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Open Innovations Association FRUCT

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Simulation-based Optimization of Signaling Procedures in IP Multimedia Subsystem

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Introduction

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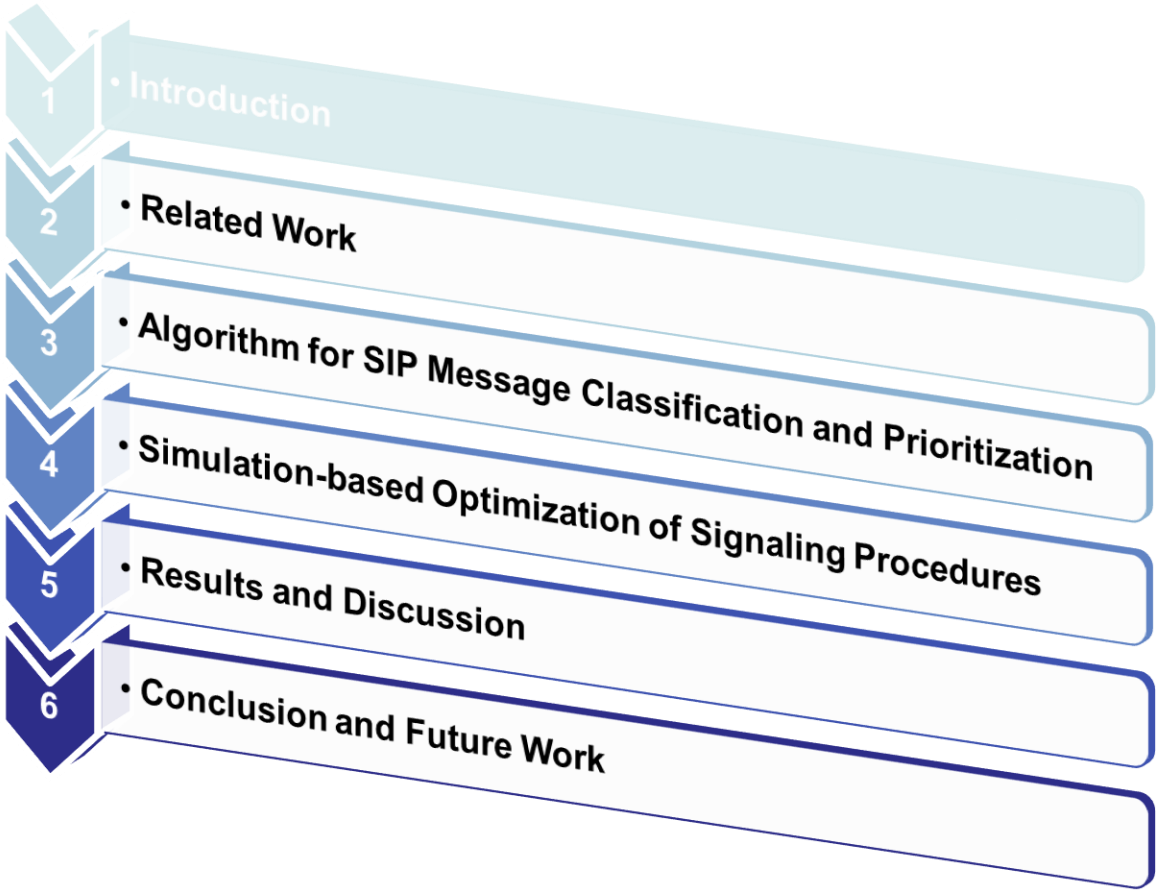

Introduction

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- IP Multimedia Subsystem (IMS)
  - Logical architecture for a Next Generation Network (NGN) control plane
  - Supports a development of next generation services
  - Faces a challenge of rapidly increasing amount of signaling
- Call Session Control Function (CSCF)
  - Manages much of the signaling that occurs in the IMS
  - Configured to process SIP messages using a FIFO scheduling
- First In First Out (FIFO)
  - Does not enable
    - SIP messages that increase the efficiency of IMS to be processed earlier
    - Service differentiation because all SIP messages are treated equally
    - Prevention of SIP messages to loopback through one or more CSCFs

