer and the frame length of the first frame in the buffer. If no frame is stored the frame length is set to 0. This indicates the arbiter that no frame of this priority is stored.

Parameters

Integer	value of the buffer priority

Returns

Pointer to struct ethernetHeaderInformation containing the priority and first frame length

5.6.3.12 getMaximumBufferSize()

```
int BuffersModule::getMaximumBufferSize ( )  [private]
```

Get the size of the buffer, which indicates the storage capacity

The maximum buffer size indicates how many frames can be stored in the buffer depending on the frame size. By default the maximum buffer size is set to 4096 Byte.

Returns

The integer value of the maximum buffer size in Byte.

5.6.3.13 getNumberSupportedPriorities()

```
int BuffersModule::getNumberSupportedPriorities ( )  [private]
```

Get the number of supported priorities.

Number of priorities is set by user in .ini file during the set up of the network. By default the number is set to 8 priorities with values between 0 and 7. The number is needed to set up the number of buffers. Each priority has its own frame buffer.

Returns

The integer value of the number of priorities.

5.6.3.14 handleBufferControlInstruction()

```
void BuffersModule::handleBufferControlInstruction (
             int instruction,
             BufferControlMessage * controlMessage )  [private]
```

Handle the instructions from the BufferControlMessage.

Their are two different instruction that the BuffersModule has to handle. The first instruction is BUFFER_CON↩ TROL_REQUEST. The arbiter send a BufferControlMessage to BuffersModule to get the fill level of the buffers. The second instruction is SEND_AUTHORISATION. The BuffersModule gets the rights from the arbiter to send an EthernetFrame.

Parameters

instruction	An integer value indicating the instruction depending on messageInformationConstant
controlMessage	Pointer to BufferControlMessage

5.6.3.15 handleMessage()

```
void BuffersModule::handleMessage (
             cMessage * msg )  [override], [virtual]
```

Only external messages to handle. There a two different types of external messages. The first one is an Ethernet↩ Frame the second one is a BufferControlMessage from the arbiter.

5.6.3.16 initialize()

```
void BuffersModule::initialize (
             void  )  [override], [virtual]
```

Initialize BuffersModule. First get the user inputs. Than set up the Buffer. For each priority there is a buffer and a maximum size.

5.6.3.17 isFristArrivingFrameWithPriority()

```
bool BuffersModule::isFristArrivingFrameWithPriority (
            int priority )  [private]
```

Check whether an EthernetFrame with its priority is already stored in the buffer.

The arbiter has to be informed for new arriving EthernetFrames. Therefore it is checked whether an EthernetFrame is the first one of its priority. If it is the first one return true and if EthernetFrames with the same priority are already stored in the buffer return false.

Parameters

priority	Integer value of the EthernetFrame priority

Returns

true, if no EthernetFrame is stored in the Buffer otherwise false.

5.6.3.18 isMessageControlMessage()

```
bool BuffersModule::isMessageControlMessage (
            cMessage * message )  [private]
```

Set true if message is a control message and false otherwise.

BuffersModule has to deal with two different message types. Message type BufferControlMessage arrives BuffersModule from "control" gate. Message type EthernetFrame arrives BuffersModule from "in" gate. To distinguished the message type check the gate at which the message arrivals.

Parameters

message	Pointer new arrived cMessage

Returns

true if message type is BufferControlMessage

5.6.3.19 sendBufferControlMessage()

```
void BuffersModule::sendBufferControlMessage (
            std::vector< ethernetHeaderInformation * > bufferInformation,
            messageInformationConstant status )  [private]
```

A BufferControlMessage is sent to the arbiter.

BufferControlMessage is sent to the arbiter. The message contains information about each buffer. The priority and the length of the first frame in each buffer is provided for the arbiter. The status of BufferControlMessage depends on the send instruction from arbiter or if a frame with a new priority arrived.

Parameters

bufferInformation	Vector containing for each buffer priority and frist frame lenght
status	Integer value status of the BufferControlMessage from type messageInformationConstant

5.6.3.20 sendEthernetFrameFromBuffer()

```
void BuffersModule::sendEthernetFrameFromBuffer (
            BufferControlMessage * controlMessage )  [private]
```

Response of SEND_AUTHORISATION from Arbiter. Contains the authorization to send an Ethernet frame.

Parameters

controlMessage	

5.6.3.21 setInitinalUserInputs()

```
void BuffersModule::setInitinalUserInputs ( )  [private]
```

Set the initial user inputs which are made in ini file.

To set up the buffers module the inputs from ini-file are taken. The number of supported priorities is taken to set up one FrameBuffer for each priority. The maximum size of the buffers indicates the storage capacity of each buffer.

5.6.3.22 setUpBufferInformation()

```
std::vector< ethernetHeaderInformation * > BuffersModule::setUpBufferInformation ( )  [private]
```

Set up the information about each buffer for the arbiter.

The BuffersModule has to provide information the arbiter with information about each buffer so that the arbiter can decide which Ethernet frame to send. The relevant informations are the priority of the buffer and the frame length of the first frame in the buffer.

Returns

A vector containing the priority and frame length of first frame in each buffer

5.6.3.23 setUpFrameBuffers()

```
void BuffersModule::setUpFrameBuffers ( )  [private]
```

Set up a frame buffer for each priority.

Depending on the number of supported priorities and the maximum buffer size a frame buffer of class FrameBuffer is set up.

5.6.3.24 storeEthernetFrameInBuffer()

```
void BuffersModule::storeEthernetFrameInBuffer (
             int priority,
             EthernetFrame * ethernetFrame )  [private]
```

Arriving EthernetFrame is stored in buffer with its priority.

Parameters

priority	Integer value of the EthernetFrame priority
ethernetFrame	Pointer to EthernetFrame that is stored in buffer

5.6.3.25 triggerUpdateMessageNewPriorityArrival()

```
void BuffersModule::triggerUpdateMessageNewPriorityArrival ( )  [private]
```

Sends a control message to Arbiter() when an EthernetFrame with new priority appears.

On arrival of an Ethernet frame with a priority that is not yet sorted in a FrameBuffer(), an control message with status BUFFER_LEVEL_UPDATE is transmit to the Arbiter(). Thus the Arbiter() is always kept up to date.

5.6.4 Member Data Documentation

5.6.4.1 frameBuffers

```
std::vector<FrameBuffer*> BuffersModule::frameBuffers  [private]
```

5.6.4.2 maximumBufferSize

```
int BuffersModule::maximumBufferSize  [private]
```

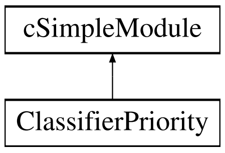
5.6.4.3 numberSupportedPriorities

```
int BuffersModule::numberSupportedPriorities  [private]
```

5.7 ClassifierPriority Class Reference

```
#include <ClassifierPriority.h>
```

Inheritance diagram for ClassifierPriority:



Public Member Functions

- ClassifierPriority ()
- virtual ∼ClassifierPriority ()
- void initialize ()
- void handleMessage (cMessage ∗message)

Private Attributes

- cModule ∗ parentModul
- int numberPriorities
- int framePriority

5.7.1 Detailed Description

The Classifier classify Frames based on the Ethernet priority and forward them in one of the priority asserted channels

5.7.2 Constructor & Destructor Documentation

5.7.2.1 ClassifierPriority()

```
ClassifierPriority::ClassifierPriority ( )
```

Constructor of the class, nothing to do

5.7.2.2 ∼ClassifierPriority()

```
ClassifierPriority::∼ClassifierPriority ( ) [virtual]
```

Destructor of the class, nothing to do

5.7.3 Member Function Documentation

5.7.3.1 handleMessage()

```
void ClassifierPriority::handleMessage (
            cMessage * message )
```

Process incomming Ethernet frames and send them based on the priority out

sort frames based on priority to class

5.7.3.2 initialize()

```
void ClassifierPriority::initialize (
            void )
```

Initialize the global Variables

5.7.4 Member Data Documentation

5.7.4.1 framePriority

```
int ClassifierPriority::framePriority [private]
```

5.7.4.2 numberPriorities

```
int ClassifierPriority::numberPriorities [private]
```

5.7.4.3 parentModul

```
cModule* ClassifierPriority::parentModul [private]
```

5.8 ConfigurationReader Class Reference

```
#include <ConfigurationReader.h>
```

Public Member Functions

- virtual ∼ConfigurationReader ()
- configVector getMACTableEntriesFromInputFile (std::string inputConfigurationFile)
- configVector getAVBTableEntriesFromInputFile (std::string inputConfigurationFile)

Static Public Member Functions

- static ConfigurationReader ∗ getInstance ()

Private Member Functions

- ConfigurationReader ()
- void openConfigurationFile (std::string inputConfigurationFile)
- configVector readOutInputFile ()
- bool isCommentLine (std::string line)
- std::vector< int > splitFileLineAndGetEntry ()

Private Attributes

- std::ifstream inputFile
- std::string fileLine
- configVector macTableVector
- configVector avbTableVector

Static Private Attributes

- static ConfigurationReader ∗ instance = 0

5.8.1 Constructor & Destructor Documentation

5.8.1.1 ∼ConfigurationReader()

```
ConfigurationReader::∼ConfigurationReader ( )  [virtual]
```

5.8.1.2 ConfigurationReader()

```
ConfigurationReader::ConfigurationReader ( )  [private]
```

5.8.2 Member Function Documentation

5.8.2.1 getAVBTableEntriesFromInputFile()

```
configVector ConfigurationReader::getAVBTableEntriesFromInputFile (
             std::string inputConfigurationFile )
```

5.8.2.2 getInstance()

```
ConfigurationReader * ConfigurationReader::getInstance ( )  [static]
```

5.8.2.3 getMACTableEntriesFromInputFile()

```
configVector ConfigurationReader::getMACTableEntriesFromInputFile (
             std::string inputConfigurationFile )
```

5.8.2.4 isCommentLine()

```
bool ConfigurationReader::isCommentLine (
             std::string line )  [private]
```

5.8.2.5 openConfigurationFile()

```
void ConfigurationReader::openConfigurationFile (
             std::string inputConfigurationFile )  [private]
```

5.8.2.6 readOutInputFile()

```
configVector ConfigurationReader::readOutInputFile ( )  [private]
```

5.8.2.7 splitFileLineAndGetEntry()

```
std::vector< int > ConfigurationReader::splitFileLineAndGetEntry ( )  [private]
```

5.8.3 Member Data Documentation

5.8.3.1 avbTableVector

```
configVector ConfigurationReader::avbTableVector  [private]
```

5.8.3.2 fileLine

```
std::string ConfigurationReader::fileLine  [private]
```

5.8.3.3 inputFile

```
std::ifstream ConfigurationReader::inputFile  [private]
```

5.8.3.4 instance

```
ConfigurationReader * ConfigurationReader::instance = 0  [static], [private]
```

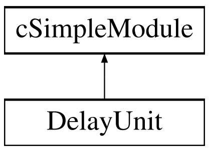
5.8.3.5 macTableVector

```
configVector ConfigurationReader::macTableVector  [private]
```

5.9 DelayUnit Class Reference

```
#include <DelayUnit.h>
```

Inheritance diagram for DelayUnit:



Public Member Functions

- DelayUnit ()
- virtual ∼DelayUnit ()

Protected Member Functions

- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override

5.9.1 Detailed Description

Adds artificial delay to the delivery of the sample to the writer to model runtime overoverhead

5.9.2 Constructor & Destructor Documentation

5.9.2.1 DelayUnit()

```
DelayUnit::DelayUnit ( )  [inline]
```

Default constructor

5.9.2.2 ∼DelayUnit()

```
DelayUnit::∼DelayUnit ( )  [virtual]
```

Default destructor

5.9.3 Member Function Documentation

5.9.3.1 handleMessage()

```
void DelayUnit::handleMessage (
             cMessage ∗ msg )  [override], [protected], [virtual]
```

Delays and forwards incoming messages

Parameters

msg	The message to delay and forward

5.9.3.2 initialize()

```
void DelayUnit::initialize ( )  [override], [protected], [virtual]
```

Nothing to initialize

5.10 E2ELatencyStatistics Class Reference

```
#include <E2ELatencyStatistics.h>
```

Public Member Functions

- E2ELatencyStatistics ()
- virtual ∼E2ELatencyStatistics ()
- int addE2ELatency (int receiverID, int globalStreamID, simtime_t delay)
- void finish ()

Private Attributes

- VectorStatistics2DMap ∗ vectorE2EStatistics = 0
- HistogramStatistics2DMap ∗ histogramE2Estatistics = 0

5.10.1 Detailed Description

This class is gathering E2E latency statistics per streamID As streams are virtual entities (no module) they must be gathered by StatisticManager.

5.10.2 Constructor & Destructor Documentation

5.10.2.1 E2ELatencyStatistics()

```
E2ELatencyStatistics::E2ELatencyStatistics ( )
```

default constructor, nothing to do

5.10.2.2 ∼E2ELatencyStatistics()

```
E2ELatencyStatistics::∼E2ELatencyStatistics ( )  [virtual]
```

default destructor, nothing to do

5.10.3 Member Function Documentation

5.10.3.1 addE2ELatency()

```
int E2ELatencyStatistics::addE2ELatency (
             int receiverID,
             int globalStreamID,
             simtime_t delay )
```

stores the end-to-end delay of at the receiver of the stream ID

Parameters

receiverID	the end node ID (must be unique)
globalStreamID	the stream ID of the received message
delay	the end-to-end delay (receive time - start time)

Returns

1 if success, see error codes within code

5.10.3.2 finish()

```
void E2ELatencyStatistics::finish ( )
```

Finishes statistics gathering for End-2-End latencies Vectors will be deleted Histograms: are firstly recorded (save to file) and next deleted

5.10.4 Member Data Documentation

5.10.4.1 histogramE2Estatistics

```
HistogramStatistics2DMap* E2ELatencyStatistics::histogramE2Estatistics = 0  [private]
```

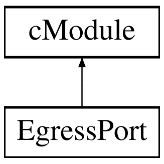
5.10.4.2 vectorE2EStatistics

```
VectorStatistics2DMap* E2ELatencyStatistics::vectorE2EStatistics = 0  [private]
```

5.11 EgressPort Class Reference

```
#include <EgressPort.h>
```

Inheritance diagram for EgressPort:



Public Member Functions

- EgressPort ()
- virtual ∼EgressPort ()

5.11.1 Detailed Description

In this EgressPort Module nothing happend here

5.11.2 Constructor & Destructor Documentation

5.11.2.1 EgressPort()

```
EgressPort::EgressPort ( )
```

Constructor EgressPort, nothing to do here

5.11.2.2 ∼EgressPort()

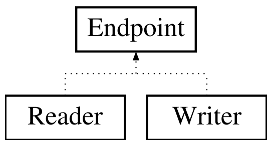
```
EgressPort::∼EgressPort ( ) [virtual]
```

Destructor EgressPort, nothing to do here

5.12 Endpoint Class Reference

```
#include <Endpoint.h>
```

Inheritance diagram for Endpoint:



Public Member Functions

- Endpoint ()
- ∼Endpoint ()
- void calculateRtpsMsgSize (RTPSEthMessage ∗rtpsMsg)
- unsigned long long getNextUniqueRtpsMsgId ()

Public Attributes

- int entityId

  The unique entity Id.
- int entityKind

  The entity kind.
- unsigned long long rtpsMsgSequenceId

  RTPS message sequence ID counter for unique frame identification of RTPS messages regarding one entity.

5.12.1 Detailed Description

Superclass of RTPS writers and readers. Implements basic functionalities used by both.

5.12.2 Constructor & Destructor Documentation

5.12.2.1 Endpoint()

```
Endpoint::Endpoint ( )  [inline]
```

The default constructor

5.12.2.2 ∼Endpoint()

```
Endpoint::∼Endpoint ( )  [inline]
```

5.12.3 Member Function Documentation

5.12.3.1 calculateRtpsMsgSize()

```
void Endpoint::calculateRtpsMsgSize (
             RTPSEthMessage ∗ rtpsMsg )
```

Calulates the rtps message size of a message and sets the corresponding parameters

Parameters

rtpsMsg	Represents the relevant message to calculate the size for.

5.12.3.2 getNextUniqueRtpsMsgId()

```
unsigned long long Endpoint::getNextUniqueRtpsMsgId ( )
```

Return and increment next unique RTPS message ID

5.12.4 Member Data Documentation

5.12.4.1 entityId

```
int Endpoint::entityId
```

The unique entity Id.

5.12.4.2 entityKind

```
int Endpoint::entityKind
```

The entity kind.

5.12.4.3 rtpsMsgSequenceId

```
unsigned long long Endpoint::rtpsMsgSequenceId
```

RTPS message sequence ID counter for unique frame identification of RTPS messages regarding one entity.

5.13 ethernetHeaderInformation Struct Reference

```
#include <EthernetHeaderInformation.h>
```

Public Attributes

- int payloadLength
- int priority
- bool ready

5.13.1 Member Data Documentation

5.13.1.1 payloadLength

```
int ethernetHeaderInformation::payloadLength
```

5.13.1.2 priority

```
int ethernetHeaderInformation::priority
```

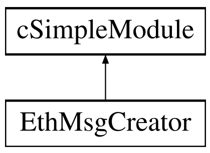
5.13.1.3 ready

```
bool ethernetHeaderInformation::ready
```

5.14 EthMsgCreator Class Reference

```
#include <EthMsgCreator.h>
```

Inheritance diagram for EthMsgCreator:



Public Member Functions

- EthMsgCreator ()
- virtual ∼EthMsgCreator ()

Protected Member Functions

- virtual void initialize () override
- virtual void finish () override
- virtual void handleMessage (cMessage ∗msg) override
- int64_t getNextUniqueFrameId ()

Protected Attributes

- bool enableFineGrainedLatencyStats

  Enables detailed statistics of the path an Ethernet message takes.
- int64_t uniqueFrameId

  The frame sequence ID unique for a given globalStreamId.

5.14.1 Detailed Description

The EthMsg Creator instantiates and forwards a raw Ethernet packet with a given size after stimulation from the preceding module.

5.14.2 Constructor & Destructor Documentation

5.14.2.1 EthMsgCreator()

```
EthMsgCreator::EthMsgCreator ( )
```

Default constructor.

5.14.2.2 ∼EthMsgCreator()

```
EthMsgCreator::∼EthMsgCreator ( )  [virtual]
```

The Destructor

5.14.3 Member Function Documentation

5.14.3.1 finish()

```
void EthMsgCreator::finish ( )  [override], [protected], [virtual]
```

Overridden method, called at the end of the simulation

5.14.3.2 getNextUniqueFrameId()

```
int64_t EthMsgCreator::getNextUniqueFrameId ( )  [inline], [protected]
```

This method calculates unique IDs for Ethernet messages. It returns the current value and increases it thereafter.

5.14.3.3 handleMessage()

```
void EthMsgCreator::handleMessage (
            cMessage * msg )  [override], [protected], [virtual]
```

Overridden method, triggered by a traffic source and creates one Ethernet message each time it is called. The message is passed to the Stack and the Ethernet network.

Parameters

msg	each incoming message is interpreted as a stimulation

5.14.3.4 initialize()

```
void EthMsgCreator::initialize ( )  [override], [protected], [virtual]
```

Overridden method, initializes the module parameters

5.14.4 Member Data Documentation

5.14.4.1 enableFineGrainedLatencyStats

```
bool EthMsgCreator::enableFineGrainedLatencyStats  [protected]
```

Enables detailed statistics of the path an Ethernet message takes.