Research Motive

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- Motive
  - Need for a differentiated handling of SIP messages in order to optmize SIP signaling procedures
- Previous work
  - Proposal of SIP message classification and prioritization algorithm
    - Class 1: SIP messages that terminate the communication session, such as BYE, CANCEL
    - Class 2: Light weight SIP messages such as REGISTER, MESSAGE, PUBLISH, NOTIFY and SUBSCRIBE
    - Class 3: SIP messages that establish the communication session, such as INVITE, and provisional responses, such as 1xx status codes

Research Aim

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- Aim
  - Implement SIP message classification and prioritization algorithm in Network Simulator version 2 (ns-2)
  - Analyze an impact of proposed algorithm on SIP performance metrics
    - Registration Request Delay, Session Request Delay, Session Disconnect Delay
  - Perform the simulation-based optimization of SIP signaling procedures
    - Under high-load or overload conditions

Related Work

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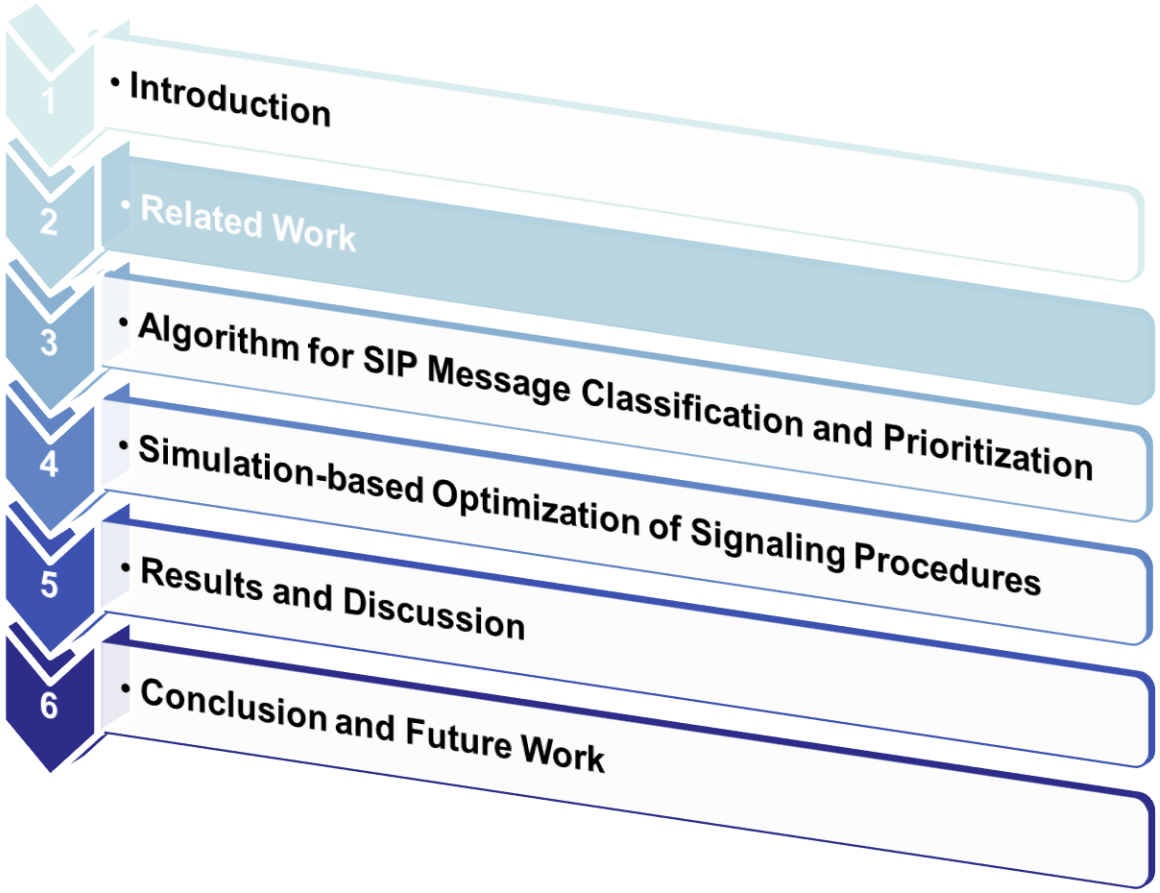

Related Work

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- SIP server overload control
  - Load balancing approach
    - Tries to avoid the overload by distributing the traffic load equally among the local SIP servers
  - Load reducing approach
    - Tries to prevent the overload collapse by reducing the traffic load in the whole SIP network
      - Priority-based
      - Push-back
      - Retransmission-based
- Focus is based on priority-based overload control
  - Mitigate overload by rejecting the SIP messages with low priority
  - Prioritization is performed by using different SIP message header fields