5.14.4.2 uniqueFrameId

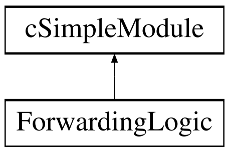
```
int64_t EthMsgCreator::uniqueFrameId  [protected]
```

The frame sequence ID unique for a given globalStreamId.

5.15 ForwardingLogic Class Reference

```
#include <ForwardingLogic.h>
```

Inheritance diagram for ForwardingLogic:



Public Member Functions

- ForwardingLogic ()
- virtual ∼ForwardingLogic ()
- virtual void initialize () override
- void handleMessage (cMessage ∗message) override

Private Member Functions

- configVector getMACTable ()
- configVector getOnlyEntriesForThisSwitch (configVector macTableEntries)
- bool forwardingByStreamID (EthernetFrame ∗ethernetFrame)
- bool dealWithUnicast (EthernetFrame ∗ethernetFrame)
- bool dealWithMulticast (EthernetFrame ∗ethernetFrame)
- void isValidNumberOfEntries (int macTableRow)
- int getPortIDFromNextHOP (int hopMACAddress)
- bool isConnectedModuleEndNode (cGate ∗nextConnectedModuleGate)
- bool isHopMACAddressEqualEndNodeMAC (int gateNumber, int hopMACAddress, cModule ∗connected←↩ Module)
- bool isHopMACAddressEqualSwitchMAC (int hopMACAddress, cModule ∗connectedModule)
- bool portIDInvalid (int portID)
- void printSimulationOutputs (simulationOutputType type)
- void errorHandling (errorType type)

Private Attributes

- int switchIndex
- int switchMAC
- int streamID
- cModule ∗ parentSwitch
- std::string macTableFile
- configVector macTable
- EthernetFrame ∗ ethernetFrame

5.15.1 Detailed Description

Module ForwardingLogic() is part of Switch() module as well as the IngressPort() and EgressPortModule(). The task of the ForwardingLogic() is to get from the MAC table the right gate index to forward an Ethernet frame.

5.15.2 Constructor & Destructor Documentation

5.15.2.1 ForwardingLogic()

```
ForwardingLogic::ForwardingLogic ( )
```

constructor: nothing to do here

default constructor

5.15.2.2 ∼ForwardingLogic()

```
ForwardingLogic::∼ForwardingLogic ( )  [virtual]
```

destructor: nothing to do here

default destructor

5.15.3 Member Function Documentation

5.15.3.1 dealWithMulticast()

```
bool ForwardingLogic::dealWithMulticast (
             EthernetFrame ∗ ethernetFrame )  [private]
```

Transmit the Ethernet frame to several end nodes (multicast).

An Ethernet frame is transmitted to several end nodes by global stream ID and connected module MAC (next hop). It is iterated over all MAC table entries and checked if the streamID is equal to stream ID of the Ethernet frame. With the same stream ID the port of the next connected Module is determined. By choosing mulitcast it is known that several entries with the same stream ID exist. The Ethernet frame is forwarded to all entries with the same stream ID until there are no more entries in the MAC table are left.

Parameters

ethernetFrame	pointer to Ethernet frame containing the information about global stream ID, among others

Returns

true, if the next portID is found to which the Ethernet frame is forwarded

5.15.3.2 dealWithUnicast()

```
bool ForwardingLogic::dealWithUnicast (
            EthernetFrame * ethernetFrame )  [private]
```

Transmit the Ethernet frame to only one end node (unicast).

An Ethernet frame is transmitted only to one end node by global stream ID and connected module MAC (next hop). It is iterated over all MAC table entries and checked if the stream ID entry is equal to stream ID of Ethernet frame. With the same stream ID the port of the next connected Module is determined. Since only one end node receives the Ethernet frame, the MAC Table entry search is aborted after transmitting the frame.

Parameters

ethernetFrame	pointer to Ethernet Frame containing the information about global stream ID, among others

Returns

true, if the next portID is found to which the Ethernet frame is forwarded

5.15.3.3 errorHandling()

```
void ForwardingLogic::errorHandling (
            errorType type )  [private]
```

A collection of output streams to handle (throw) errors.

Error 1 INCORRECT_MESSAGE_TYPE: cMessage cannot cast the Ethernet frame Error 2 UNKNOWN_STREA↩
M_ID: stream ID in .config-file does not correspond to stream ID of the Ethernet frame Error 3 INVALID_NUMBER↩
_MAC_TABLE_ENTRIES: the number of entries in the mac Table set by user is invalid Error 4 INVALID_PORT_ID: There is no Port for given next connected module MAC address

Parameters

type	value of enum errorType.

5.15.3.4 forwardingByStreamID()

```
bool ForwardingLogic::forwardingByStreamID (
            EthernetFrame * ethernetFrame )  [private]
```

A incoming Ethernet frame is forwarded by global and unique streamID

The global stream ID is obtained from an Ethernet frame. The Port ID of the next module (next Hop) is determined to which the Ethernet frame is forwarded is determined from MAC Table. A distinction is made as to whether the frame is transmitted unicast (only to one end node) or multicast (to several end nodes)

Parameters

ethernetFrame	pointer to a Ethernet frame containing the information about global stream ID, among others

Returns

true, if the next portID is found to which the Ethernet frame is forwarded

5.15.3.5 getMACTable()

```
configVector ForwardingLogic::getMACTable ( )  [private]
```

Get the all MAC Table entries.

MAC Table is defined as a .config-file by user. All MAC address of the network are entered in .config.-file.

Returns

the MAC Table which is defined in the .config file as vector of vectors of integers

5.15.3.6 getOnlyEntriesForThisSwitch()

```
configVector ForwardingLogic::getOnlyEntriesForThisSwitch (
             configVector macTableEntries )  [private]
```

Get only the MAC Table entries which affects this switch.

A given MAC Table configVector is searched iteratively according to entries that are only intended for it.

Parameters

macTableEntries	a configVector that contains the MACTable which is set by user and generated form ConfigurationReader

Returns

a MACTable which includes only entries intended for a specific switch

5.15.3.7 getPortIDFromNextHOP()

```
int ForwardingLogic::getPortIDFromNextHOP (
             int hopMACAddress )  [private]
```

Get the port ID of the next connected module (hop)

Forwarding by stream ID requires the MAC address of the next connected module (hop). The module MAC address is set in the .config-file by user. With this MAC address the Port ID within the switch is determined. All connected gates in the switch and the corresponding MAC address of the connected modules are searched until the hop MAC address of .config-file is found. If no the hop MAC address does not exist, a -1 is returned.

Parameters

hopMACAddress	integer value of the connected module MAC (next hop) get from configVector macTable

Returns

the portID of the next connected module or -1 if the entry is not found

5.15.3.8 handleMessage()

```
void ForwardingLogic::handleMessage (
             cMessage * message )  [override]
```

Handle an incoming message. Cast it to an Ethernet frame and check if it is forwarded only to one end node (unicast) or several nodes (multicast)

5.15.3.9 initialize()

```
void ForwardingLogic::initialize (
             void  )  [override], [virtual]
```

The initialization of the switch. The MAC address of the switch is set, the MAC Table for this switch is generated and some outputs are made.

5.15.3.10 isConnectedModuleEndNode()

```
bool ForwardingLogic::isConnectedModuleEndNode (
             cGate * nextConnectedModuleGate )  [private]
```

Is true if the next connected module is an EndNode otherwise false.

It is important to distinguish Switch() and EndNode() modules. The port MAC address of a Switch() is always the same as the switch MAC address. The port MAC address of EndNodes() can differ from the MAC address of the EndNode().

Parameters

nextConnectedModuleGate	Pointer to cGate of the next connected module

Returns

true if the next connected module is an EndNode() otherwise false

5.15.3.11 isHopMACAddressEqualEndNodeMAC()

```
bool ForwardingLogic::isHopMACAddressEqualEndNodeMAC (
            int gateNumber,
            int hopMACAddress,
            cModule * connectedModule )  [private]
```

Returns true if EndNode() MAC address and hop MAC address is equal, otherwise returns false.

The MAC addresses from EndNode() module and EndNode ports can be differ. Therefore, all submodules of type IngressPort() from the EndNode() are checked to get the port MAC address. The MAC address is compared to the nextHopMAC address. With the same MAC the gate index from the switch must be checked. The reason for this is the support of multiple EndNode ports. To transmit the Ethernet frame over the correct channel, the gateNumber must be equal to the gateIndex.

Parameters

gateNumber	Integer value, contains the gate index of switch
hopMACAddress	Integer value of the next hop MAC address
connectedModule	Pointer to cModule of the next connected module

Returns

true if EndNOde() MAC address and hop MAC address are equal

5.15.3.12 isHopMACAddressEqualSwitchMAC()

```
bool ForwardingLogic::isHopMACAddressEqualSwitchMAC (
            int hopMACAddress,
            cModule * connectedModule )  [private]
```

Returns true if the Switch() MAC addres is equal to the next hop MAC address, otherwise false.

The MAC address from switch ports and switch module is the same. With connectedModules the MAC address of the connected switch is obtained. These MAC address is compared to the hopMACAddress.

Parameters

hopMACAddress	Integer value of next hop MAC address
connectedModule	Pointer to cModule of the next connected Module

Returns

true if Switch() MAC address is equal to hop MAC address

5.15.3.13 isValidNumberOfEntries()

```
void ForwardingLogic::isValidNumberOfEntries (
            int macTableRow ) [private]
```

Checks if the number of entries in the MAC table row is valid

The number of in the is 3. First entry corresponds to the switch MAC address, second entry to global stream ID and the third to the MAC address of the next connected module (hop). With an higher number of entries an error is thrown otherwise the procedure continues.

Parameters

macTableEntries	is a integer value of a specific row entry in the configVector

5.15.3.14 portIDInvalid()

```
bool ForwardingLogic::portIDInvalid (
            int portID ) [private]
```

Checks if the portID is valid.

If the MAC address of the next connected module (hop) does not exist a -1 is returned. This functions checks if portID is -1 one. If this is the case, an error is thrown.

Parameters

portID	integer value of the MAC address of the next connected Module

Returns

true, if the value is lower than 0 are greater than the number of connected gates in the switch, otherwise false

5.15.3.15 printSimulationOutputs()

```
void ForwardingLogic::printSimulationOutputs (
            simulationOutputType type ) [private]
```

A collection of stream outputs which are shown during the simulation.

It contains only information for the user. Type 1: INIT_OUTPUT print the MAC address of the initialized switch as well as the number of loaded elements Type 2: MAC_TABLE_CONFIGURATION_INFO is printed if there is no entry in MAC table for a switch.

Parameters

type	value of enum simulationOutputType.

5.15.4 Member Data Documentation

5.15.4.1 ethernetFrame

```
EthernetFrame* ForwardingLogic::ethernetFrame  [private]
```

5.15.4.2 macTable

```
configVector ForwardingLogic::macTable  [private]
```

5.15.4.3 macTableFile

```
std::string ForwardingLogic::macTableFile  [private]
```

5.15.4.4 parentSwitch

```
cModule* ForwardingLogic::parentSwitch  [private]
```

5.15.4.5 streamID

```
int ForwardingLogic::streamID  [private]
```

5.15.4.6 switchIndex

```
int ForwardingLogic::switchIndex  [private]
```

5.15.4.7 switchMAC

```
int ForwardingLogic::switchMAC  [private]
```

5.16 FrameBuffer Class Reference

```
#include <FrameBuffer.h>
```

Public Member Functions

- FrameBuffer (int priority, int maximumBufferSize)
- virtual ∼FrameBuffer ()
- int getFramePriority ()
- int getFrameFillLevel ()
- int getNextFrameLength ()
- void pushFrameToBack (EthernetFrame ∗frame)
- EthernetFrame ∗ popNextFrame ()
- EthernetFrame ∗ deleteFramesInBuffer ()

Private Member Functions

- int updateFreeBufferSize (bufferUpdate status, int frameLength)
- bool freeSpaceInBuffer (int frameLenght)

Private Attributes

- int framePriority
- int bufferSize
- int frameNumberInBuffer
- int storedBytesInBuffer
- int droppedFramesInBuffer
- int droppedBytesInBuffer
- cOutVector frameNumberVector
- cOutVector storedBytesVector
- cOutVector droppedFramesVector
- cOutVector droppedBytesVector
- std::list< EthernetFrame ∗ > frameBuffer

5.16.1 Detailed Description

Class FrameBuffer is one buffer in which are frames (e.g. Ethernet frames) are stored. Only frames of the same priority are in one buffer. The Buffer size (capacity in byte) depends on the module BufferModuls.ned

FrameBuffer is similar to a queue. New arriving frames are stored at the end of the buffers. Always the first element is selected for transmission.

5.16.2 Constructor & Destructor Documentation

5.16.2.1 FrameBuffer()

```
FrameBuffer::FrameBuffer (
            int priority,
            int maximumBufferSize )
```

Constructor of FrameBuffer. By creating a new object FrameBuffer it is necessary to set the priority and the size (Byte) of the buffer

Parameters

priority	integer value of the FrameBuffer priority depending on frame priority
maximumBufferSize	integer value that defines the buffer size (set per default to 4096 byte)

5.16.2.2 ∼FrameBuffer()

```
FrameBuffer::∼FrameBuffer ( )  [virtual]
```

Destructor of FrameBuffer -> empty, nothing to do here

5.16.3 Member Function Documentation

5.16.3.1 deleteFramesInBuffer()

```
EthernetFrame * FrameBuffer::deleteFramesInBuffer ( )
```

This function is called by destructor ∼BuffersModule() to delete every remaining frame in the buffer.

After finishing the simulation every remaining Ethernet frame in a buffer must be deleted. In contrast to popNextFrame() no statistics are collected here. Due to the statistics popNextFrame() is improper for the destructor.

Returns

Pointer to the first stored Ethernet frame in buffer.

5.16.3.2 freeSpaceInBuffer()

```
bool FrameBuffer::freeSpaceInBuffer (
            int frameLenght )  [private]
```

checks if there is enough space in the buffer to store a frame

Parameters

frameLength	Integer value, indicates the length of the frame to be stored

Returns

returns true if the bufferSize is larger than frame length otherwise false

5.16.3.3 getFrameFillLevel()

```
int FrameBuffer::getFrameFillLevel ( )
```

Get the number of frames stored in the FrameBuffer

Returns

The integer value number of frames stored in the buffer

5.16.3.4 getFramePriority()

```
int FrameBuffer::getFramePriority ( )
```

Get the priority of a FrameBuffer and thus the stored frame priority

Returns

The integer value priority of a FrameBuffer

5.16.3.5 getNextFrameLength()

```
int FrameBuffer::getNextFrameLength ( )
```

Get the frame length of the first frame in the buffer

Returns

The length of the first frame in the buffer (in byte)

5.16.3.6 popNextFrame()

```
EthernetFrame * FrameBuffer::popNextFrame ( )
```

Remove the first frame of the FrameBuffer. To simulate "first in, first out" (FIFO) frames are only be removed from the front of the buffer

Returns

Pointer to first EthernetFrame in Buffer.

5.16.3.7 pushFrameToBack()

```
void FrameBuffer::pushFrameToBack (
            EthernetFrame * frame )
```

Add a new frame into the FrameBuffer. Frame buffer is similar to a queue. Frames can only be added at the end of the buffer

Parameters

frame	Pointer of EthernetFrame that is added to FrameBuffer

5.16.3.8 updateFreeBufferSize()

```
int FrameBuffer::updateFreeBufferSize (
            bufferUpdate status,
            int frameLength ) [private]
```

Update the number of free space in buffer.

By adding or removing a frame the frame buffer size has to be updated. The frame length of a new arrived frame decreases the buffer size. The frame length of a removed frame increases the buffer size

Parameters

status	Specifies whether a frame is added or removed
frameLength	integer value indicating the added/removed frame length

Returns

integer value of the updated buffer size (in byte)

5.16.4 Member Data Documentation

5.16.4.1 bufferSize

```
int FrameBuffer::bufferSize  [private]
```

5.16.4.2 droppedBytesInBuffer

```
int FrameBuffer::droppedBytesInBuffer  [private]
```

5.16.4.3 droppedBytesVector

```
cOutVector FrameBuffer::droppedBytesVector  [private]
```

5.16.4.4 droppedFramesInBuffer

```
int FrameBuffer::droppedFramesInBuffer  [private]
```

5.16.4.5 droppedFramesVector

```
cOutVector FrameBuffer::droppedFramesVector  [private]
```

5.16.4.6 frameBuffer

```
std::list<EthernetFrame*> FrameBuffer::frameBuffer  [private]
```

One FrameBuffer is implemented as list but acts like a queue (first in, first out)

5.16.4.7 frameNumberInBuffer

```
int FrameBuffer::frameNumberInBuffer  [private]
```

5.16.4.8 frameNumberVector

```
cOutVector FrameBuffer::frameNumberVector  [private]
```

5.16.4.9 framePriority

```
int FrameBuffer::framePriority  [private]
```

5.16.4.10 storedBytesInBuffer

```
int FrameBuffer::storedBytesInBuffer  [private]
```

5.16.4.11 storedBytesVector

```
cOutVector FrameBuffer::storedBytesVector  [private]
```

5.17 FramesLostStatistics Class Reference

```
#include <FramesLostStatistics.h>
```

Public Member Functions

- FramesLostStatistics ()
- virtual ∼FramesLostStatistics ()
- void finish ()
- void addLostFrame (int receiverID, int globalStreamID, int counter)
- void addLostFrameTrace (int receiverID, int globalStreamID, int counter)

Private Attributes

- VectorStatistics2DMap $*$ vectorLostFramesPerStream = 0
- VectorStatistics2DMap $*$ vectorLostFramesTracePerStream = 0
- HistogramStatistics2DMap $*$ histogramLostFramesPerStream = 0

5.17.1 Detailed Description

This class is gathering statistics for the frame loss per streamID As streams are virtual entities (no module) they must be gathered by StatisticManager.

5.17.2 Constructor & Destructor Documentation

5.17.2.1 FramesLostStatistics()

```
FramesLostStatistics::FramesLostStatistics ( )
```

default constructor, nothing to do

5.17.2.2 ∼FramesLostStatistics()

```
FramesLostStatistics::∼FramesLostStatistics ( )  [virtual]
```

default destructor, nothing to do

5.17.3 Member Function Documentation

5.17.3.1 addLostFrame()

```
void FramesLostStatistics::addLostFrame (
             int receiverID,
             int globalStreamID,
             int counter )
```

stores the number of lost frames at the receiver by the stream with streamID

Parameters

receiverID	the end node ID (must be unique)
globalStreamID	the stream ID of the received message
counter	number of lost frames

5.17.3.2 addLostFrameTrace()

```
void FramesLostStatistics::addLostFrameTrace (
             int receiverID,
             int globalStreamID,
             int counter )
```

5.17.3.3 finish()

```
void FramesLostStatistics::finish ( )
```

5.17.4 Member Data Documentation

5.17.4.1 histogramLostFramesPerStream

```
HistogramStatistics2DMap* FramesLostStatistics::histogramLostFramesPerStream = 0  [private]
```

5.17.4.2 vectorLostFramesPerStream

```
VectorStatistics2DMap* FramesLostStatistics::vectorLostFramesPerStream = 0  [private]
```

5.17.4.3 vectorLostFramesTracePerStream

```
VectorStatistics2DMap* FramesLostStatistics::vectorLostFramesTracePerStream = 0  [private]
```

5.18 Frer_ID Struct Reference

```
#include <GlobalMacros.h>
```

Public Attributes

- int port_ids [2]

5.18.1 Member Data Documentation

5.18.1.1 port_ids

```
int Frer_ID::port_ids[2]
```

5.19 HistogramStatistics2DMap Class Reference

```
#include <HistogramStatistics2DMap.h>
```

Public Member Functions

- HistogramStatistics2DMap (const char ∗prefix, const char ∗modulePrefix, const char ∗submodulePrefix)
- virtual ∼HistogramStatistics2DMap ()
- void finish ()
- void addIntegerResult (int moduleID, int submoduleID, int value)
- void addLatency (int moduleID, int submpduleID, simtime_t value)

Private Attributes

- std::map< int, std::map< int, cDoubleHistogram ∗ > ∗ > ∗ storedMeasurements = 0

  histogram containing the stored results
- const char ∗ prefix

  prefix is a string which stores information allowing to indentify the type of statistics which is gathered e.g. E2E latency, packet drop etc.
- const char ∗ modulePrefix

  modulePrefix is a string which denotes the module where statistics are gathered e.g. sink with a selected ID
- const char ∗ submodulePrefix

  submodule is a string which prefix denotes for which component the statistics are gathered, it could be streamID or buffer ID
- const char ∗ valuePrefix

  value prefix is a string allowing to identify the type of stored data

5.19.1 Detailed Description

Helper class used for storing the histogram statistics for objects which do not have physical modules e.g. streams or DDS samples with two parameters describing each entry e.g. moduleID and submoduleID

5.19.2 Constructor & Destructor Documentation

5.19.2.1 HistogramStatistics2DMap()

```
HistogramStatistics2DMap::HistogramStatistics2DMap (
            const char * prefix,
            const char * modulePrefix,
            const char * submodulePrefix )
```

Constructor of the class Stores parameters which will be later used for the creation of the string which is used to identify results.