Algorithm Description

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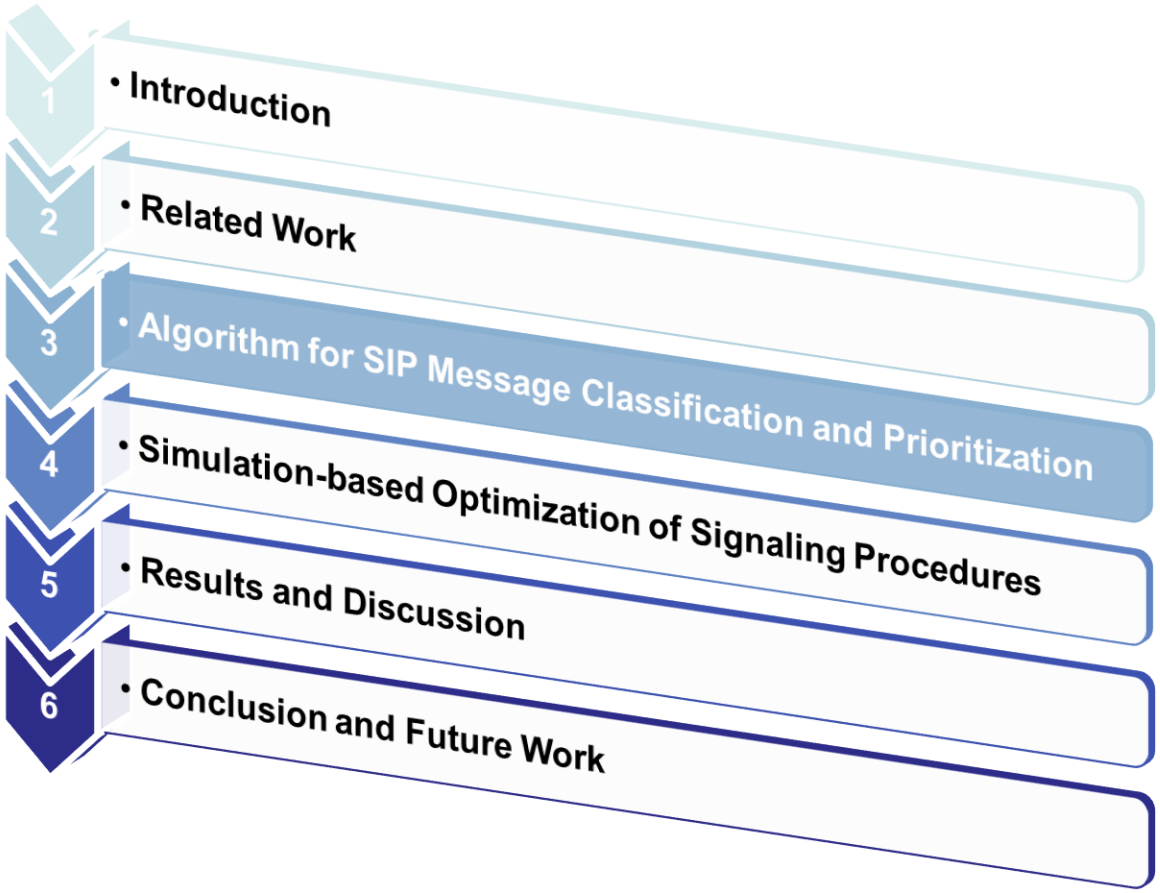

Informal Algorithm Description

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- SIP message classification and prioritization algorithm
  - Two modes of operation:
    - Normal mode, wherein the SIP messages are processed using FIFO scheduling
    - Priority mode, wherein the SIP messages are processed by our three-priority level classification scheme
  - Normal mode of operation is switched to the priority mode when congestion is detected
    - Congestion is determined by exceeding the predefined queue length
  - Priority mode of operation implies the packet's content check and classification according to SIP message type

Formal Algorithm Description

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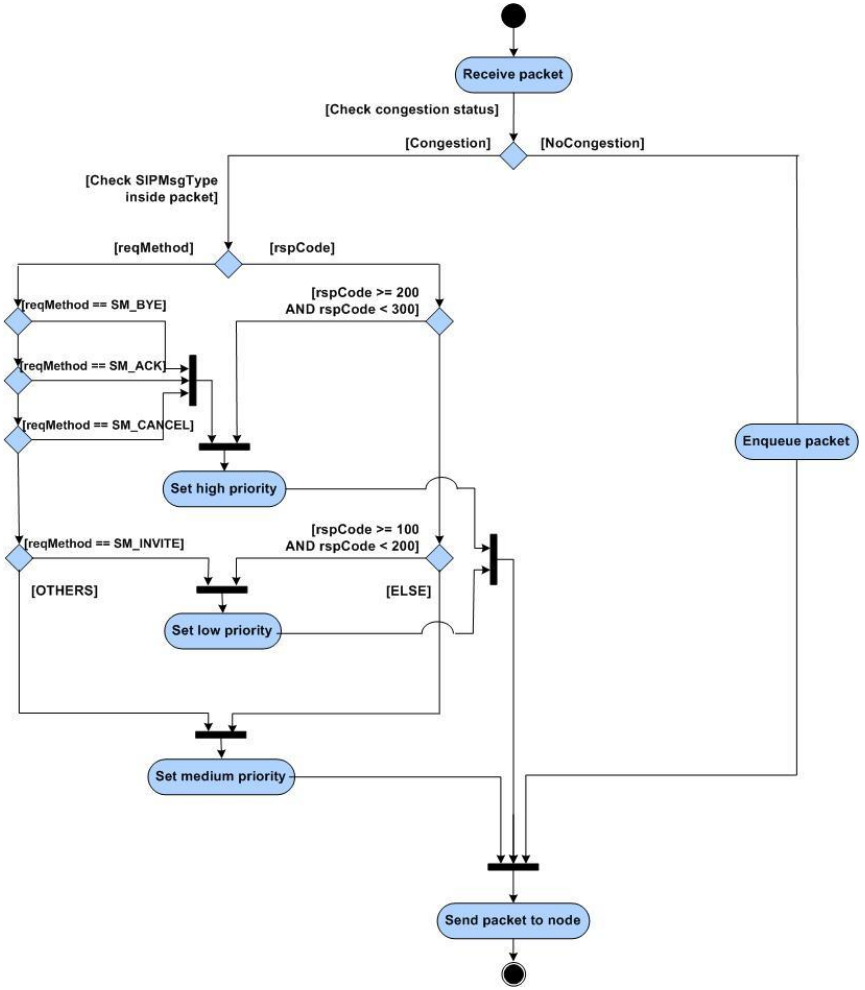

Pseudocode 1 SIP message classification and prioritization

```
Algorithm SIPMsgClassPrio
   receive packet
   IF congestion status is true THEN
      CASE msgType inside packet OF
         CASE reqMethod OF
            SM_BYE     :
            SM_ACK     :
            SM_CANCEL  :
            set high priority
            SM_INVITE  :
            set low priority
            OTHERS     :
            set medium priority
         ENDCASE
         CASE rspCode OF
            IF rspCode >= 100 AND rspCode < 200 THEN
               set low priority
            ELSE IF rspCode >= 200 AND rspCode < 300 THEN
               set high priority
            ELSE IF rspCode >= 300 AND rspCode < 700 THEN
               set medium priority
            ELSE
               set low priority
            ENDIF
         ENDCASE
      ENDCASE
   ELSE
      enqueue packet
   ENDIF
      send packet to node
END SIPMsgClassPrio
```