Parameters

prefix	
modulePrefix	
submodulePrefix	creates the statistic collector
prefix	what name should be addded to the statistic Histogram?
is	this collection using the stream ID or the stream priority

5.19.2.2 ∼HistogramStatistics2DMap()

```
HistogramStatistics2DMap::∼HistogramStatistics2DMap ( )  [virtual]
```

Destructor, nothing to do

5.19.3 Member Function Documentation

5.19.3.1 addIntegerResult()

```
void HistogramStatistics2DMap::addIntegerResult (
             int moduleID,
             int submoduleID,
             int value )
```

Function stores the integer measurement results into the statistics histogram

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. streamID
value	- the measured value, must be an integer

5.19.3.2 addLatency()

```
void HistogramStatistics2DMap::addLatency (
             int moduleID,
             int submoduleID,
             simtime_t value )
```

Function stores the simulation latency measurement results into the statistics histogram

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. streamID
value	- the measured value, must be an simtime_t

stores the given time associated with the switchMAC, portID and priority

5.19.3.3 finish()

```
void HistogramStatistics2DMap::finish ( )
```

Finish function is used to clear & save the statistics at the end of simulation

this calls recordAs on the histograms with the name given in add_simtime/add_int if there are any values stored, delete them (free memory and reset pointers)

5.19.4 Member Data Documentation

5.19.4.1 modulePrefix

```
const char* HistogramStatistics2DMap::modulePrefix  [private]
```

modulePrefix is a string which denotes the module where statistics are gathered e.g. sink with a selected ID

5.19.4.2 prefix

```
const char* HistogramStatistics2DMap::prefix  [private]
```

prefix is a string which stores information allowing to indentify the type of statistics which is gathered e.g. E2E latency, packet drop etc.

5.19.4.3 storedMeasurements

```
std::map<int, std::map<int, cDoubleHistogram*>*>* HistogramStatistics2DMap::storedMeasurements
= 0  [private]
```

histogram containing the stored results

5.19.4.4 submodulePrefix

```
const char* HistogramStatistics2DMap::submodulePrefix  [private]
```

submodule is a string which prefix denotes for which component the statistics are gathered, it could be streamID or buffer ID

5.19.4.5 valuePrefix

```
const char* HistogramStatistics2DMap::valuePrefix  [private]
```

value prefix is a string allowing to identify the type of stored data

5.20 HistogramStatistics3DMap Class Reference

```
#include <HistogramStatistics3DMap.h>
```

Public Member Functions

- HistogramStatistics3DMap (const char ∗prefix, const char ∗modulePrefix, const char ∗submodulePrefix, const char ∗valuePrefix)
- virtual ∼HistogramStatistics3DMap ()
- void finish ()
- void addInteger (int moduleID, int submoduleID, int valueID, int value)
- void addLatency (int moduleID, int submoduleID, int valueID, simtime_t value)
- void addLatency (int moduleID, int submoduleID, int valueID, const std::string &valueIDStr, simtime_t value)

Private Member Functions

- cDoubleHistogram ∗ getEntry (int moduleID, int submoduleID, int valueID)
- cDoubleHistogram ∗ getEntry (int moduleID, int submoduleID, int valueID, const std::string &valueIDStr)

Private Attributes

- const char ∗ prefix = 0

  prefix is a string which stores information allowing to identify the type of statistics which is gathered e.g. E2E latency, packet drop etc.
- const char ∗ modulePrefix = 0

  modulePrefix is a string which denotes the module where statistics are gathered e.g. sink with a selected ID
- const char ∗ submodulePrefix = 0

  submodule is a string which prefix denotes for which component the statistics are gathered, it could be streamID or buffer ID
- const char ∗ valuePrefix = 0

  value prefix is a string allowing to identify the type of stored data
- std::map< int, std::map< int, std::map< int, cDoubleHistogram ∗ > ∗ > ∗ > ∗ storedMeasurements = 0

  histogram containing the stored results, thre dimmensional

Static Private Attributes

- static const std::string empty

  helper variable used when there is no valueID

5.20.1 Detailed Description

Helper class used for storing histogram statistics for objects which do not have physical modules e.g. streams or DDS samples with three parameters describing each entry e.g. moduleID and submoduleID and Value ID for instance port, buffer queue, streamID

5.20.2 Constructor & Destructor Documentation

5.20.2.1 HistogramStatistics3DMap()

```
HistogramStatistics3DMap::HistogramStatistics3DMap (
             const char * prefix,
             const char * modulePrefix,
             const char * submodulePrefix,
             const char * valuePrefix )
```

Constructor of the class Stores parameters which will be later used for the creation of the string which is used to identify results.

Parameters

prefix	
modulePrefix	
submodulePrefix	
valuePrefix	

5.20.2.2 ∼HistogramStatistics3DMap()

```
HistogramStatistics3DMap::∼HistogramStatistics3DMap ( )  [virtual]
```

Destructor, nothing to do

5.20.3 Member Function Documentation

5.20.3.1 addInteger()

```
void HistogramStatistics3DMap::addInteger (
             int moduleID,
             int submoduleID,
             int valueID,
             int value )
```

Function stores the integer measurement results into the statistics histogram

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. bufferID
valueID	- id of the stream/streams for which statistics has been taken e.g. priority, streamID
value	- the measured value, must be an integer

5.20.3.2 addLatency() [1/2]

```
void HistogramStatistics3DMap::addLatency (
            int moduleID,
            int submoduleID,
            int valueID,
            const std::string & valueIDStr,
            simtime_t value )
```

Function stores the integer measurement results into the statistics histogram

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. bufferID
valueID	- id of the stream/streams for which statistics has been taken e.g. priority, streamID
valueIDStr	- substitutes the valueID if defined
value	- the measured value, must be an simtime_t

5.20.3.3 addLatency() [2/2]

```
void HistogramStatistics3DMap::addLatency (
            int moduleID,
            int submoduleID,
            int valueID,
            simtime_t value )
```

Function stores the integer measurement results into the statistics histogram

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. bufferID
valueID	- id of the stream/streams for which statistics has been taken e.g. priority, streamID
value	- the measured value, must be an simtime_t

5.20.3.4 finish()

```
void HistogramStatistics3DMap::finish ( )
```

Finish function is used to clear & save the statistics at the end of simulation

5.20.3.5 getEntry() [1/2]

```
cDoubleHistogram * HistogramStatistics3DMap::getEntry (
            int moduleID,
            int submoduleID,
            int valueID )  [private]
```

Function which returns an entry identified by parameters valueIDStr is defined to be empty

Parameters

moduleID	- module where measurement has been takes e.g. portID
submoduleID-	module for which measurement has been take e.g. bufferID
valueID	- additional parameter e.g. streamID

Returns

5.20.3.6 getEntry() [2/2]

```
cDoubleHistogram* HistogramStatistics3DMap::getEntry (
            int moduleID,
            int submoduleID,
            int valueID,
            const std::string & valueIDStr )  [private]
```

Function which returns an entry identified by parameters

Parameters

moduleID	- module where measurement has been takes e.g. portID
submoduleID-	module for which measurement has been take e.g. bufferID
valueID	- additional parameter e.g. streamID
valueIDStr	- string identification, substitutes valueID if defined

Returns

5.20.4 Member Data Documentation

5.20.4.1 empty

```
const string HistogramStatistics3DMap::empty  [static], [private]
```

helper variable used when there is no valueID

5.20.4.2 modulePrefix

```
const char* HistogramStatistics3DMap::modulePrefix = 0  [private]
```

modulePrefix is a string which denotes the module where statistics are gathered e.g. sink with a selected ID

5.20.4.3 prefix

```
const char* HistogramStatistics3DMap::prefix = 0  [private]
```

prefix is a string which stores information allowing to identify the type of statistics which is gathered e.g. E2E latency, packet drop etc.

5.20.4.4 storedMeasurements

```
std::map<int, std::map<int, std::map<int, cDoubleHistogram*>*>*>* HistogramStatistics3DMap↩
::storedMeasurements = 0  [private]
```

histogram containing the stored results, thre dimmensional

5.20.4.5 submodulePrefix

```
const char* HistogramStatistics3DMap::submodulePrefix = 0  [private]
```

submodule is a string which prefix denotes for which component the statistics are gathered, it could be streamID or buffer ID

5.20.4.6 valuePrefix

```
const char* HistogramStatistics3DMap::valuePrefix = 0  [private]
```

value prefix is a string allowing to identify the type of stored data

5.21 HistorySampleEntry Class Reference

```
#include <HistoryEntry.h>
```

Public Member Functions

- HistorySampleEntry ()
- ∼HistorySampleEntry ()

Public Attributes

- int sampleSize

  Information on sample granularity.
- int sampleSequenceNumber
- int globalStreamId

  The writers global stream ID.
- int readerEntityId
- int readerParticipantEntityId
- int writerEntityId
- int writerParticipantEntityId
- int numberFragments

  Fragment information storage.
- SampleFragment ** sampleFragmentArray
- bool complete

  Evaluation specific.
- bool lifespanExpired

  Invalidates the entry after the lifespan expired.
- bool historySizeExeeded

  Invalidates the entry when too many samples are in the cache.
- bool deadlineViolation

  Deadline violation corresponding to latency budget.
- simtime_t generationTime
- simtime_t writerArrivalTime

  Sample creation time (arrival in RTPS component)
- simtime_t writerFirstInjectionTime

  Injection time of the first rtps message into the network.
- simtime_t subscriberReceiveTime

  Completely received at the reader.
- std::list< simtime_t > rtpsMsgLatencies

  Latencies of the individual rtps_messages.

5.21.1 Detailed Description

Represents a sample in the history cache

5.21.2 Constructor & Destructor Documentation

5.21.2.1 HistorySampleEntry()

```
HistorySampleEntry::HistorySampleEntry ( )  [inline]
```

The default constructor

5.21.2.2 ∼HistorySampleEntry()

```
HistorySampleEntry::∼HistorySampleEntry ( )  [inline]
```

The default destructor

5.21.3 Member Data Documentation

5.21.3.1 complete

```
bool HistorySampleEntry::complete
```

Evaluation specific.

5.21.3.2 deadlineViolation

```
bool HistorySampleEntry::deadlineViolation
```

Deadline violation corresponding to latency budget.

5.21.3.3 generationTime

```
simtime_t HistorySampleEntry::generationTime
```

Statistic related Sample generation time (in generator)

5.21.3.4 globalStreamId

```
int HistorySampleEntry::globalStreamId
```

The writers global stream ID.

5.21.3.5 historySizeExeeded

```
bool HistorySampleEntry::historySizeExeeded
```

Invalidates the entry when too many samples are in the cache.

5.21.3.6 lifespanExpired

```
bool HistorySampleEntry::lifespanExpired
```

Invalidates the entry after the lifespan expired.

5.21.3.7 numberFragments

```
int HistorySampleEntry::numberFragments
```

Fragment information storage.

5.21.3.8 readerEntityId

```
int HistorySampleEntry::readerEntityId
```

5.21.3.9 readerParticipantEntityId

```
int HistorySampleEntry::readerParticipantEntityId
```

5.21.3.10 rtpsMsgLatencies

```
std::list<simtime_t> HistorySampleEntry::rtpsMsgLatencies
```

Latencies of the individual rtps_messages.

5.21.3.11 sampleFragmentArray

```
SampleFragment** HistorySampleEntry::sampleFragmentArray
```

5.21.3.12 sampleSequenceNumber

```
int HistorySampleEntry::sampleSequenceNumber
```

5.21.3.13 sampleSize

```
int HistorySampleEntry::sampleSize
```

Information on sample granularity.

5.21.3.14 subscriberReceiveTime

```
simtime_t HistorySampleEntry::subscriberReceiveTime
```

Completely received at the reader.

5.21.3.15 writerArrivalTime

```
simtime_t HistorySampleEntry::writerArrivalTime
```

Sample creation time (arrival in RTPS component)

5.21.3.16 writerEntityId

```
int HistorySampleEntry::writerEntityId
```

5.21.3.17 writerFirstInjectionTime

```
simtime_t HistorySampleEntry::writerFirstInjectionTime
```

Injection time of the first rtps message into the network.

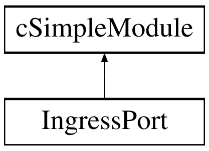
5.21.3.18 writerParticipantEntityId

```
int HistorySampleEntry::writerParticipantEntityId
```

5.22 IngressPort Class Reference

```
#include <IngressPort.h>
```

Inheritance diagram for IngressPort:



Public Member Functions

- IngressPort ()
- virtual ∼IngressPort ()
- void initialize ()
- void handleMessage (cMessage ∗message)

Private Member Functions

- void dealWithInternalMessage (cMessage ∗message)
- void dealWithExternalMessage (cMessage ∗message)
- EthernetFrame ∗ checkAndCastEthernetFrame (cMessage ∗message)
- void dealWithEthernetFrame (EthernetFrame ∗ethernetFrame)

Private Attributes

- int macAddress
- int ingressPortID
- simtime_t sampleTimePeriod
- cMessage ∗ triggerSelf = new cMessage()
- int numBytes
- cOutVector linkUtilizationStatistics

5.22.1 Constructor & Destructor Documentation

5.22.1.1 IngressPort()

```
IngressPort::IngressPort ( )
```

Constructor IngressPort, nothing to do here

Constructor

5.22.1.2 ∼IngressPort()

```
IngressPort::∼IngressPort ( ) [virtual]
```

Destructor IngressPort Cancel and delete self trigger Messages from type cMessage

Destructor

5.22.2 Member Function Documentation

5.22.2.1 checkAndCastEthernetFrame()

```
EthernetFrame ∗ IngressPort::checkAndCastEthernetFrame (
            cMessage ∗ message ) [private]
```

check if incoming Message is an Ethernet Frame and if so return the Frame

Parameters

message	Pointer to type cMessage

Returns

message Pointer of type EthernetFrame

5.22.2.2 dealWithEthernetFrame()

```
void IngressPort::dealWithEthernetFrame (
            EthernetFrame ∗ ethernetFrame ) [private]
```

Sends out the incoming Ethernet Frame

Parameters

message	Pointer of type EthernetFrame

5.22.2.3 dealWithExternalMessage()

```
void IngressPort::dealWithExternalMessage (
            cMessage * message )  [private]
```

deal with incoming external Messages and check if it is an Ethernet Frame

Parameters

message	Pointer of type cMessage

5.22.2.4 dealWithInternalMessage()

```
void IngressPort::dealWithInternalMessage (
            cMessage * message )  [private]
```

deal with internal self Messages Take next snapshot for statistic values if Message is triggerSelf

Parameters

message	Pointer to type cMessage

5.22.2.5 handleMessage()

```
void IngressPort::handleMessage (
            cMessage * message )
```

deal with incoming Messages and select between Messages from outside e.g. Ethernet Messages or self Messages

Parameters

message	Pointer to type cMessage, can be EthernetFrame or self Messages

5.22.2.6 initialize()

```
void IngressPort::initialize (
            void )
```

initialization of variables form ned files Initialize vector for statistics and set self trigger first time

5.22.3 Member Data Documentation

5.22.3.1 ingressPortID

```
int IngressPort::ingressPortID  [private]
```

5.22.3.2 linkUtilizationStatistics

```
cOutVector IngressPort::linkUtilizationStatistics  [private]
```

5.22.3.3 macAddress

```
int IngressPort::macAddress  [private]
```

5.22.3.4 numBytes

```
int IngressPort::numBytes  [private]
```

5.22.3.5 sampleTimePeriod

```
simtime_t IngressPort::sampleTimePeriod  [private]
```

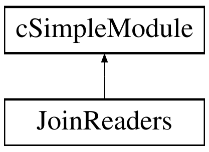
5.22.3.6 triggerSelf

```
cMessage* IngressPort::triggerSelf = new cMessage()  [private]
```

5.23 JoinReaders Class Reference

`#include <JoinReaders.h>`

Inheritance diagram for JoinReaders:



Public Member Functions

- JoinReaders ()
- virtual ∼JoinReaders ()

Protected Member Functions

- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override
- virtual void finish () override

5.23.1 Detailed Description

Implementation of a join. All input messages are directly forwarded to the single output.

5.23.2 Constructor & Destructor Documentation

5.23.2.1 JoinReaders()

```
JoinReaders::JoinReaders ( )  [inline]
```

The default constructor.

5.23.2.2 ∼JoinReaders()

```
JoinReaders::∼JoinReaders ( )  [virtual]
```

The default destructor

5.23.3 Member Function Documentation

5.23.3.1 finish()

```
void JoinReaders::finish ( )  [override], [protected], [virtual]
```

Nothing to do after finishing.

5.23.3.2 handleMessage()

```
void JoinReaders::handleMessage (
            cMessage * msg )  [override], [protected], [virtual]
```

5.23.3.3 initialize()

```
void JoinReaders::initialize ( )  [override], [protected], [virtual]
```

Nothing to initialize here.

5.24 LinkTransmissionStatistics Class Reference

```
#include <LinkTransmissionStatistics.h>
```

Public Member Functions

- LinkTransmissionStatistics ()
- virtual ∼LinkTransmissionStatistics ()
- void finish ()
- void ethernetFrameStartedSending (int switchMAC, int portIndex, int streamID)
- void ethernetFrameFinishedSending (int switchMAC, int portIndex, int streamID)

Private Attributes

- VectorStatistics3DMap ∗ activationPeriod = 0

5.24.1 Detailed Description

The statistic LinkTransmissionStatistic records the transmission time from one module to the next module.

5.24.2 Constructor & Destructor Documentation

5.24.2.1 LinkTransmissionStatistics()

```
LinkTransmissionStatistics::LinkTransmissionStatistics ( )
```

default constructor, nothing to do here

5.24.2.2 ∼LinkTransmissionStatistics()

```
LinkTransmissionStatistics::∼LinkTransmissionStatistics ( )  [virtual]
```

default destructor, nothing to do here

5.24.3 Member Function Documentation

5.24.3.1 ethernetFrameFinishedSending()

```
void LinkTransmissionStatistics::ethernetFrameFinishedSending (
             int switchMAC,
             int portIndex,
             int streamID )
```

An Ethernet frame has finished its transmission (between two modules)

It records the finishing time when an Ethernet frame start its transmission at a given port on a given switch with a given streamID. First a 0 is stored and then a 1. This is done to receive a right angle in result output.

Parameters

switchMAC	integer value of the switch MAC address to identifies the switch
portIndex	integer value of a specific port in the switch.
streamID	integer value of the streamID which identifies the Ethernet frame

5.24.3.2 ethernetFrameStartedSending()

```
void LinkTransmissionStatistics::ethernetFrameStartedSending (
             int switchMAC,
             int portIndex,
             int streamID )
```

An Ethernet frame has started its transmission (between two modules)

It records the start time when an Ethernet frame start its transmission at a given port on a given switch with a given streamID. First a 0 is stored and then a 1. This is done to receive a right angle in result output.

Parameters

switchMAC	integer value of the switch MAC address to identifies the switch
portIndex	integer value of a specific port in the switch.
streamID	integer value of the streamID which identifies the Ethernet frame

5.24.3.3 finish()

```
void LinkTransmissionStatistics::finish ( )
```

is called by finishing the simulation.

5.24.4 Member Data Documentation

5.24.4.1 activationPeriod

```
VectorStatistics3DMap* LinkTransmissionStatistics::activationPeriod = 0  [private]
```

5.25 lostFrameCounter Struct Reference

```
#include <GlobalMacros.h>
```

Public Attributes

- int newestFrameID
- std::unordered_set< int > lostFrames

5.25.1 Member Data Documentation

5.25.1.1 lostFrames

```
std::unordered_set<int> lostFrameCounter::lostFrames
```

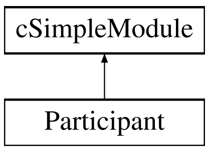
5.25.1.2 newestFrameID

```
int lostFrameCounter::newestFrameID
```

5.26 Participant Class Reference

```
#include <Participant.h>
```

Inheritance diagram for Participant:



Public Member Functions

- Participant ()
- virtual ∼Participant ()

Protected Member Functions

- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override
- virtual void finish () override

Private Attributes

- int participantId

  The globally unique ID of the participant.
- int nbrWriters

  Store the number of reader and writer locally.
- int nbrReaders
- int ∗ writerIds

  Registry for reader IDs to gate-index mappings.
- int ∗ readerIds

  Registry for writer IDs to gate-index mappings.

5.26.1 Detailed Description

Dispatches the messages and pass them either to the correct reader/writer for receiving or to the shaper for sending

5.26.2 Constructor & Destructor Documentation

5.26.2.1 Participant()

```
Participant::Participant ( )  [inline]
```

Default constructor

5.26.2.2 ∼Participant()

```
Participant::∼Participant ( )  [virtual]
```

Default destructor

5.26.3 Member Function Documentation

5.26.3.1 finish()

```
void Participant::finish ( )  [override], [protected], [virtual]
```

Deletes all stored context

5.26.3.2 handleMessage()

```
void Participant::handleMessage (
             cMessage * msg )  [override], [protected], [virtual]
```

Handles and dispatches (forwards) incoming messages

Parameters

msg	The incoming msg to forward, based on its origin and content

5.26.3.3 initialize()

```
void Participant::initialize ( )  [override], [protected], [virtual]
```

Initialization to load the module parameters

5.26.4 Member Data Documentation

5.26.4.1 nbrReaders

```
int Participant::nbrReaders  [private]
```

5.26.4.2 nbrWriters

```
int Participant::nbrWriters  [private]
```

Store the number of reader and writer locally.

5.26.4.3 participantId

```
int Participant::participantId  [private]
```

The globally unique ID of the participant.

5.26.4.4 readerIds

```
int* Participant::readerIds  [private]
```

Registry for writer IDs to gate-index mappings.

5.26.4.5 writerIds

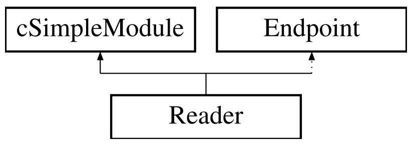
```
int* Participant::writerIds  [private]
```

Registry for reader IDs to gate-index mappings.

5.27 Reader Class Reference

```
#include <Reader.h>
```

Inheritance diagram for Reader:



Public Member Functions

- Reader ()
- virtual ∼Reader ()

Protected Member Functions

- virtual void finish () override
- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override
- void registerReader ()
- std::list< HistorySampleEntry ∗ > ∗ getCache (int sourceParticipantId, int writerId)
- void updateCache (RTPSEthMessage ∗rtpsMsg, std::list< HistorySampleEntry ∗ > ∗historyCache)
- bool relevantNewSample (int sequenceNumber, int writerEntityId, int sourceParticipantId, std::list< HistorySampleEntry ∗ > ∗historyCache)
- void insertSampleInCache (HistorySampleEntry ∗sample)
- void checkCompletion (std::list< HistorySampleEntry ∗ > ∗historyCache)
- void checkLifespan (std::list< HistorySampleEntry ∗ > ∗historyCache)
- void cleanHistoryCache (std::list< HistorySampleEntry ∗ > ∗historyCache)
- void sendSampleToSink (HistorySampleEntry ∗entry)

Private Attributes

- cMessage ∗ registerEvent

  Self message to register the reader at the participant.
- int historySizeQoS

  The size of the history cache.
- bool bestEffort

  Configuration of best effort or reliable communication.
- simtime_t lifespan

  The lifespan of the samples.
- simtime_t deadline

  The deadline of the samples.
- int transportPriority

  The transport priority QoS parameter.
- ReaderHistory ∗ readerHistoryCache

  The history cache.
- cHistogram SampleLatencySinceGenerationStat

  Histogram for sample Latency from sample generation.
- cOutVector SampleLatencySinceGenerationStatVec

  Vector for sample Latency from sample generation.
- cHistogram SampleLatencySinceWriterArrivalStat

  Histogram for sample Latency from arrival at writer.
- cOutVector SampleLatencySinceWriterArrivalStatVec

  Vector for sample Latency from arrival at writer.
- cHistogram SampleLatencySinceSampleInjectionStat

  Histogram for sample Latency from first network injection of the first packet.
- cOutVector SampleLatencySinceSampleInjectionStatVec

  Vector for sample Latency from first network injection of the first packet.
- cHistogram frameLatencyInjectionToReception

  Frame network latency histogram.

- cOutVector frameLatencyInjectionToReceptionVec

  Frame network latency vector.
- int sourceMac

  The own MAC address.
- int entityId

  The own endity ID.
- int streamEthernetPriority

  The Ethernet Priority.

Additional Inherited Members

5.27.1 Detailed Description

The RTPS Reader entity subscribes to remote writers and delivers completely received samples to the application/sink

5.27.2 Constructor & Destructor Documentation

5.27.2.1 Reader()

```
Reader::Reader ( )  [inline]
```

The default constructor

5.27.2.2 ∼Reader()

```
Reader::∼Reader ( )  [virtual]
```

The default destructor

5.27.3 Member Function Documentation

5.27.3.1 checkCompletion()

```
void Reader::checkCompletion (
            std::list< HistorySampleEntry * > * historyCache )  [protected]
```

Check all samples in the cache corresponding to a writer for completion.

Parameters

historyCache	The history Cache for which all samples are checked for completion.

5.27.3.2 checkLifespan()

```
void Reader::checkLifespan (
            std::list< HistorySampleEntry * > * historyCache )  [protected]
```

Check the lifespan of all samples in the cache corresponding to a writer.

Parameters

historyCache	The history Cache for which all samples are checked for lifespan expiration.

5.27.3.3 cleanHistoryCache()

```
void Reader::cleanHistoryCache (
            std::list< HistorySampleEntry * > * historyCache )  [protected]
```

Remove samples from the history cache after its maximum size has been exeeded.

Parameters

historyCache	The history cache to clean from completed, or exceeded entries.

5.27.3.4 finish()

```
void Reader::finish ( )  [override], [protected], [virtual]
```

Record the histograms here.

5.27.3.5 getCache()

```
std::list< HistorySampleEntry * > * Reader::getCache (
            int sourceParticipantId,
            int writerId )  [protected]
```

Get the partial history Cache corresponding to the referenced writer

Parameters

source↩ ParticiapntId	The ID of the participant related to the writer.
writerId	The ID of the writer itself. @ret Returns the cache corresponding to the specified unique writer.

5.27.3.6 handleMessage()

```
void Reader::handleMessage (
            cMessage * msg )  [override], [protected], [virtual]
```

Handles incoming messages

Parameters

msg	Receives RTPSEthMessages and evaluates them.

5.27.3.7 initialize()

```
void Reader::initialize ( )  [override], [protected], [virtual]
```

Initialize all relevant parameters and register the reader at the participant.

5.27.3.8 insertSampleInCache()

```
void Reader::insertSampleInCache (
            HistorySampleEntry * sample )  [protected]
```

Inserts a sample to the correct place in the cache (ordered by the sequence number).

Parameters

sample	The sample to be placed.

5.27.3.9 registerReader()

```
void Reader::registerReader ( )  [protected]
```

Register the reader at the participant for message dispatching.

5.27.3.10 relevantNewSample()

```
bool Reader::relevantNewSample (
            int sequenceNumber,
            int writerEntityId,
            int sourceParticipantId,
            std::list< HistorySampleEntry * > * historyCache ) [protected]
```

Checks if the received RTPS message contains data from a sample which is not yet stored in the cache

Parameters

sequenceNumber	The sequence number of the received sample.
writerEntityId	The entity ID of the samples writer.
source↩ ParticipantId	The ID of the participant the sample writer is placed in.
historyCache	The history Cache related to the samples writer at the reader. @ret True if the sample is relevant.

5.27.3.11 sendSampleToSink()

```
void Reader::sendSampleToSink (
            HistorySampleEntry * entry ) [protected]
```

Creates a sample message from the completed sample Entry and sends it to the sample sink.

Parameters

entry	The sample entry to convert to a sample message.

5.27.3.12 updateCache()

```
void Reader::updateCache (
            RTPSEthMessage * rtpsMsg,
            std::list< HistorySampleEntry * > * historyCache ) [protected]
```

Update the cache after receiving a new RTPS message

Parameters

rtpsMsg	The received RTPS message to be to update the corresponding cache with.
historyChache	The cache to update.

5.27.4 Member Data Documentation

5.27.4.1 bestEffort

```
bool Reader::bestEffort  [private]
```

Configuration of best effort or reliable communication.

5.27.4.2 deadline

```
simtime_t Reader::deadline  [private]
```

The deadline of the samples.

5.27.4.3 entityId

```
int Reader::entityId  [private]
```

The own endity ID.

5.27.4.4 frameLatencyInjectionToReception

```
cHistogram Reader::frameLatencyInjectionToReception  [private]
```

Frame network latency histogram.

5.27.4.5 frameLatencyInjectionToReceptionVec

```
cOutVector Reader::frameLatencyInjectionToReceptionVec  [private]
```

Frame network latency vector.

5.27.4.6 historySizeQoS

```
int Reader::historySizeQoS  [private]
```

The size of the history cache.

5.27.4.7 lifespan

```
simtime_t Reader::lifespan  [private]
```

The lifespan of the samples.

5.27.4.8 readerHistoryCache

```
ReaderHistory* Reader::readerHistoryCache  [private]
```

The history cache.

5.27.4.9 registerEvent

```
cMessage* Reader::registerEvent  [private]
```

Self message to register the reader at the participant.

5.27.4.10 SampleLatencySinceGenerationStat

```
cHistogram Reader::SampleLatencySinceGenerationStat  [private]
```

Histogram for sample Latency from sample generation.

5.27.4.11 SampleLatencySinceGenerationStatVec

```
cOutVector Reader::SampleLatencySinceGenerationStatVec  [private]
```

Vector for sample Latency from sample generation.

5.27.4.12 SampleLatencySinceSampleInjectionStat

```
cHistogram Reader::SampleLatencySinceSampleInjectionStat  [private]
```

Histogram for sample Latency from first network injection of the first packet.

5.27.4.13 SampleLatencySinceSampleInjectionStatVec

```
cOutVector Reader::SampleLatencySinceSampleInjectionStatVec  [private]
```

Vector for sample Latency from first network injection of the first packet.

5.27.4.14 SampleLatencySinceWriterArrivalStat

```
cHistogram Reader::SampleLatencySinceWriterArrivalStat  [private]
```

Histogram for sample Latency from arrival at writer.

5.27.4.15 SampleLatencySinceWriterArrivalStatVec

```
cOutVector Reader::SampleLatencySinceWriterArrivalStatVec  [private]
```

Vector for sample Latency from arrival at writer.

5.27.4.16 sourceMac

```
int Reader::sourceMac  [private]
```

The own MAC address.

5.27.4.17 streamEthernetPriority

```
int Reader::streamEthernetPriority  [private]
```

The Ethernet Priority.

5.27.4.18 transportPriority

```
int Reader::transportPriority  [private]
```

The transport priority QoS parameter.

5.28 ReaderHistory Class Reference

```
#include <HistoryEntry.h>
```

Public Member Functions

- ReaderHistory (int size)
- ∼ReaderHistory ()

Public Attributes

- int nbrStreams

  Number of incoming streams.
- int maxNbrStreams

  The maximum history size (maximum number of writers to subscribe)
- std::list< HistorySampleEntry ∗ > ∗∗ cache

  The cache.

5.28.1 Detailed Description

This class represents the history cache for the reader, which can subscribe to multiple writer streams

5.28.2 Constructor & Destructor Documentation

5.28.2.1 ReaderHistory()

```
ReaderHistory::ReaderHistory (
            int size )  [inline]
```

The constructor

@ param size Initializes the history with a given size

5.28.2.2 ∼ReaderHistory()

```
ReaderHistory::∼ReaderHistory ( )  [inline]
```

The default constructor

5.28.3 Member Data Documentation

5.28.3.1 cache

```
std::list<HistorySampleEntry*>** ReaderHistory::cache
```

The cache.

5.28.3.2 maxNbrStreams

```
int ReaderHistory::maxNbrStreams
```

The maximum history size (maximum number of writers to subscribe)

5.28.3.3 nbrStreams

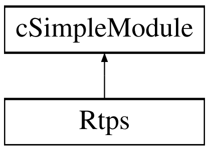
```
int ReaderHistory::nbrStreams
```

Number of incoming streams.

5.29 Rtps Class Reference

```
#include <Rtps.h>
```

Inheritance diagram for Rtps:



Public Member Functions

- Rtps ()
- virtual ~Rtps ()

Protected Member Functions

- virtual void initialize () override

5.29.1 Detailed Description

The module containing the RTPS entities

5.29.2 Constructor & Destructor Documentation

5.29.2.1 Rtps()

```
Rtps::Rtps ( )  [inline]
```

The default constructor

5.29.2.2 ∼Rtps()

```
Rtps::∼Rtps ( )  [virtual]
```

The default destructor

5.29.3 Member Function Documentation

5.29.3.1 initialize()

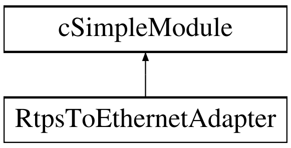
```
void Rtps::initialize ( )  [override], [protected], [virtual]
```

The default initialization method

5.30 RtpsToEthernetAdapter Class Reference

```
#include <RtpsToEthernetAdapter.h>
```

Inheritance diagram for RtpsToEthernetAdapter:



Public Member Functions

- RtpsToEthernetAdapter ()
- virtual ∼RtpsToEthernetAdapter ()

Public Attributes

- unsigned long long frameSequenceId

  Frame sequence ID counter for unique frame identification of the middleware.

Protected Member Functions

- void sendRtpsPacket (RTPSEthMessage ∗packet)
- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override
- virtual void finish () override
- unsigned long long getNextFrameSequenceId ()

5.30.1 Detailed Description

The adapter fills the EthernetFrame parameters to the RTPSEthMessage, from which it is derived.

5.30.2 Constructor & Destructor Documentation

5.30.2.1 RtpsToEthernetAdapter()

```
RtpsToEthernetAdapter::RtpsToEthernetAdapter ( )
```

Default constructor

5.30.2.2 ∼RtpsToEthernetAdapter()

```
RtpsToEthernetAdapter::∼RtpsToEthernetAdapter ( )  [virtual]
```

Default destructor

5.30.3 Member Function Documentation

5.30.3.1 finish()

```
void RtpsToEthernetAdapter::finish ( )  [override], [protected], [virtual]
```

Returns the number of send frames

5.30.3.2 getNextFrameSequenceId()

```
unsigned long long RtpsToEthernetAdapter::getNextFrameSequenceId ( )  [protected]
```

Return and increment the frame sequence ID

5.30.3.3 handleMessage()

```
void RtpsToEthernetAdapter::handleMessage (
             cMessage * msg )  [override], [protected], [virtual]
```

Initializes the relevant context of the derived EthernetFrame to the packet.

Parameters

msg	represents the outgoing msg to adapt for EthernetFrame compliance.

5.30.3.4 initialize()

```
void RtpsToEthernetAdapter::initialize ( )  [override], [protected], [virtual]
```

Empty initialization

5.30.3.5 sendRtpsPacket()

```
void RtpsToEthernetAdapter::sendRtpsPacket (
             RTPSEthMessage * packet )  [protected]
```

Put the information from the middleware to configure the Ethernet message.

Parameters

packet	the outgoing packet to send and to configure for Ethernet transmission.

5.30.4 Member Data Documentation

5.30.4.1 frameSequenceId

```
unsigned long long RtpsToEthernetAdapter::frameSequenceId
```

Frame sequence ID counter for unique frame identification of the middleware.

5.31 SampleFragment Class Reference

```
#include <HistoryEntry.h>
```

Public Member Functions

- SampleFragment ()
- ∼SampleFragment ()

Public Attributes

- int fragmentSequenceNumber

  The fragment sequence number.
- int fragmentSize

  The size of the fragment.
- HistorySampleEntry ∗ sampleReference

  Reference to the corresponding sample.
- bool send

  True if the fragment has already been send and has not been negatively acknowledged (writer side)
- bool acked

  True if the fragment has been positively acknowledged (writer side)
- bool received

  True if the fragment has been received (reader side)
- simtime_t sendTime

  The last time the fragment was send by the writer.

5.31.1 Detailed Description

Represents a fragment and stores its send/receive state

5.31.2 Constructor & Destructor Documentation

5.31.2.1 SampleFragment()

```
SampleFragment::SampleFragment ( )  [inline]
```

The default constructor

5.31.2.2 ∼SampleFragment()

```
SampleFragment::∼SampleFragment ( ) [inline]
```

The default destructor

5.31.3 Member Data Documentation

5.31.3.1 acked

```
bool SampleFragment::acked
```

True if the fragment has been positively acknowledged (writer side)

5.31.3.2 fragmentSequenceNumber

```
int SampleFragment::fragmentSequenceNumber
```

The fragment sequence number.

5.31.3.3 fragmentSize

```
int SampleFragment::fragmentSize
```

The size of the fragment.

5.31.3.4 received

```
bool SampleFragment::received
```

True if the fragment has been received (reader side)

5.31.3.5 sampleReference

```
HistorySampleEntry∗ SampleFragment::sampleReference
```

Reference to the corresponding sample.

5.31.3.6 send

```
bool SampleFragment::send
```

True if the fragment has already been send and has not been negatively acknowledged (writer side)

5.31.3.7 sendTime

```
simtime_t SampleFragment::sendTime
```

The last time the fragment was send by the writer.