Simulation

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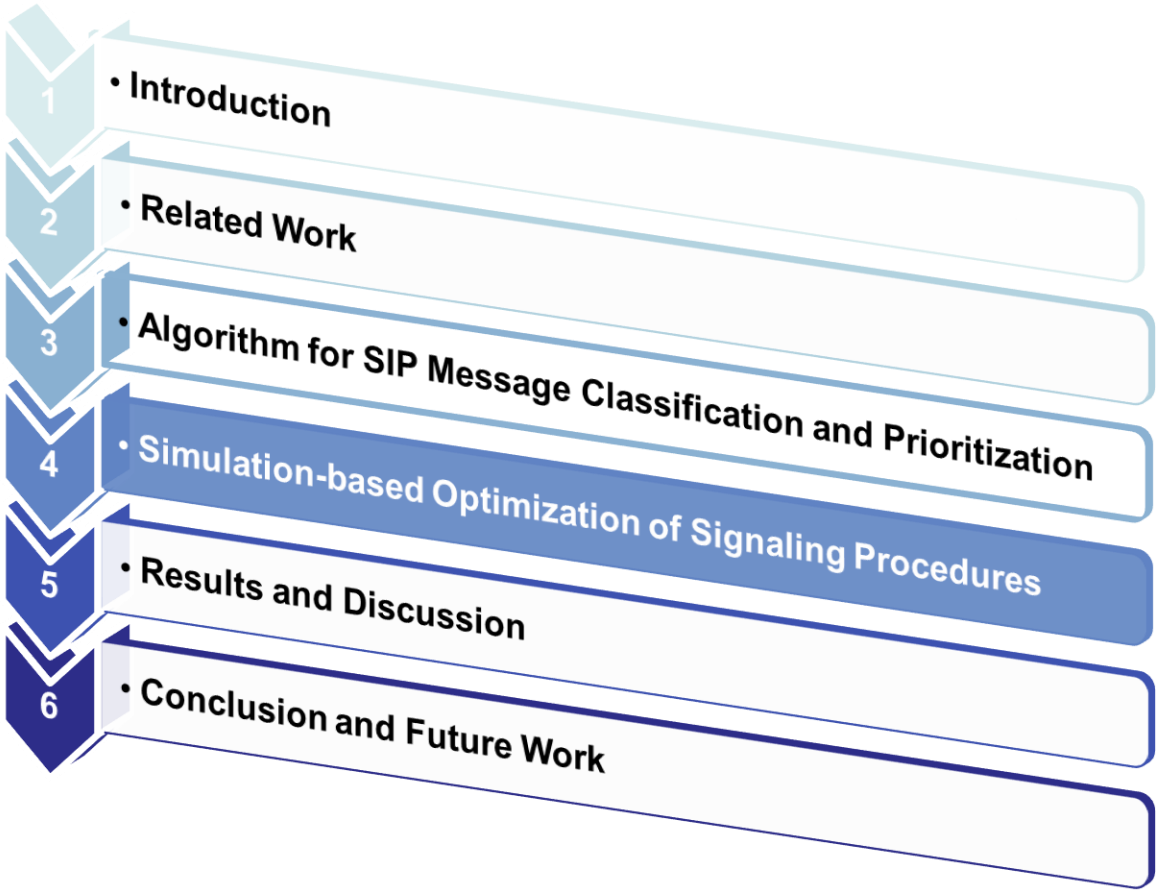

Simulation Environment

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- Simulation environment for SIP message classification and prioritization algorithm
  - Different simulators are compared
    - ns-2, ns-3, OPNET, OMNET++, QualNet
  - Comaprison in terms of
    - Modelling capabilities
    - Credibility of simulation models and results
    - Extendibility
    - Usability
    - Cost of licenses
  - Simulator ns-2 is chosen (version 2.27)
    - Free and open-source simulator
    - Provides IMS functionality by adding an independently developed SIP module
      - SIP proxy server incorporate the functionality of CSCF

Simulation Setup

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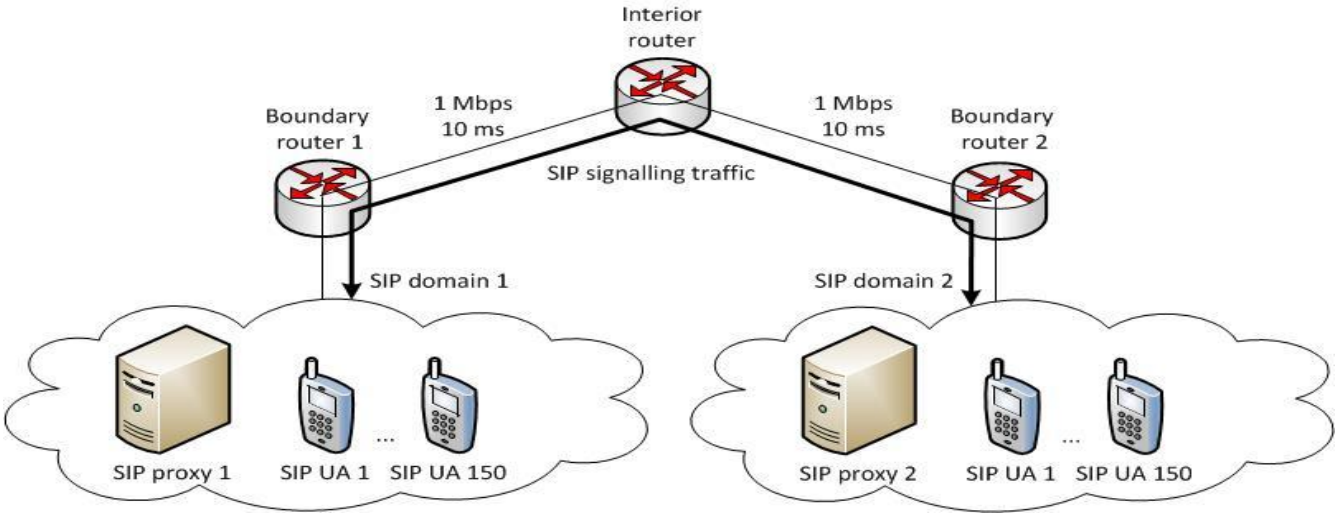