5.32 SampleLatencyStatistics Class Reference

```
#include <ddsSampleLatencyStatistics.h>
```

Public Member Functions

- SampleLatencyStatistics ()
- virtual ~SampleLatencyStatistics ()
- void addMessage (int participantId, int readerId, int globalStreamId, simtime_t delay)
- void report (const omnetpp::simtime_t &latency, int participantId, int readerId, int globalStreamId)
- void finish ()

Private Attributes

- VectorStatistics3DMap ∗ sampleLatencyStatisticsVector = nullptr
- HistogramStatistics3DMap ∗ sampleLatencyStatisticsHistogram = nullptr

5.32.1 Detailed Description

This class is gathering E2E latency statistics per DDS samples As DDS samples are virtual entities (no module) they must be gathered by StatisticManager.

5.32.2 Constructor & Destructor Documentation

5.32.2.1 SampleLatencyStatistics()

```
SampleLatencyStatistics::SampleLatencyStatistics ( )
```

default constructor, nothing to do

5.32.2.2 ∼SampleLatencyStatistics()

```
SampleLatencyStatistics::∼SampleLatencyStatistics ( )  [virtual]
```

default destructor, nothing to do

Destructor.

5.32.3 Member Function Documentation

5.32.3.1 addMessage()

```
void SampleLatencyStatistics::addMessage (
            int participantId,
            int readerId,
            int globalStreamId,
            simtime_t delay )
```

stores the end to end statistics for the samples

Parameters

participantId	- DDS participant ID
readerId	- DDS reader ID
global↩ StreamId	- id of the stream
delay	- end to end latency for the sample

5.32.3.2 finish()

```
void SampleLatencyStatistics::finish ( )
```

Finishes statistics gathering for End-2-End latencies Vectors will be deleted Histograms: are firstly recorded (save to file) and next deleted

5.32.3.3 report()

```
void SampleLatencyStatistics::report (
            const omnetpp::simtime_t & latency,
            int participantId,
            int readerId,
            int globalStreamId )
```

Stores the results into the vectors Helper function

Parameters

latency	
participantId	
readerId	
global←↩ StreamId	

5.32.4 Member Data Documentation

5.32.4.1 sampleLatencyStatisticsHistogram

```
HistogramStatistics3DMap* SampleLatencyStatistics::sampleLatencyStatisticsHistogram = nullptr
[private]
```

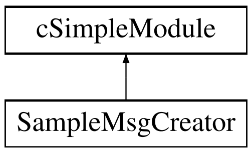
5.32.4.2 sampleLatencyStatisticsVector

```
VectorStatistics3DMap* SampleLatencyStatistics::sampleLatencyStatisticsVector = nullptr  [private]
```

5.33 SampleMsgCreator Class Reference

```
#include <SampleMsgCreator.h>
```

Inheritance diagram for SampleMsgCreator:



Public Member Functions

- SampleMsgCreator ()
- virtual ∼SampleMsgCreator ()

Protected Member Functions

- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override
- virtual void finish () override
- int64_t getNextSampleSequenceNumberId ()

Protected Attributes

- int64_t sampleSequenceNumberId

    The frame sequence ID unique for a given globalStreamId.

5.33.1 Detailed Description

Create and forwards an RTPS sample after stimulation from a source module

5.33.2 Constructor & Destructor Documentation

5.33.2.1 SampleMsgCreator()

```
SampleMsgCreator::SampleMsgCreator ( )
```

Empty default constructor

5.33.2.2 ∼SampleMsgCreator()

```
SampleMsgCreator::∼SampleMsgCreator ( )  [virtual]
```

Empty default destructor

5.33.3 Member Function Documentation

5.33.3.1 finish()

```
void SampleMsgCreator::finish ( )  [override], [protected], [virtual]
```

Overridden method, called at the end of the simulation

5.33.3.2 getNextSampleSequenceNumberId()

```
int64_t SampleMsgCreator::getNextSampleSequenceNumberId ( )  [inline], [protected]
```

Calculates the unique sequence number of the writer streams samples.

5.33.3.3 handleMessage()

```
void SampleMsgCreator::handleMessage (
             cMessage * msg )  [override], [protected], [virtual]
```

Overridden method, triggered by a traffic source and creates one Sample each time it is called. The sample is then passed to the middleware.

Parameters

msg	Each incoming message is interpreted as a stimulation

5.33.3.4 initialize()

```
void SampleMsgCreator::initialize ( )  [override], [protected], [virtual]
```

Overwritten method, initializes module after its creation.

5.33.4 Member Data Documentation

5.33.4.1 sampleSequenceNumberId

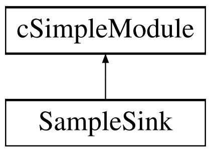
```
int64_t SampleMsgCreator::sampleSequenceNumberId  [protected]
```

The frame sequence ID unique for a given globalStreamId.

5.34 SampleSink Class Reference

```
#include <SampleSink.h>
```

Inheritance diagram for SampleSink:



Protected Member Functions

- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override

Private Attributes

- int myMac

  One MAC Address of the Endpoint.

5.34.1 Detailed Description

SampleSink that gathers statistics for incoming samples.

5.34.2 Member Function Documentation

5.34.2.1 handleMessage()

```
void SampleSink::handleMessage (
             cMessage * msg )  [override], [protected], [virtual]
```

Handles incoming messages

Parameters

msg	The incoming sample

5.34.2.2 initialize()

```
void SampleSink::initialize ( )  [override], [protected], [virtual]
```

5.34.3 Member Data Documentation

5.34.3.1 myMac

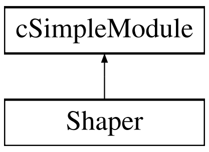
```
int SampleSink::myMac  [private]
```

One MAC Address of the Endpoint.

5.35 Shaper Class Reference

```
#include <Shaper.h>
```

Inheritance diagram for Shaper:



Public Member Functions

- Shaper ()
- virtual ∼Shaper ()

Protected Member Functions

- void send_from_queue ()
- virtual void finish () override
- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override

Private Attributes

- bool shaperEnabled

  Enable/Disable the shaper.
- simtime_t shapingDuration

  Duration of shaping, i.e. the time between two consecutive shaped messages.
- cMessage ∗ nextMsgReady
- std::list< RTPSEthMessage ∗ > rtpsMsgQueue

5.35.1 Constructor & Destructor Documentation

5.35.1.1 Shaper()

```
Shaper::Shaper ( )  [inline]
```

Default constructor

5.35.1.2 ∼Shaper()

```
Shaper::∼Shaper ( )  [virtual]
```

Default destructor

5.35.2 Member Function Documentation

5.35.2.1 finish()

```
void Shaper::finish ( )  [override], [protected], [virtual]
```

5.35.2.2 handleMessage()

```
void Shaper::handleMessage (
             cMessage * msg )  [override], [protected], [virtual]
```

5.35.2.3 initialize()

```
void Shaper::initialize ( )  [override], [protected], [virtual]
```

5.35.2.4 send_from_queue()

```
void Shaper::send_from_queue ( )  [protected]
```

Send the message from the queue

5.35.3 Member Data Documentation

5.35.3.1 nextMsgReady

```
cMessage* Shaper::nextMsgReady  [private]
```

5.35.3.2 rtpsMsgQueue

```
std::list<RTPSEthMessage*> Shaper::rtpsMsgQueue  [private]
```

5.35.3.3 shaperEnabled

```
bool Shaper::shaperEnabled  [private]
```

Enable/Disable the shaper.

5.35.3.4 shapingDuration

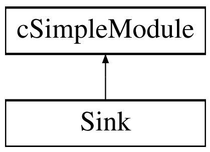
```
simtime_t Shaper::shapingDuration [private]
```

Duration of shaping, i.e. the time between two consecutive shaped messages.

5.36 Sink Class Reference

```
#include <Sink.h>
```

Inheritance diagram for Sink:



Protected Member Functions

- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override

Private Member Functions

- virtual bool checkDestinationsMAC (EthernetFrame ∗ethMsg)

    check if frame arrived to the correct destination based on MAC
- void processEthernetFrameAtDestination (EthernetFrame ∗ethMsg)

    gather end2end latency and return error if latency is negative
- void checkForMissingFrame (EthernetFrame ∗ethMsg)

    check if there are lost frames evntl. gather statistics
- void finish ()

    finishing statistics gathering

Private Attributes

- int macAddress

    MAC address of the sink.
- std::map< int, int > lostFrameCounters

    counter used to track lost frames
- std::map< int, int > trackMissingDataMap

    here we check whether all data was delivered

5.36.1 Detailed Description

Sink module for the Ethernet frames (which are send directly without the DDS) Mainly used to gathers statistics.

5.36.2 Member Function Documentation

5.36.2.1 checkDestinationsMAC()

```
bool Sink::checkDestinationsMAC (
            EthernetFrame * ethMsg )  [inline], [private], [virtual]
```

check if frame arrived to the correct destination based on MAC

5.36.2.2 checkForMissingFrame()

```
void Sink::checkForMissingFrame (
            EthernetFrame * ethMsg )  [private]
```

check if there are lost frames evntl. gather statistics

5.36.2.3 finish()

```
void Sink::finish ( )  [private]
```

finishing statistics gathering

5.36.2.4 handleMessage()

```
void Sink::handleMessage (
            cMessage * msg )  [override], [protected], [virtual]
```

Casts the msg to the EthernetFrame and processes it.

Parameters

msg	

5.36.2.5 initialize()

```
void Sink::initialize ( )  [override], [protected], [virtual]
```

Constructor

5.36.2.6 processEthernetFrameAtDestination()

```
void Sink::processEthernetFrameAtDestination (
             EthernetFrame * ethMsg )  [private]
```

gather end2end latency and return error if latency is negative

5.36.3 Member Data Documentation

5.36.3.1 lostFrameCounters

```
std::map<int, int> Sink::lostFrameCounters  [private]
```

counter used to track lost frames

5.36.3.2 macAddress

```
int Sink::macAddress  [private]
```

MAC address of the sink.

5.36.3.3 trackMissingDataMap

```
std::map<int, int> Sink::trackMissingDataMap  [private]
```

here we check whether all data was delivered

5.37 StatisticManager Class Reference

```
#include <StatisticManager.h>
```

Public Member Functions

- virtual ∼StatisticManager ()
- E2ELatencyStatistics * getDelayStatistics ()
- FramesLostStatistics * getFramesLostStatistics ()
- SampleLatencyStatistics * getSampleLatencyStatistics ()
- LinkTransmissionStatistics * getLinkTransmissionStatistics ()
- TimeAwareShaperSegmentStatistic * getTimeAwareShaperStatistics ()
- virtual void finishAll ()

Static Public Member Functions

- static StatisticManager & getInstance ()

Private Member Functions

- StatisticManager ()

  this is singleton, make constructor private

Private Attributes

- bool hasFinishedAll = false

  variable to indicate if running finish will be necessary
- E2ELatencyStatistics ∗ pathDelayStats = 0

  object to store E2E latencies
- FramesLostStatistics ∗ framesLostStats = 0

  object to store lost frames statistics
- SampleLatencyStatistics ∗ sampleLatencyStats = 0

  object to store DDS samples latencies
- LinkTransmissionStatistics ∗ linkTransmission = 0

  object to store link transmission statistics
- TimeAwareShaperSegmentStatistic ∗ tsnTASStatistics

  object to store TAS statistics

5.37.1 Detailed Description

StatisticManager introduces an virtual module for statistic gathering. It is necessary whenever we are gathering statistics for entities which does not have representation in form of an Omnet++ module. For instance, DDS samples from specific reader/writer pairs, or latencies for particular stream. Omnet++ does not support such statistics natively as framework was oriented towards average / performanced optimized results.

5.37.2 Constructor & Destructor Documentation

5.37.2.1 ∼StatisticManager()

```
StatisticManager::∼StatisticManager ( )  [virtual]
```

Desctructor, should stay empty

5.37.2.2 StatisticManager()

```
StatisticManager::StatisticManager ( )  [private]
```

this is singleton, make constructor private

5.37.3 Member Function Documentation

5.37.3.1 finishAll()

```
void StatisticManager::finishAll ( ) [virtual]
```

finishes off all individual collections (see individual functions), frees memory and resets pointer

5.37.3.2 getDelayStatistics()

```
E2ELatencyStatistics * StatisticManager::getDelayStatistics ( )
```

Function to return an object storing the delay statistics. The statistics are stored for End-2-End communication within the network. If an object does not exist it declares a new one.

Returns

5.37.3.3 getFramesLostStatistics()

```
FramesLostStatistics * StatisticManager::getFramesLostStatistics ( )
```

Function to return an object storing the lost frames statistics. If an object does not exist it declares a new one.

Returns

5.37.3.4 getInstance()

```
static StatisticManager& StatisticManager::getInstance ( ) [inline], [static]
```

Returns the singleton instance of the collector, which allows to gather statistics from different simulation modules in one object.

5.37.3.5 getLinkTransmissionStatistics()

```
LinkTransmissionStatistics * StatisticManager::getLinkTransmissionStatistics ( )
```

Function to return an object storing the transmission time of an Ethernet frame from one module to the next module.

Returns

5.37.3.6 getSampleLatencyStatistics()

```
SampleLatencyStatistics * StatisticManager::getSampleLatencyStatistics ( )
```

Function to return an object storing the latency of whole DDS samples. Note, that each sample may be constructed from multiple frames. If an object does not exist it declares a new one.

Returns

5.37.3.7 getTimeAwareShaperStatistics()

```
TimeAwareShaperSegmentStatistic * StatisticManager::getTimeAwareShaperStatistics ( )
```

Function to return an object of the time aware shaper (TAS) segments. The period of TAS is divided in four segments. For evaluation these segments are represented as statistics.

5.37.4 Member Data Documentation

5.37.4.1 framesLostStats

```
FramesLostStatistics* StatisticManager::framesLostStats = 0  [private]
```

object to store lost frames statistics

5.37.4.2 hasFinishedAll

```
bool StatisticManager::hasFinishedAll = false  [private]
```

variable to indicate if running finish will be necessary

5.37.4.3 linkTransmission

```
LinkTransmissionStatistics* StatisticManager::linkTransmission = 0  [private]
```

object to store link transmission statistics

5.37.4.4 pathDelayStats

```
E2ELatencyStatistics* StatisticManager::pathDelayStats = 0  [private]
```

object to store E2E latencies

5.37.4.5 sampleLatencyStats

```
SampleLatencyStatistics* StatisticManager::sampleLatencyStats = 0  [private]
```

object to store DDS samples latencies

5.37.4.6 tsnTASStatistics

```
TimeAwareShaperSegmentStatistic* StatisticManager::tsnTASStatistics  [private]
```

object to store TAS statistics

5.38 TimeAwareShaperSegmentStatistic Class Reference

```
#include <TimeAwareShaperSegmentStatistic.h>
```

Public Member Functions

- TimeAwareShaperSegmentStatistic ()
- virtual ∼TimeAwareShaperSegmentStatistic ()
- void criticalSendingSegmentStarts (int switchMac, int portIndex)
- void criticalGuardbandSegmentStarts (int switchMac, int portIndex)
- void noncriticalSendingSegmentStarts (int switchMac, int portIndex)
- void noncriticalGuardbandSegmentStarts (int switchMac, int portIndex)
- virtual void finish ()

Private Attributes

- VectorStatistics2DMap ∗ tasPortTimeSegments = 0

5.38.1 Detailed Description

Time aware shaper (IEEE802.1Qbv) is a circuit-switched arbitration. To evaluate the arbiter the TimeAwareShaper↩ SegmentStatistics draws the four time segments:

1. Critical sending, 2. critical guardband, 3. noncritical sending,
2. noncritical guardband.

5.38.2 Constructor & Destructor Documentation

5.38.2.1 TimeAwareShaperSegmentStatistic()

```
TimeAwareShaperSegmentStatistic::TimeAwareShaperSegmentStatistic ( )
```

Auto-generated constructor, nothing to do here

5.38.2.2 ∼TimeAwareShaperSegmentStatistic()

```
TimeAwareShaperSegmentStatistic::∼TimeAwareShaperSegmentStatistic ( ) [virtual]
```

Auto-generated destructor, nothing to do here

5.38.3 Member Function Documentation

5.38.3.1 criticalGuardbandSegmentStarts()

```
void TimeAwareShaperSegmentStatistic::criticalGuardbandSegmentStarts (
            int switchMac,
            int portIndex )
```

This function is called when the TAS critical guardband segment starts. For each switch and port within the switch it is set.

Parameters

switchMac	integer value of switch MAC address to identify the switch
portIndex	integer value of the port index in the switch

5.38.3.2 criticalSendingSegmentStarts()

```
void TimeAwareShaperSegmentStatistic::criticalSendingSegmentStarts (
            int switchMac,
            int portIndex )
```

This function is called when the TAS critical sending segment starts. For each switch and port within the switch it is set.

Parameters

switchMac	integer value of switch MAC address to identify the switch
portIndex	integer value of the port index in the switch

5.38.3.3 finish()

```
void TimeAwareShaperSegmentStatistic::finish ( )  [virtual]
```

finishes off all individual collections (see individual functions), frees memory and resets pointer

5.38.3.4 noncriticalGuardbandSegmentStarts()

```
void TimeAwareShaperSegmentStatistic::noncriticalGuardbandSegmentStarts (
            int switchMac,
            int portIndex )
```

This function is called when the TAS noncritical guardband segment starts. For each switch and port within the switch it is set.

Parameters

switchMac	integer value of switch MAC address to identify the switch
portIndex	integer value of the port index in the switch

5.38.3.5 noncriticalSendingSegmentStarts()

```
void TimeAwareShaperSegmentStatistic::noncriticalSendingSegmentStarts (
              int switchMac,
              int portIndex )
```

This function is called when the TAS noncritical sending segment starts. For each switch and port within the switch it is set.

Parameters

switchMac	integer value of switch MAC address to identify the switch
portIndex	integer value of the port index in the switch

5.38.4 Member Data Documentation

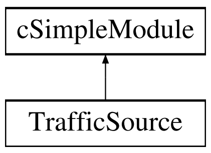
5.38.4.1 tasPortTimeSegments

```
VectorStatistics2DMap* TimeAwareShaperSegmentStatistic::tasPortTimeSegments = 0  [private]
```

5.39 TrafficSource Class Reference

```
#include <TrafficSource.h>
```

Inheritance diagram for TrafficSource:



Public Member Functions

- TrafficSource ()
- virtual ∼TrafficSource ()

Protected Member Functions

- virtual void initialize ()
- virtual void handleMessage (cMessage ∗msg)
- void sendPacket ()
- void scheduleNextBurst (simtime_t offset)
- void scheduleNextIntraBurst ()

Private Attributes

- bool generatorEnable

  Controlls if the generator should be active.
- int globalStreamId

  The global stream Id passed to Ethernet messages if created in the following helper module.
- cMessage ∗ intraBurstMsg

  The intra-burst self event. Signals that a burst is currently scheduled (blocking until next event)
- cMessage ∗ interBurstMsg

  The inter-burst self event. Signals that the next activation to send out is ready.
- int pendingBursts

  The number of pending bursts.
- int pendingIntraBurstSize

  The number of pending activations of the current burst.

5.39.1 Detailed Description

Implementation of the stimuli-generating component based on a periodic burst model

5.39.2 Constructor & Destructor Documentation

5.39.2.1 TrafficSource()

```
TrafficSource::TrafficSource ( )
```

5.39.2.2 ∼TrafficSource()

```
TrafficSource::∼TrafficSource ( )  [virtual]
```

5.39.3 Member Function Documentation

5.39.3.1 handleMessage()

```
void TrafficSource::handleMessage (
            cMessage ∗ msg )  [protected], [virtual]
```

Receiving self messages to control the output of source packets

Parameters

msg	A self message to start a new burst or a single transmission inside of a burst

5.39.3.2 initialize()

```
void TrafficSource::initialize ( )  [protected], [virtual]
```

Initialize the module

5.39.3.3 scheduleNextBurst()

```
void TrafficSource::scheduleNextBurst (
             simtime_t offset )  [protected]
```

Creates the next generation message according with the specified parameters. Is only called after interBurstMsg self event. Schedules the next event in a burst.

Parameters

offset	Is only set the first time this method is called

5.39.3.4 scheduleNextIntraBurst()

```
void TrafficSource::scheduleNextIntraBurst ( )  [protected]
```

Starts a burst if no burst is currently active

5.39.3.5 sendPacket()

```
void TrafficSource::sendPacket ( )  [protected]
```

Sends a packet and reduces the bust count. Also activates pending bursts if present.

5.39.4 Member Data Documentation

5.39.4.1 generatorEnable

```
bool TrafficSource::generatorEnable  [private]
```

Controlls if the generator should be active.

5.39.4.2 globalStreamId

```
int TrafficSource::globalStreamId  [private]
```

The global stream Id passed to Ethernet messages if created in the following helper module.

5.39.4.3 interBurstMsg

```
cMessage* TrafficSource::interBurstMsg  [private]
```

The inter-burst self event. Signals that the next activation to send out is ready.

5.39.4.4 intraBurstMsg

```
cMessage* TrafficSource::intraBurstMsg  [private]
```

The intra-burst self event. Signals that a burst is currently scheduled (blocking until next event)

5.39.4.5 pendingBursts

```
int TrafficSource::pendingBursts  [private]
```

The number of pending bursts.

5.39.4.6 pendingIntraBurstSize

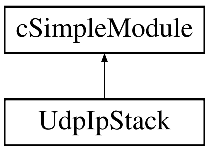
```
int TrafficSource::pendingIntraBurstSize  [private]
```

The number of pending activations of the current burst.

5.40 UdpIpStack Class Reference

```
#include <UdpIpStack.h>
```

Inheritance diagram for UdpIpStack:



Public Member Functions

- UdpIpStack ()
- virtual ∼UdpIpStack ()
- void initialize () override
- void handleMessage (cMessage ∗msg) override

5.40.1 Detailed Description

Passes the data from the middleware and pure Ethernet generators to the ethernet network ports. Passes the data from the Ethernet network ports to either the middleware or the pure Ethernet sink.

5.40.2 Constructor & Destructor Documentation

5.40.2.1 UdpIpStack()

```
UdpIpStack::UdpIpStack ( )
```

Default constructor

5.40.2.2 ∼UdpIpStack()

```
UdpIpStack::∼UdpIpStack ( ) [virtual]
```

Default destructor

5.40.3 Member Function Documentation

5.40.3.1 handleMessage()

```
void UdpIpStack::handleMessage (
            cMessage ∗ msg ) [override]
```

forwarding the messages between the Ethernet network ports and the middleware and pure Ethernet generators/sink

Parameters

msg	The message to be forwarded

5.40.3.2 initialize()

```
void UdpIpStack::initialize ( )  [override]
```

Empty initialization function

5.41 ValidationHandler Class Reference

```
#include <ValidationHandler.h>
```

Static Public Member Functions

- static void ThrowError (const char ∗message)
- template<typename T >
  static void validateInputBounds (T input, T min, T max, const char ∗message)

5.41.1 Member Function Documentation

5.41.1.1 ThrowError()

```
static void ValidationHandler::ThrowError (
             const char * message )  [inline], [static]
```

5.41.1.2 validateInputBounds()

```
template<typename T >
static void ValidationHandler::validateInputBounds (
             T input,
             T min,
             T max,
             const char * message )  [inline], [static]
```

Validates the input is within the minimum and maximum bounds. Throws an exception if the input is out of bounds.

5.42 VectorStatistics2DMap Class Reference

```
#include <VectorStatistics2DMap.h>
```

Public Member Functions

- VectorStatistics2DMap (const char ∗prefix, const char ∗modulePrefix, const char ∗submodulePrefix)
- virtual ∼VectorStatistics2DMap ()
- void finish ()
- void addInteger (int moduleID, int submoduleID, int value)
- void accumulateInteger (int moduleID, int submoduleID, int value)
- void addLatency (int moduleID, int submpduleID, simtime_t value)

Private Member Functions

- std::pair< cOutVector ∗, long > & getEntry (int module_ID, int submodule_ID)

Private Attributes

- std::map< int, std::map< int, std::pair< cOutVector ∗, long > > ∗ > ∗ storedMeasurements = 0

  vector containing the stored results
- const char ∗ prefix

  prefix is a string which stores information allowing to indentify the type of statistics which is gathered e.g. E2E latency, packet drop etc.
- const char ∗ modulePrefix

  modulePrefix is a string which denotes the module where statistics are gathered e.g. sink with a selected ID
- const char ∗ submodulePrefix

  submodule is a string which prefix denotes for which component the statistics are gathered, it could be streamID or buffer ID
- const char ∗ valuePrefix

  value prefix is a string allowing to identify the type of stored data

5.42.1 Detailed Description

Helper class used for storing the vector statistics for objects which do not have physical modules e.g. streams or DDS samples with two parameters describing each entry e.g. moduleID and submoduleID

5.42.2 Constructor & Destructor Documentation

5.42.2.1 VectorStatistics2DMap()

```
VectorStatistics2DMap::VectorStatistics2DMap (
              const char ∗ prefix,
              const char ∗ modulePrefix,
              const char ∗ submodulePrefix )
```

Constructor of the class Generates the string using the parameter variables which is later used to describe/identif measurement results

Parameters

prefix	
module_fix	
submodule_fix	

5.42.2.2 ∼VectorStatistics2DMap()

```
VectorStatistics2DMap::∼VectorStatistics2DMap ( )  [virtual]
```

Destructor of the class, nothing to do here

5.42.3 Member Function Documentation

5.42.3.1 accumulateInteger()

```
void VectorStatistics2DMap::accumulateInteger (
             int moduleID,
             int submoduleID,
             int value )
```

Function firstly accumulates the value to the last one and later stores the integer measurement results into the statistics vector

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. streamID
value	- the measured value, must be an integer

5.42.3.2 addInteger()

```
void VectorStatistics2DMap::addInteger (
             int moduleID,
             int submoduleID,
             int value )
```

Function stores the integer measurement results into the statistics vector

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. streamID
value	- the measured value, must be an integer

5.42.3.3 addLatency()

```
void VectorStatistics2DMap::addLatency (
            int moduleID,
            int submpduleID,
            simtime_t value )
```

Function stores the simulation latency measurement results into the statistics vector

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. streamID
value	- the measured value, must be an simtime_t

5.42.3.4 finish()

```
void VectorStatistics2DMap::finish ( )
```

Finish function is used to save the statistics at the end of simulation

5.42.3.5 getEntry()

```
pair< cOutVector *, long > & VectorStatistics2DMap::getEntry (
            int module_ID,
            int submodule_ID )  [private]
```

Function which returns an entry identified by parameters

Parameters

module_ID	- module where measurement has been takes e.g. bufferID
submodule_ID	- module for which measurmenet has been take e.g. streamID

Returns

5.42.4 Member Data Documentation

5.42.4.1 modulePrefix

```
const char* VectorStatistics2DMap::modulePrefix  [private]
```

modulePrefix is a string which denotes the module where statistics are gathered e.g. sink with a selected ID

5.42.4.2 prefix

```
const char* VectorStatistics2DMap::prefix  [private]
```

prefix is a string which stores information allowing to indentify the type of statistics which is gathered e.g. E2E latency, packet drop etc.

5.42.4.3 storedMeasurements

```
std::map<int, std::map<int, std::pair<cOutVector*, long> >*>* VectorStatistics2DMap::stored←
Measurements = 0  [private]
```

vector containing the stored results

5.42.4.4 submodulePrefix

```
const char* VectorStatistics2DMap::submodulePrefix  [private]
```

submodule is a string which prefix denotes for which component the statistics are gathered, it could be streamID or buffer ID

5.42.4.5 valuePrefix

```
const char* VectorStatistics2DMap::valuePrefix  [private]
```

value prefix is a string allowing to identify the type of stored data

5.43 VectorStatistics3DMap Class Reference

```
#include <VectorStatistics3DMap.h>
```

Public Member Functions

- VectorStatistics3DMap (const char ∗prefix, const char ∗modulePrefix, const char ∗submodulePrefix, const char ∗valuePrefix)
- virtual ∼VectorStatistics3DMap ()
- void finish ()
- void addInteger (int moduleID, int submoduleID, int valueID, int value)
- void accumulateInteger (int moduleID, int submoduleID, int valueID, int value)
- void addLatency (int moduleID, int submoduleID, int valueID, simtime_t value)
- void addLatency (int moduleID, int submoduleID, int valueID, const std::string &valueIDStr, simtime_t value)

Private Member Functions

- pair< cOutVector ∗, long > & getEntry (int moduleID, int submoduleID, int valueID)
- pair< cOutVector ∗, long > & getEntry (int moduleID, int submoduleID, int valueID, const std::string &value←IDStr)

Private Attributes

- const char ∗ prefix = 0

  prefix is a string which stores information allowing to identify the type of statistics which is gathered e.g. E2E latency, packet drop etc.
- const char ∗ modulePrefix = 0

  modulePrefix is a string which denotes the module where statistics are gathered e.g. sink with a selected ID
- const char ∗ submodulePrefix = 0

  submodule is a string which prefix denotes for which component the statistics are gathered, it could be streamID or buffer ID
- const char ∗ valuePrefix = 0

  value prefix is a string allowing to identify the type of stored data
- map< int, map< int, map< int, pair< cOutVector ∗, long > > ∗ > ∗ > ∗ storedMeasurements

  histogram containing the stored results, thre dimmensional

Static Private Attributes

- static const std::string empty

5.43.1 Constructor & Destructor Documentation

5.43.1.1 VectorStatistics3DMap()

```
VectorStatistics3DMap::VectorStatistics3DMap (
             const char ∗ prefix,
             const char ∗ modulePrefix,
             const char ∗ submodulePrefix,
             const char ∗ valuePrefix )
```

Constructor of the class Stores parameters which will be later used for the creation of the string which is used to identify results.

Parameters

prefix	
modulePrefix	
submodulePrefix	
valuePrefix	

5.43.1.2 ∼VectorStatistics3DMap()

```
VectorStatistics3DMap::∼VectorStatistics3DMap ( )  [virtual]
```

Destructor, nothing to do

5.43.2 Member Function Documentation

5.43.2.1 accumulateInteger()

```
void VectorStatistics3DMap::accumulateInteger (
             int moduleID,
             int submoduleID,
             int valueID,
             int value )
```

Function stores the integer measurement results into the statistics vector

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. bufferID
valueID	- id of the stream/streams for which statistics has been taken e.g. priority, streamID
value	- the measured value, must be an integer

5.43.2.2 addInteger()

```
void VectorStatistics3DMap::addInteger (
             int moduleID,
             int submoduleID,
             int valueID,
             int value )
```

Function stores the integer measurement results into the statistics vector

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. bufferID
valueID	- id of the stream/streams for which statistics has been taken e.g. priority, streamID
value	- the measured value, must be an integer

5.43.2.3 addLatency() [1/2]

```
void VectorStatistics3DMap::addLatency (
            int moduleID,
            int submoduleID,
            int valueID,
            const std::string & valueIDStr,
            simtime_t value )
```

Function stores the integer measurement results into the statistics vector

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. bufferID
valueID	- id of the stream/streams for which statistics has been taken e.g. priority, streamID
valueIDStr	- substitutes the valueID if defined
value	- the measured value, must be an simtime_t

5.43.2.4 addLatency() [2/2]

```
void VectorStatistics3DMap::addLatency (
            int moduleID,
            int submoduleID,
            int valueID,
            simtime_t value )
```

Function firstly accumulates the value to the last one and later stores the integer measurement results into the statistics vector

Parameters

moduleID	- id of the module where the measurement has been taken
submoduleID	- id of the module for which the statistics has been taken e.g. bufferID
valueID	- id of the stream/streams for which statistics has been taken e.g. priority, streamID
value	- the measured value, must be an simtime_t

5.43.2.5 finish()

```
void VectorStatistics3DMap::finish ( )
```

Finish function is used to clear & save the statistics at the end of simulation

5.43.2.6 getEntry() [1/2]

```
pair< cOutVector *, long > & VectorStatistics3DMap::getEntry (
             int moduleID,
             int submoduleID,
             int valueID )  [private]
```

5.43.2.7 getEntry() [2/2]

```
pair<cOutVector*, long>& VectorStatistics3DMap::getEntry (
             int moduleID,
             int submoduleID,
             int valueID,
             const std::string & valueIDStr )  [private]
```

5.43.3 Member Data Documentation

5.43.3.1 empty

```
const string VectorStatistics3DMap::empty  [static], [private]
```

5.43.3.2 modulePrefix

```
const char* VectorStatistics3DMap::modulePrefix = 0  [private]
```

modulePrefix is a string which denotes the module where statistics are gathered e.g. sink with a selected ID

5.43.3.3 prefix

```
const char* VectorStatistics3DMap::prefix = 0  [private]
```

prefix is a string which stores information allowing to identify the type of statistics which is gathered e.g. E2E latency, packet drop etc.

5.43.3.4 storedMeasurements

```
map<int, map<int, map<int, pair<cOutVector*, long> >*>*>* VectorStatistics3DMap::stored←
Measurements [private]
```

histogram containing the stored results, thre dimmensional

5.43.3.5 submodulePrefix

```
const char* VectorStatistics3DMap::submodulePrefix = 0 [private]
```

submodule is a string which prefix denotes for which component the statistics are gathered, it could be streamID or buffer ID

5.43.3.6 valuePrefix

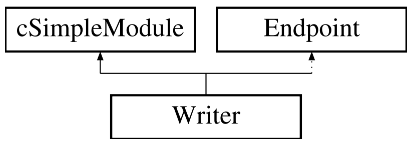
```
const char* VectorStatistics3DMap::valuePrefix = 0 [private]
```

value prefix is a string allowing to identify the type of stored data

5.44 Writer Class Reference

```
#include <Writer.h>
```

Inheritance diagram for Writer:



Public Member Functions

- Writer ()
- virtual ~Writer ()

Protected Member Functions

- virtual void initialize () override
- virtual void handleMessage (cMessage ∗msg) override
- virtual void finish () override
- void registerWriter ()
- bool addNextFragmentToSendList ()
- void sendMessage ()
- void checkLifespanOfSamples ()
- RTPSEthMessage ∗ createRtpsMsgFromFragment (SampleFragment ∗sampleFragment)

Private Attributes

- cMessage ∗ sendEvent

  Send event self message.
- cMessage ∗ registerEvent

  Self event to trigger the registration of the writer at the participant.
- int sourceMac

  The own MAC address.
- int destinationMac

  The MAC address of the remote reader(s)
- int entityId

  The own entity ID.
- int destinationEntityId

  The endity ID of the remote reader(s)
- int streamEthernetPriority

  The Ethernet Priority indicator.
- int globalStreamId

  The writers global stream ID.
- simtime_t shapingDuration

  Shaping duration for messages of the individual writer.
- int historySizeQoS

  The size of the history cache.
- simtime_t lifespan

  The lifespan duration.
- bool bestEffort

  Choose best effort or reliable communication.
- int fragmentSize

  The fragment size.
- int transportPriority

  The transport priority of the writer.
- std::list< HistorySampleEntry ∗ > historyCache

  The history cache queue of the writer.
- std::list< SampleFragment ∗ > send_queue

  The send queue.
- int currentSampleSequenceNumber

  The current sample sequence number.

Additional Inherited Members

5.44.1 Detailed Description

The RTPS Writer entity sends generated samples to its subscribed readers based on the streamID routing mechanism implemented in the network.

5.44.2 Constructor & Destructor Documentation

5.44.2.1 Writer()

```
Writer::Writer ( )
```

The default constructor

5.44.2.2 ∼Writer()

```
Writer::∼Writer ( ) [virtual]
```

The default destructor

5.44.3 Member Function Documentation

5.44.3.1 addNextFragmentToSendList()

```
bool Writer::addNextFragmentToSendList ( ) [protected]
```

Choose the next fragment to send and add it in the send queue

5.44.3.2 checkLifespanOfSamples()

```
void Writer::checkLifespanOfSamples ( ) [protected]
```

Check for all samples if their lifespan have been expired

5.44.3.3 createRtpsMsgFromFragment()

```
RTPSEthMessage * Writer::createRtpsMsgFromFragment (
            SampleFragment * sampleFragment ) [protected]
```

Create an RTPS message from a sample fragment in order to send it

Parameters

sampleFragment	The fragment to send

5.44.3.4 finish()

```
void Writer::finish ( ) [override], [protected], [virtual]
```

Nothing to finish here

5.44.3.5 handleMessage()

```
void Writer::handleMessage (
            cMessage * msg )  [override], [protected], [virtual]
```

Handles incoming messages, which are Samples from the application (generator), RTPS messages or self messages.

Parameters

msg	The incoming message.

5.44.3.6 initialize()

```
void Writer::initialize ( )  [override], [protected], [virtual]
```

5.44.3.7 registerWriter()

```
void Writer::registerWriter ( )  [protected]
```

Register the writer at the participant

5.44.3.8 sendMessage()

```
void Writer::sendMessage ( )  [protected]
```

When this method is called and the sendEvent is not scheduled, than a new fragment is send out if one is pending

5.44.4 Member Data Documentation

5.44.4.1 bestEffort

```
bool Writer::bestEffort  [private]
```

Choose best effort or reliable communication.

5.44.4.2 currentSampleSequenceNumber

```
int Writer::currentSampleSequenceNumber  [private]
```

The current sample sequence number.

5.44.4.3 destinationEntityId

```
int Writer::destinationEntityId  [private]
```

The endity ID of the remote reader(s)

5.44.4.4 destinationMac

```
int Writer::destinationMac  [private]
```

The MAC address of the remote reader(s)

5.44.4.5 entityId

```
int Writer::entityId  [private]
```

The own entity ID.

5.44.4.6 fragmentSize

```
int Writer::fragmentSize  [private]
```

The fragment size.

5.44.4.7 globalStreamId

```
int Writer::globalStreamId  [private]
```

The writers global stream ID.

5.44.4.8 historyCache

```
std::list<HistorySampleEntry*> Writer::historyCache  [private]
```

The history cache queue of the writer.

5.44.4.9 historySizeQoS

```
int Writer::historySizeQoS  [private]
```

The size of the history cache.

5.44.4.10 lifespan

```
simtime_t Writer::lifespan  [private]
```

The lifespan duration.

5.44.4.11 registerEvent

```
cMessage* Writer::registerEvent  [private]
```

Self event to trigger the registration of the writer at the participant.

5.44.4.12 send_queue

```
std::list<SampleFragment*> Writer::send_queue  [private]
```

The send queue.

5.44.4.13 sendEvent

```
cMessage* Writer::sendEvent  [private]
```

Send event self message.

5.44.4.14 shapingDuration

```
simtime_t Writer::shapingDuration  [private]
```

Shaping duration for messages of the individual writer.

5.44.4.15 sourceMac

```
int Writer::sourceMac  [private]
```

The own MAC address.

5.44.4.16 streamEthernetPriority

```
int Writer::streamEthernetPriority  [private]
```

The Ethernet Priority indicator.

5.44.4.17 transportPriority

```
int Writer::transportPriority  [private]
```

The transport priority of the writer.