- Different number of SIP messages exchanged during SIP signaling procedures
  - Three types of SIP signaling procedures considered: registration, establishment and termination of session
- Simultaneous SIP signaling procedures are used to generate background traffic
  - Number of simultaneous SIP signaling procedures is in the range from 0 to 900
- Simulations are run for 500 simulations seconds

Results and Discussion

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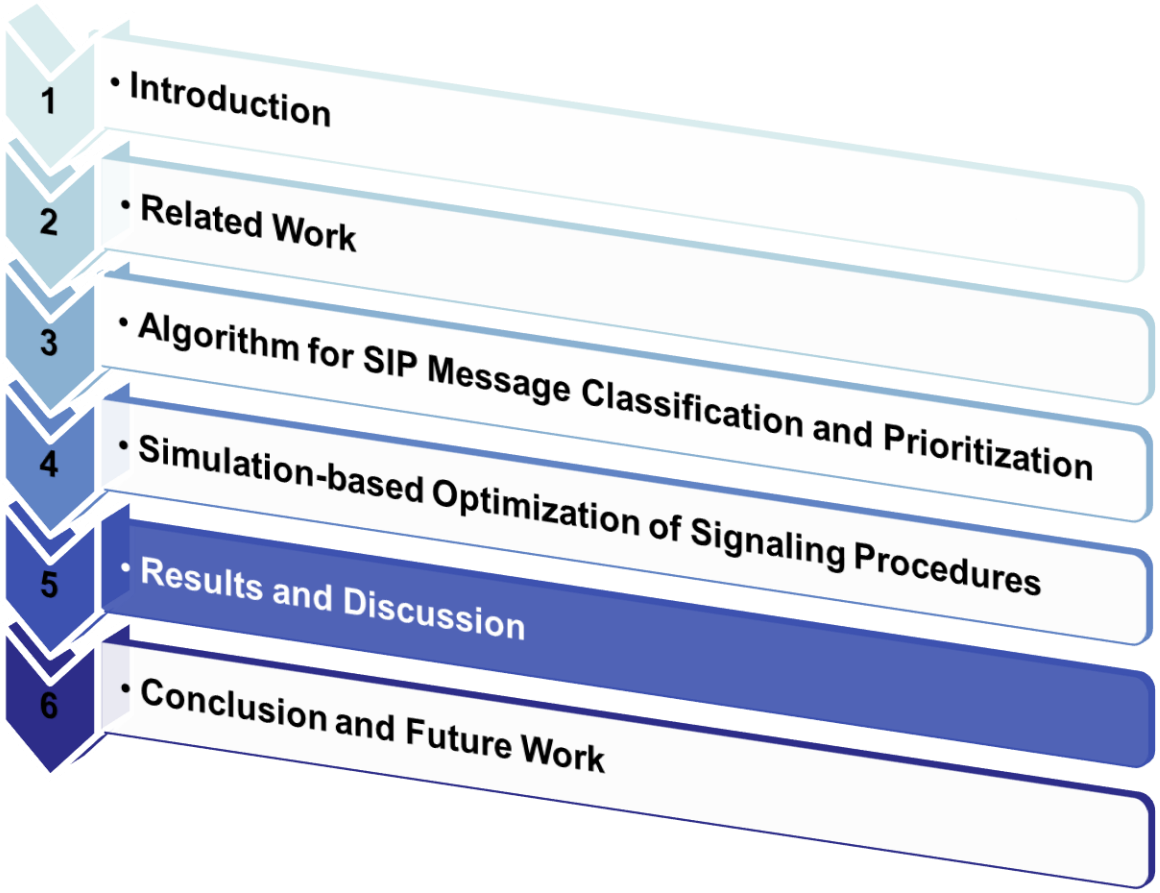