Chapter 6

File Documentation

6.1 ArbiterAVB.cc File Reference

```
#include "ArbiterAVB.h"
```

6.2 ArbiterAVB.h File Reference

```
#include <omnetpp.h>
#include "../../common/ConfigurationReader.h"
#include "../../messagetype/BufferControlMessage_m.h"
#include "../../messagetype/EthernetFrame_m.h"
#include "../../common/EthernetMacros.h"
```

Classes

- struct arbiterAVBClass
- class ArbiterAVB

Enumerations

- enum avbTablePostition {
  SWITCH_MAC = 0, EGRESS_PORT_ID = 1, PRIORITY = 2, SEND_SLOPE = 3,
  IDLE_SLOPE = 4 }
- enum arbiterClassStatus {
  CLASS_IDLE = 0, CLASS_SENDING = 1, CLASS_WAITING = 2, CLASS_BLOCKED = 3,
  CLASS_NOTSHAPED = 4 }

Functions

- Define_Module (ArbiterAVB)

6.2.1 Enumeration Type Documentation

6.2.1.1 arbiterClassStatus

```
enum arbiterClassStatus
```

Enumerations for Status of Arbiter Classes

Enumerator

CLASS_IDLE	
CLASS_SENDING	
CLASS_WAITING	
CLASS_BLOCKED	
CLASS_NOTSHAPED	

6.2.1.2 avbTablePostition

```
enum avbTablePostition
```

Enumeration for Position in AVB configuration File

Enumerator

SWITCH_MAC	
EGRESS_PORT_ID	
PRIORITY	
SEND_SLOPE	
IDLE_SLOPE	

6.2.2 Function Documentation

6.2.2.1 Define_Module()

```
Define_Module (
            ArbiterAVB  )
```

6.3 ArbiterIEEE802_1Q.cc File Reference

```
#include "ArbiterIEEE802_1Q.h"
```

6.4 ArbiterIEEE802_1Q.h File Reference

```
#include <stdio.h>
#include <fstream>
#include <string.h>
#include <omnetpp.h>
#include <map>
#include <vector>
#include "../../messagetype/BufferControlMessage_m.h"
#include "../../messagetype/EthernetFrame_m.h"
#include "../../common/EthernetMacros.h"
```

Classes

- class ArbiterIEEE802_1Q

Functions

- Define_Module (ArbiterIEEE802_1Q)

6.4.1 Function Documentation

6.4.1.1 Define_Module()

```
Define_Module (
            ArbiterIEEE802_1Q  )
```

6.5 ArbiterIEEE802_1Qbv.cc File Reference

```
#include "ArbiterIEEE802_1Qbv.h"
```

6.6 ArbiterIEEE802_1Qbv.h File Reference

```
#include <omnetpp.h>
#include <stdio.h>
#include <fstream>
#include <unordered_set>
#include <map>
#include "../../messagetype/BufferControlMessage_m.h"
#include "../../messagetype/EthernetFrame_m.h"
#include "../../common/EthernetMacros.h"
#include "../../statistics/StatisticManager.h"
```

Classes

- class ArbiterIEEE802_1Qbv

Enumerations

- enum timeSegments { CRITICAL_SENDING = 1, CRITICAL_GUARDBAND = 2, NONCRITICAL_SENDING = 3, NONCRITICAL_GUARDBAND = 4 }

Functions

- Define_Module (ArbiterIEEE802_1Qbv)

6.6.1 Enumeration Type Documentation

6.6.1.1 timeSegments

```
enum timeSegments
```

Enum of TAS time segments

Enumerator

CRITICAL_SENDING	
CRITICAL_GUARDBAND	
NONCRITICAL_SENDING	
NONCRITICAL_GUARDBAND	

6.6.2 Function Documentation

6.6.2.1 Define_Module()

```
Define_Module (
            ArbiterIEEE802_1Qbv   )
```

6.7 ArbiterIEEE802_3.cc File Reference

```
#include "ArbiterIEEE802_3.h"
```

6.8 ArbiterIEEE802_3.h File Reference

```
#include <stdio.h>
#include <fstream>
#include <string.h>
#include <omnetpp.h>
#include <map>
#include <vector>
#include "../../messagetype/BufferControlMessage_m.h"
#include "../../messagetype/EthernetFrame_m.h"
#include "../../common/EthernetMacros.h"
```

Classes

- class ArbiterIEEE802_3

Functions

- Define_Module (ArbiterIEEE802_3)

6.8.1 Function Documentation

6.8.1.1 Define_Module()

```
Define_Module (
            ArbiterIEEE802_3 )
```

6.9 BuffersModule.cc File Reference

```
#include "BuffersModule.h"
```

6.10 BuffersModule.h File Reference

```
#include <omnetpp.h>
#include "../../messagetype/EthernetFrame_m.h"
#include "../../messagetype/BufferControlMessage_m.h"
#include "FrameBuffer.h"
```

Classes

- class BuffersModule

Functions

- Define_Module (BuffersModule)

6.10.1 Function Documentation

6.10.1.1 Define_Module()

```
Define_Module (
            BuffersModule  )
```

6.11 ClassifierPriority.cc File Reference

```
#include "ClassifierPriority.h"
```

6.12 ClassifierPriority.h File Reference

```
#include <omnetpp.h>
#include "../../messagetype/EthernetFrame_m.h"
```

Classes

- class ClassifierPriority

Functions

- Define_Module (ClassifierPriority)

6.12.1 Function Documentation

6.12.1.1 Define_Module()

```
Define_Module (
          ClassifierPriority )
```

6.13 ConfigurationReader.cc File Reference

```
#include "../common/ConfigurationReader.h"
```

6.14 ConfigurationReader.h File Reference

```
#include <string>
#include <sstream>
#include <fstream>
#include <iostream>
#include <vector>
#include <map>
#include <omnetpp.h>
```

Classes

- class ConfigurationReader

Macros

- #define COMMENT_SYMBOL "#"
- #define COMMENT_POSITION 0

Typedefs

- typedef std::vector< std::vector< int > > configVector

6.14.1 Macro Definition Documentation

6.14.1.1 COMMENT_POSITION

```
#define COMMENT_POSITION 0
```

6.14.1.2 COMMENT_SYMBOL

```
#define COMMENT_SYMBOL "#"
```

6.14.2 Typedef Documentation

6.14.2.1 configVector

```
typedef std::vector<std::vector<int> > configVector
```

6.15 ddsSampleLatencyStatistics.cc File Reference

```
#include "ddsSampleLatencyStatistics.h"
#include "../common/ValidationHandler.h"
```

6.16 ddsSampleLatencyStatistics.h File Reference

```
#include <omnetpp.h>
#include "helperModulesStatistics/HistogramStatistics3DMap.h"
#include "helperModulesStatistics/VectorStatistics3DMap.h"
```

Classes

- class SampleLatencyStatistics

6.17 DelayUnit.cc File Reference

```
#include "../../../../endnode/middleware/rtps/delayunit/DelayUnit.h"
#include "../../../../common/GlobalMacros.h"
```

Functions

- Define_Module (DelayUnit)

6.17.1 Function Documentation

6.17.1.1 Define_Module()

```
Define_Module (
            DelayUnit  )
```

6.18 DelayUnit.h File Reference

```
#include <omnetpp.h>
```

Classes

- class DelayUnit

6.19 E2ELatencyStatistics.cc File Reference

```
#include "E2ELatencyStatistics.h"
```

6.20 E2ELatencyStatistics.h File Reference

```
#include <omnetpp.h>
#include <string>
#include "../common/GlobalMacros.h"
#include "../messagetype/EthernetFrame_m.h"
#include "helperModulesStatistics/HistogramStatistics2DMap.h"
#include "helperModulesStatistics/VectorStatistics2DMap.h"
```

Classes

- class E2ELatencyStatistics

6.21 EgressPort.cc File Reference

```
#include "EgressPort.h"
```

6.22 EgressPort.h File Reference

```
#include <omnetpp.h>
```

Classes

- class EgressPort

Functions

- Define_Module (EgressPort)

6.22.1 Function Documentation

6.22.1.1 Define_Module()

```
Define_Module (
            EgressPort  )
```

6.23 Endpoint.cc File Reference

```
#include "../../../../endnode/middleware/rtps/entities/Endpoint.h"
#include "./../../../../common/ValidationHandler.h"
#include "../../../../common/RtpsMacros.h"
```

6.24 Endpoint.h File Reference

```
#include "./../messages/RTPSEthMessage_m.h"
#include <omnetpp.h>
```

Classes

- class Endpoint

6.25 EthernetHeaderInformation.h File Reference

Classes

- struct ethernetHeaderInformation

6.26 EthernetMacros.h File Reference

```
#include <math.h>
#include <stdlib.h>
#include "GlobalMacros.h"
```

Macros

- #define _MIN_ETH_PAYLOAD_ (42)
- #define _MIN_ETH_PAYLOAD_UNTAGGED (46)
- #define _MAX_ETH_PAYLOAD_ (1500)
- #define _PAYLOAD_INTERMEDIATE_PREEMPTION_ (60)
- #define _FRAME_OVERHEAD_ (6 + 6 + 4 + 2 + 4)
- #define _PACKET_OVERHEAD_ (7 + 1)
- #define _PACKET_OVERHEAD_FIRST_PREEMPTION_ (7 + 1 + 6 + 6 + 4 + 2)
- #define _PACKET_OVERHEAD_INTERMEDIATE_PREEMPTION_ (6 + 1 + 1)
- #define _CRC_ (4)
- #define _INTERPACKET_GAP_ (12)
- #define _CRC_INTERPACKET_GAP_ (_INTERPACKET_GAP_ + _CRC_)
- #define _MIN_ETH_FRAME_SIZE_ (_MIN_ETH_PAYLOAD_ + _FRAME_OVERHEAD_)
- #define _MIN_ETH_PACKET_SIZE_ (_MIN_ETH_FRAME_SIZE_ + _PACKET_OVERHEAD_ + _INTERPACKET_GAP_)
- #define _MIN_ETH_PACKET_SIZE_PREEMPTION_ (144)
- #define _eth_check_for_padding_(payload) (payload>=_MIN_ETH_PAYLOAD_?payload:_MIN_ETH_PA↩
  YLOAD_)
- #define _eth_check_for_max_payload_(payload) (payload<=_MAX_ETH_PAYLOAD_?payload:_MAX_E↩
  TH_PAYLOAD_)
- #define _eth_framesize_from_payload_(payload) (payload+ _FRAME_OVERHEAD_)
- #define _eth_packetsize_from_payload_(payload) (payload + _FRAME_OVERHEAD_ + _PACKET_OVERHEAD_
  + _INTERPACKET_GAP_)
- #define _std_eth_colour_ (_msg_red_)

Enumerations

- enum _eth_egress_helper_message_type_ {
  frame_arrived = 0, frame_started_sending = 1, frame_finished_sending = 3, frame_dropped = 5,
  port_update = 10 }

6.26.1 Macro Definition Documentation

6.26.1.1 _CRC_

```
#define _CRC_ (4)
```

6.26.1.2 _CRC_INTERPACKET_GAP_

```
#define _CRC_INTERPACKET_GAP_ (_INTERPACKET_GAP_ + _CRC_)
```

6.26.1.3 _eth_check_for_max_payload_

```
#define _eth_check_for_max_payload_(
             payload ) (payload<=_MAX_ETH_PAYLOAD_?payload:_MAX_ETH_PAYLOAD_)
```

6.26.1.4 _eth_check_for_padding_

```
#define _eth_check_for_padding_(
             payload ) (payload>=_MIN_ETH_PAYLOAD_?payload:_MIN_ETH_PAYLOAD_)
```

6.26.1.5 _eth_framesize_from_payload_

```
#define _eth_framesize_from_payload_(
             payload ) (payload+ _FRAME_OVERHEAD_)
```

6.26.1.6 _eth_packetsize_from_payload_

```
#define _eth_packetsize_from_payload_(
             payload ) (payload + _FRAME_OVERHEAD_ + _PACKET_OVERHEAD_ + _INTERPACKET_GAP_)
```

6.26.1.7 _FRAME_OVERHEAD_

```
#define _FRAME_OVERHEAD_ (6 + 6 + 4 + 2 + 4)
```

6.26.1.8 _INTERPACKET_GAP_

```
#define _INTERPACKET_GAP_ (12)
```

6.26.1.9 _MAX_ETH_PAYLOAD_

```
#define _MAX_ETH_PAYLOAD_ (1500)
```

6.26.1.10 _MIN_ETH_FRAME_SIZE_

```
#define _MIN_ETH_FRAME_SIZE_ (_MIN_ETH_PAYLOAD_ + _FRAME_OVERHEAD_)
```

6.26.1.11 _MIN_ETH_PACKET_SIZE_

```
#define _MIN_ETH_PACKET_SIZE_ (_MIN_ETH_FRAME_SIZE_ + _PACKET_OVERHEAD_ + _INTERPACKET_GAP_)
```

6.26.1.12 _MIN_ETH_PACKET_SIZE_PREEMPTION_

```
#define _MIN_ETH_PACKET_SIZE_PREEMPTION_ (144)
```

6.26.1.13 _MIN_ETH_PAYLOAD_

```
#define _MIN_ETH_PAYLOAD_ (42)
```

6.26.1.14 _MIN_ETH_PAYLOAD_UNTAGGED

```
#define _MIN_ETH_PAYLOAD_UNTAGGED (46)
```

6.26.1.15 _PACKET_OVERHEAD_

```
#define _PACKET_OVERHEAD_ (7 + 1)
```

6.26.1.16 _PACKET_OVERHEAD_FIRST_PREEMPTION_

```
#define _PACKET_OVERHEAD_FIRST_PREEMPTION_ (7 + 1 + 6 + 6 + 4 + 2)
```

6.26.1.17 _PACKET_OVERHEAD_INTERMEDIATE_PREEMPTION_

```
#define _PACKET_OVERHEAD_INTERMEDIATE_PREEMPTION_ (6 + 1 + 1)
```

6.26.1.18 _PAYLOAD_INTERMEDIATE_PREEMPTION_

```
#define _PAYLOAD_INTERMEDIATE_PREEMPTION_ (60)
```

6.26.1.19 _std_eth_colour_

```
#define _std_eth_colour_ (_msg_red_)
```

6.26.2 Enumeration Type Documentation

6.26.2.1 _eth_egress_helper_message_type_

```
enum _eth_egress_helper_message_type_
```

Enumerator

frame_arrived	
frame_started_sending	
frame_finished_sending	
frame_dropped	
port_update	

6.27 EthMsgCreator.cc File Reference

```
#include "../msgcreators/EthMsgCreator.h"
#include "../../../common/GlobalMacros.h"
#include "../../../common/EthernetMacros.h"
#include "../../../messagetype/EthernetFrame_m.h"
```

6.28 EthMsgCreator.h File Reference

```
#include <omnetpp.h>
```

Classes

- class EthMsgCreator

Functions

- Define_Module (EthMsgCreator)

6.28.1 Function Documentation

6.28.1.1 Define_Module()

```
Define_Module (
            EthMsgCreator  )
```

6.29 ForwardingLogic.cc File Reference

```
#include "ForwardingLogic.h"
```

6.30 ForwardingLogic.h File Reference

```
#include <stdio.h>
#include <fstream>
#include <string.h>
#include <omnetpp.h>
#include <map>
#include <vector>
#include "../../common/ConfigurationReader.h"
#include "../../common/GlobalMacros.h"
#include "../../messagetype/EthernetFrame_m.h"
```

Classes

- class ForwardingLogic

Enumerations

- enum macTableEntriesPositon { SWITCH_MAC = 0, STREAM_ID = 1, NEXT_HOP_MAC = 2 }
- enum simulationOutputType { INIT_OUTPUT = 0, MAC_TABLE_CONFIGURATION_INFO = 1 }
- enum errorType { INCORRECT_MESSAGE_TYPE = 0, UNKNOWN_STREAM_ID = 1, INVALID_NUMBER_MAC_TABLE_ENT
  = 2, INVALID_PORT_ID = 3 }

Functions

- Define_Module (ForwardingLogic)

6.30.1 Enumeration Type Documentation

6.30.1.1 errorType

```
enum errorType
```

Options for throw an error for error handling

INCORRECT_MESSAGE_TYPE: cMessage cannot cast into an Ethernet frame UNKNOWN_STREAM_ID: Entered stream ID in .config-file is unequal to streamID in Ethernet frame (no matching entry in .config-file) INVALI←
D_NUMBER_MAC_TABLE_ENTRIES: the number of entries in MAC Table and therefore in .config-file is unequal 3 INVALID_PORT_ID: No matching portID to connected next module MAC (hop) is found.

Enumerator

INCORRECT_MESSAGE_TYPE	
UNKNOWN_STREAM_ID	
INVALID_NUMBER_MAC_TABLE_ENTRIES	
INVALID_PORT_ID	

6.30.1.2 macTableEntriesPositon

```
enum macTableEntriesPositon
```

Each entry in the configVector macTable is at a certain position.

First position the MAC address of a specific switch is entered Second position the global streamID of an Ethernet frame is stored. Third position the MAC address of the next connected module (hop) to which the Ethernet frame will be forwarded is stored.

Enumerator

SWITCH_MAC	
STREAM_ID	
NEXT_HOP_MAC	

6.30.1.3 simulationOutputType

```
enum simulationOutputType
```

Options for printing outputs during the simulation

INIT_OUT: prints characteristics about the switch MAC_TABLE_CONFIGURATION_INFO: only set if no entry in MAC table is set for a specific switch

Enumerator

INIT_OUTPUT	
MAC_TABLE_CONFIGURATION_INFO	

6.30.2 Function Documentation

6.30.2.1 Define_Module()

```
Define_Module (
            ForwardingLogic  )
```

6.31 FrameBuffer.cc File Reference

```
#include "FrameBuffer.h"
```

6.32 FrameBuffer.h File Reference

```
#include <omnetpp.h>
#include <iostream>
#include "../../messagetype/EthernetFrame_m.h"
```

Classes

- class FrameBuffer

Enumerations

- enum bufferUpdate { ADDED_FRAME = 0, REMOVED_FRAME = 1 }

6.32.1 Enumeration Type Documentation

6.32.1.1 bufferUpdate

```
enum bufferUpdate
```

Enum for updating the FrameBuffer. ADDED_FRAME indicates that a new frame is stored into the buffer. REMO←VED_FRAME indicates that a frame is deleted.

Enumerator

ADDED_FRAME	
REMOVED_FRAME	

6.33 FramesLostStatistics.cc File Reference

```
#include "../statistics/FramesLostStatistics.h"
```

6.34 FramesLostStatistics.h File Reference

```
#include <omnetpp.h>
#include "helperModulesStatistics/HistogramStatistics2DMap.h"
#include "helperModulesStatistics/VectorStatistics2DMap.h"
```

Classes

- class FramesLostStatistics

6.35 GlobalMacros.h File Reference

```
#include <omnetpp.h>
#include <unordered_set>
```

Classes

- struct Frer_ID
- struct lostFrameCounter

Macros

- #define _min_(x, y) (y<x?y:x)
- #define _max_(x, y) (x>y?x:y)
- #define _msg_red_ 0
- #define _msg_green_ 1
- #define _msg_blue_ 2
- #define _msg_white_ 3
- #define _msg_yellow_ 4
- #define _msg_cyan_ 5
- #define _msg_magenta_ 6
- #define _msg_black_ 7
- #define _CAN2CAN_LOOKUP_ 0
- #define _CAN2ETH_LOOKUP_ 0
- #define _ETH2CAN_LOOKUP_ 0
- #define _ETH2ETH_LOOKUP_ 0

Typedefs

- typedef std::vector< std::vector< std::string > > csvVector

Functions

- template<typename T >
  T truncate_min_max (T input, T min, T max)
- omnetpp::simtime_t simtime_modulo (omnetpp::simtime_t s1, omnetpp::simtime_t s2)

6.35.1 Macro Definition Documentation

6.35.1.1 _CAN2CAN_LOOKUP_

```
#define _CAN2CAN_LOOKUP_ 0
```

6.35.1.2 _CAN2ETH_LOOKUP_

```
#define _CAN2ETH_LOOKUP_ 0
```

6.35.1.3 _ETH2CAN_LOOKUP_

```
#define _ETH2CAN_LOOKUP_ 0
```

6.35.1.4 _ETH2ETH_LOOKUP_

```
#define _ETH2ETH_LOOKUP_ 0
```

6.35.1.5 _max_

```
#define _max_(
              x,
              y ) (x>y?x:y)
```

6.35.1.6 _min_

```
#define _min_(
              x,
              y ) (y<x?y:x)
```

6.35.1.7 _msg_black_

```
#define _msg_black_ 7
```

6.35.1.8 _msg_blue_

```
#define _msg_blue_ 2
```

6.35.1.9 _msg_cyan_

```
#define _msg_cyan_ 5
```

6.35.1.10 _msg_green_

```
#define _msg_green_ 1
```

6.35.1.11 _msg_magenta_

```
#define _msg_magenta_ 6
```

6.35.1.12 _msg_red_

```
#define _msg_red_ 0
```

6.35.1.13 _msg_white_

```
#define _msg_white_ 3
```

6.35.1.14 _msg_yellow_

```
#define _msg_yellow_ 4
```

6.35.2 Typedef Documentation

6.35.2.1 csvVector

```
typedef std::vector<std::vector<std::string> > csvVector
```

6.35.3 Function Documentation

6.35.3.1 simtime_modulo()

```
omnetpp::simtime_t simtime_modulo (
             omnetpp::simtime_t s1,
             omnetpp::simtime_t s2 )  [inline]
```

s1 % s2; what is the reminder of dividing s1 by s2

6.35.3.2 truncate_min_max()

```
template<typename T >
T truncate_min_max (
             T input,
             T min,
             T max )  [inline]
```

6.36 HistogramStatistics2DMap.cc File Reference

```
#include "HistogramStatistics2DMap.h"
```

6.37 HistogramStatistics2DMap.h File Reference

```
#include <omnetpp.h>
#include "../../common/GlobalMacros.h"
```

Classes

- class HistogramStatistics2DMap

6.38 HistogramStatistics3DMap.cc File Reference

```
#include "HistogramStatistics3DMap.h"
```

6.39 HistogramStatistics3DMap.h File Reference

```
#include <omnetpp.h>
```

Classes

- class HistogramStatistics3DMap

6.40 HistoryEntry.h File Reference

```
#include <omnetpp.h>
```

Classes

- class ReaderHistory
- class HistorySampleEntry
- class SampleFragment

6.41 IngressPort.cc File Reference

```
#include "IngressPort.h"
```

6.42 IngressPort.h File Reference

```
#include <stdio.h>
#include <string.h>
#include <omnetpp.h>
#include "../../common/EthernetMacros.h"
#include "../../messagetype/EthernetFrame_m.h"
```

Classes

- class IngressPort

Functions

- Define_Module (IngressPort)

6.42.1 Function Documentation

6.42.1.1 Define_Module()

```
Define_Module (
            IngressPort  )
```

6.43 JoinReaders.cc File Reference

```
#include "../../../../endnode/middleware/rtps/adapters/JoinReaders.h"
```

Functions

- Define_Module (JoinReaders)

6.43.1 Function Documentation

6.43.1.1 Define_Module()

```
Define_Module (
            JoinReaders  )
```

6.44 JoinReaders.h File Reference

```
#include <omnetpp.h>
```

Classes

- class JoinReaders

6.45 LinkTransmissionStatistics.cc File Reference

```
#include "LinkTransmissionStatistics.h"
```

6.46 LinkTransmissionStatistics.h File Reference

```
#include <omnetpp.h>
#include <map>
#include "helperModulesStatistics/VectorStatistics3DMap.h"
```

Classes

- class LinkTransmissionStatistics

6.47 Participant.cc File Reference

```
#include "../../../../endnode/middleware/rtps/participant/Participant.h"
#include "../../../../endnode/middleware/rtps/messages/RegisterEntity_m.h"
#include "../../../../endnode/middleware/rtps/messages/RTPSEthMessage_m.h"
#include "../../../../common/ValidationHandler.h"
#include "string"
#include "sstream"
```

6.48 Participant.h File Reference

```
#include <omnetpp.h>
```

Classes

- class Participant

Functions

- Define_Module (Participant)

6.48.1 Function Documentation

6.48.1.1 Define_Module()

```
Define_Module (
            Participant  )
```

6.49 Reader.cc File Reference

```
#include "../../../../endnode/middleware/rtps/entities/Reader.h"
#include <string.h>
#include <math.h>
#include "./../messages/RTPSEthMessage_m.h"
#include "./../../../../common/EthernetMacros.h"
#include "./../../../../messagetype/EthernetFrame_m.h"
#include "./../../../../endnode/middleware/rtps/messages/RegisterEntity_m.↩
h"
#include "./../../../../endnode/middleware/rtps/messages/Sample_m.h"
```

6.50 Reader.h File Reference

```
#include "../../../../endnode/middleware/rtps/entities/Endpoint.h"
#include "../../../../endnode/middleware/rtps/entities/HistoryEntry.h"
#include "./../../../../common/ValidationHandler.h"
#include <omnetpp.h>
```

Classes

- class Reader

Functions

- Define_Module (Reader)

6.50.1 Function Documentation

6.50.1.1 Define_Module()

```
Define_Module (
          Reader  )
```

6.51 README_RTPS.md File Reference

6.52 Rtps.cc File Reference

```
#include "../../../endnode/middleware/rtps/Rtps.h"
```

Functions

- Define_Module (Rtps)

6.52.1 Function Documentation

6.52.1.1 Define_Module()

```
Define_Module (
          Rtps  )
```

6.53 Rtps.h File Reference

```
#include <omnetpp.h>
```

Classes

- class Rtps

6.54 RtpsMacros.h File Reference

```
#include <math.h>
#include <stdlib.h>
#include "GlobalMacros.h"
#include "EthernetMacros.h"
```

Macros

- #define _MIN_RTPS_PAYLOAD_ (0)
- #define _MAX_RTPS_PAYLOAD_ (4294967296)
- #define _UDP_HEADER_SIZE_ (8)

  Sizes UDP IP Header.
- #define _IP_HEADER_SIZE_ (20)
- #define _RTPS_HEADER_SIZE_ (20)

  Size of RTPS header.
- #define _RTPS_INFO_DST_SIZE_ (16)

  Sizes of relevant RTPS submessages (static part)
- #define _RTPS_INFO_TS_SIZE_ (12)
- #define _RTPS_HEARTBEATFRAG_SIZE (28)
- #define _RTPS_DATAFRAG_STATIC_SIZE_ (36)
- #define _RTPS_NACKFRAG_STATIC_SIZE_ (32)
- #define _RTPS_MAX_MSG_SIZE_ (_MAX_ETH_PAYLOAD_ - _IP_HEADER_SIZE_ - _UDP_HEADER_SIZE_)

  Maximum RTPS sizes.
- #define _RTPS_MAX_FRAG_SIZE_ (_RTPS_MAX_MSG_SIZE_ - _RTPS_HEADER_SIZE_ - _RTPS_INFO_DST_SIZE_ - _RTPS_INFO_TS_SIZE_ - _RTPS_DATAFRAG_STATIC_SIZE_)
- #define _rtps_check_for_max_payload_(payload) (payload<=_MAX_RTPS_PAYLOAD_?payload:_MAX_↩ RTPS_PAYLOAD_)

  RTPS specific methods.
- #define _rtps_add_udp_ip_overhead_(rtps_msg_size) (rtps_msg_size + _IP_HEADER_SIZE_ + _UDP_HEADER_SIZE_)

Enumerations

- enum rtpsEntityKind {
  unknown = 0, participant = 1, writerWithKey = 2, writerNoKey = 3,
  readerNoKey = 4, readerWithKey = 7 }

  RTPS entity kinds.

6.54.1 Macro Definition Documentation

6.54.1.1 _IP_HEADER_SIZE_

```
#define _IP_HEADER_SIZE_ (20)
```

6.54.1.2 _MAX_RTPS_PAYLOAD_

```
#define _MAX_RTPS_PAYLOAD_ (4294967296)
```

6.54.1.3 _MIN_RTPS_PAYLOAD_

```
#define _MIN_RTPS_PAYLOAD_ (0)
```

CONSTANT definitions Minimum and maximum RTPS payload

6.54.1.4 _rtps_add_udp_ip_overhead_

```
#define _rtps_add_udp_ip_overhead_(
              rtps_msg_size ) (rtps_msg_size + _IP_HEADER_SIZE_ + _UDP_HEADER_SIZE_)
```

6.54.1.5 _rtps_check_for_max_payload_

```
#define _rtps_check_for_max_payload_(
              payload ) (payload<=_MAX_RTPS_PAYLOAD_?payload:_MAX_RTPS_PAYLOAD_)
```

RTPS specific methods.

6.54.1.6 _RTPS_DATAFRAG_STATIC_SIZE_

```
#define _RTPS_DATAFRAG_STATIC_SIZE_ (36)
```

6.54.1.7 _RTPS_HEADER_SIZE_

```
#define _RTPS_HEADER_SIZE_ (20)
```

Size of RTPS header.

6.54.1.8 _RTPS_HEARTBEATFRAG_SIZE

```
#define _RTPS_HEARTBEATFRAG_SIZE (28)
```

6.54.1.9 _RTPS_INFO_DST_SIZE_

```
#define _RTPS_INFO_DST_SIZE_ (16)
```

Sizes of relevant RTPS submessages (static part)

6.54.1.10 _RTPS_INFO_TS_SIZE_

```
#define _RTPS_INFO_TS_SIZE_ (12)
```

6.54.1.11 _RTPS_MAX_FRAG_SIZE_

```
#define _RTPS_MAX_FRAG_SIZE_ (_RTPS_MAX_MSG_SIZE_ - _RTPS_HEADER_SIZE_ - _RTPS_INFO_DST_SIZE_
- _RTPS_INFO_TS_SIZE_ - _RTPS_DATAFRAG_STATIC_SIZE_)
```

6.54.1.12 _RTPS_MAX_MSG_SIZE_

```
#define _RTPS_MAX_MSG_SIZE_ (_MAX_ETH_PAYLOAD_ - _IP_HEADER_SIZE_ - _UDP_HEADER_SIZE_)
```

Maximum RTPS sizes.

6.54.1.13 _RTPS_NACKFRAG_STATIC_SIZE_

```
#define _RTPS_NACKFRAG_STATIC_SIZE_ (32)
```

6.54.1.14 _UDP_HEADER_SIZE_

```
#define _UDP_HEADER_SIZE_ (8)
```

Sizes UDP IP Header.

6.54.2 Enumeration Type Documentation

6.54.2.1 rtpsEntityKind

```
enum rtpsEntityKind
```

RTPS entity kinds.

Enumerator

unknown	
participant	
writerWithKey	
writerNoKey	
readerNoKey	
readerWithKey	

6.55 RtpsToEthernetAdapter.cc File Reference

```
#include "../../../../endnode/middleware/rtps/adapters/RtpsToEthernetAdapter.↩
h"
#include "./../messages/RTPSEthMessage_m.h"
#include "./../../../../common/EthernetMacros.h"
#include "./../../../../common/ValidationHandler.h"
#include "../../../../common/RtpsMacros.h"
```

Functions

- Define_Module (RtpsToEthernetAdapter)

6.55.1 Function Documentation

6.55.1.1 Define_Module()

```
Define_Module (
          RtpsToEthernetAdapter  )
```

6.56 RtpsToEthernetAdapter.h File Reference

```
#include "../../../../common/ValidationHandler.h"
#include "../../../../endnode/middleware/rtps/messages/RTPSEthMessage_m.h"
#include <omnetpp.h>
```

Classes

- class RtpsToEthernetAdapter

Macros

- #define _adapter_src_verbose_ if (false)

6.56.1 Macro Definition Documentation

6.56.1.1 _adapter_src_verbose_

```
#define _adapter_src_verbose_ if (false)
```

6.57 SampleMsgCreator.cc File Reference

```
#include "../msgcreators/SampleMsgCreator.h"
#include "../../../common/GlobalMacros.h"
#include "../../../common/RtpsMacros.h"
#include "./../../../common/ValidationHandler.h"
#include "../../../endnode/middleware/rtps/messages/Sample_m.h"
```

6.58 SampleMsgCreator.h File Reference

```
#include <omnetpp.h>
```

Classes

- class SampleMsgCreator

Functions

- Define_Module (SampleMsgCreator)

6.58.1 Function Documentation

6.58.1.1 Define_Module()

```
Define_Module (
            SampleMsgCreator )
```

6.59 SampleSink.cc File Reference

```
#include "SampleSink.h"
```

Functions

- Define_Module (SampleSink)

6.59.1 Function Documentation

6.59.1.1 Define_Module()

```
Define_Module (
            SampleSink  )
```

6.60 SampleSink.h File Reference

```
#include <stdio.h>
#include <string.h>
#include <map>
#include "../../messagetype/EthernetFrame_m.h"
#include "../../common/ValidationHandler.h"
#include "../../endnode/middleware/rtps/messages/Sample_m.h"
#include "../../statistics/StatisticManager.h"
#include <omnetpp.h>
```

Classes

- class SampleSink

Macros

- #define _eth_sampleSink_verbose_ if(true)

6.60.1 Macro Definition Documentation

6.60.1.1 _eth_sampleSink_verbose_

```
#define _eth_sampleSink_verbose_ if(true)
```

6.61 Shaper.cc File Reference

```
#include "../../../../endnode/middleware/rtps/shaper/Shaper.h"
#include "../../../../common/ValidationHandler.h"
```

Functions

- Define_Module (Shaper)

6.61.1 Function Documentation

6.61.1.1 Define_Module()

```
Define_Module (
          Shaper  )
```

6.62 Shaper.h File Reference

```
#include "../../../../endnode/middleware/rtps/messages/RTPSEthMessage_m.h"
#include <omnetpp.h>
```

Classes

- class Shaper

6.63 Sink.cc File Reference

```
#include "Sink.h"
#include <sstream>
```

6.64 Sink.h File Reference

```
#include <omnetpp.h>
#include <stdio.h>
#include <string.h>
#include <sstream>
#include <map>
#include "../../common/ValidationHandler.h"
#include "../../messagetype/EthernetFrame_m.h"
#include "../../statistics/StatisticManager.h"
```

Classes

- class Sink

Functions

- Define_Module (Sink)

6.64.1 Function Documentation

6.64.1.1 Define_Module()

```
Define_Module (
            Sink  )
```

6.65 StatisticManager.cc File Reference

```
#include "StatisticManager.h"
```

6.66 StatisticManager.h File Reference

```
#include <map>
#include <stdio.h>
#include <string.h>
#include <omnetpp.h>
#include "FramesLostStatistics.h"
#include "ddsSampleLatencyStatistics.h"
#include "E2ELatencyStatistics.h"
#include "LinkTransmissionStatistics.h"
#include "TimeAwareShaperSegmentStatistic.h"
```

Classes

- class StatisticManager

6.67 TimeAwareShaperSegmentStatistic.cc File Reference

```
#include "TimeAwareShaperSegmentStatistic.h"
```

6.68 TimeAwareShaperSegmentStatistic.h File Reference

```
#include <omnetpp.h>
#include <map>
#include "helperModulesStatistics/VectorStatistics2DMap.h"
```

Classes

- class TimeAwareShaperSegmentStatistic

Enumerations

- enum tasTimeSegments { CRITICAL_SENDING_SEGMENT = 2, CRITICAL_GUARDBAND_SEGMENT = 1, NONCRITICAL_SENDING_SEGMENT = -2, NONCRITICAL_GUARDBAND_SEGMENT = -1 }

6.68.1 Enumeration Type Documentation

6.68.1.1 tasTimeSegments

```
enum tasTimeSegments
```

Enum of TAS time segments

Enumerator

CRITICAL_SENDING_SEGMENT	
CRITICAL_GUARDBAND_SEGMENT	
NONCRITICAL_SENDING_SEGMENT	
NONCRITICAL_GUARDBAND_SEGMENT	

6.69 TrafficSource.cc File Reference

```
#include "../trafficsrcs/TrafficSource.h"
#include "../../../common/GlobalMacros.h"
#include "../../../common/ValidationHandler.h"
```

6.70 TrafficSource.h File Reference

```
#include <omnetpp.h>
```

Classes

- class TrafficSource

Macros

- #define _burst_src_verbose_ if (true)

Functions

- Define_Module (TrafficSource)

6.70.1 Macro Definition Documentation

6.70.1.1 _burst_src_verbose_

```
#define _burst_src_verbose_ if (true)
```

6.70.2 Function Documentation

6.70.2.1 Define_Module()

```
Define_Module (
            TrafficSource  )
```

6.71 UdpIpStack.cc File Reference

```
#include "../../endnode/udpipstack/UdpIpStack.h"
#include "../../common/ValidationHandler.h"
#include "../../endnode/middleware/rtps/messages/RTPSEthMessage_m.h"
#include "../../messagetype/EthernetFrame_m.h"
#include <string.h>
#include <sstream>
```

6.72 UdpIpStack.h File Reference

```
#include <omnetpp.h>
```

Classes

- class UdpIpStack

Functions

- Define_Module (UdpIpStack)

6.72.1 Function Documentation

6.72.1.1 Define_Module()

```
Define_Module (
            UdpIpStack  )
```

6.73 ValidationHandler.h File Reference

```
#include <omnetpp.h>
```

Classes

- class ValidationHandler

6.74 VectorStatistics2DMap.cc File Reference

```
#include "VectorStatistics2DMap.h"
```

6.75 VectorStatistics2DMap.h File Reference

```
#include <omnetpp.h>
#include <tuple>
#include "../../common/GlobalMacros.h"
```

Classes

- class VectorStatistics2DMap

6.76 VectorStatistics3DMap.cc File Reference

```
#include <sstream>
#include "VectorStatistics3DMap.h"
```

6.77 VectorStatistics3DMap.h File Reference

```
#include <omnetpp.h>
#include <tuple>
#include <map>
```

Classes

- class VectorStatistics3DMap

6.78 Writer.cc File Reference

```
#include "../../../../endnode/middleware/rtps/entities/Writer.h"
#include <math.h>
#include "./../messages/RTPSEthMessage_m.h"
#include "./../../../../common/ValidationHandler.h"
#include "./../../../../endnode/middleware/rtps/messages/RegisterEntity_m.↩
h"
#include "./../../../../endnode/middleware/rtps/messages/Sample_m.h"
#include "../../../../common/RtpsMacros.h"
```

6.79 Writer.h File Reference

```
#include "../../../../endnode/middleware/rtps/entities/Endpoint.h"
#include "../../../../endnode/middleware/rtps/entities/HistoryEntry.h"
#include "../../../../endnode/middleware/rtps/messages/RTPSEthMessage_m.h"
#include <omnetpp.h>
```

Classes

- class Writer

Functions

- Define_Module (Writer)

6.79.1 Function Documentation

6.79.1.1 Define_Module()

```
Define_Module (
            Writer  )
```

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