Simulation results

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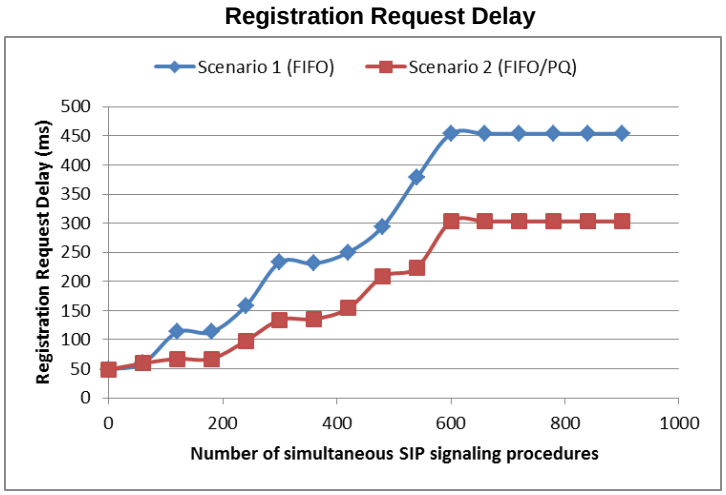
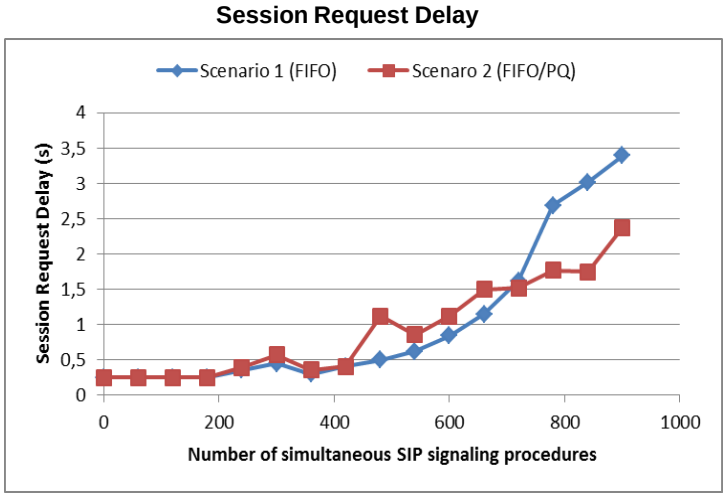
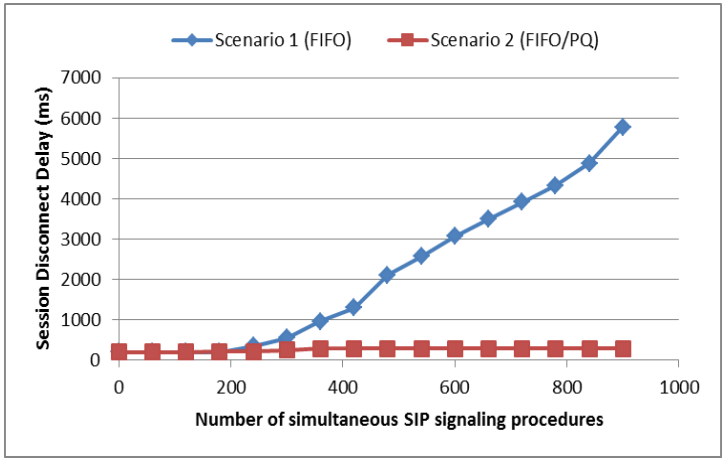
- SIP performance metrics
  - Registration Request Delay
  - Session Request Delay
  - Session Disconnect Delay
- Defined in RFC 6076







Discussion

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- Priority mode of operation
  - High priority value
    - SIP messages to terminate the session
      - Improve QoS, e.g., reduce duration of session termination procedure
      - Improve QoE, e.g., improve billing user experience
  - Low priority value
    - SIP messages to establish the session
      - Improve QoS, e.g. , block a new communication sessions
      - Improve QoE, e.g., users do not accept service degradation or interruption

Conclusion and Future Work

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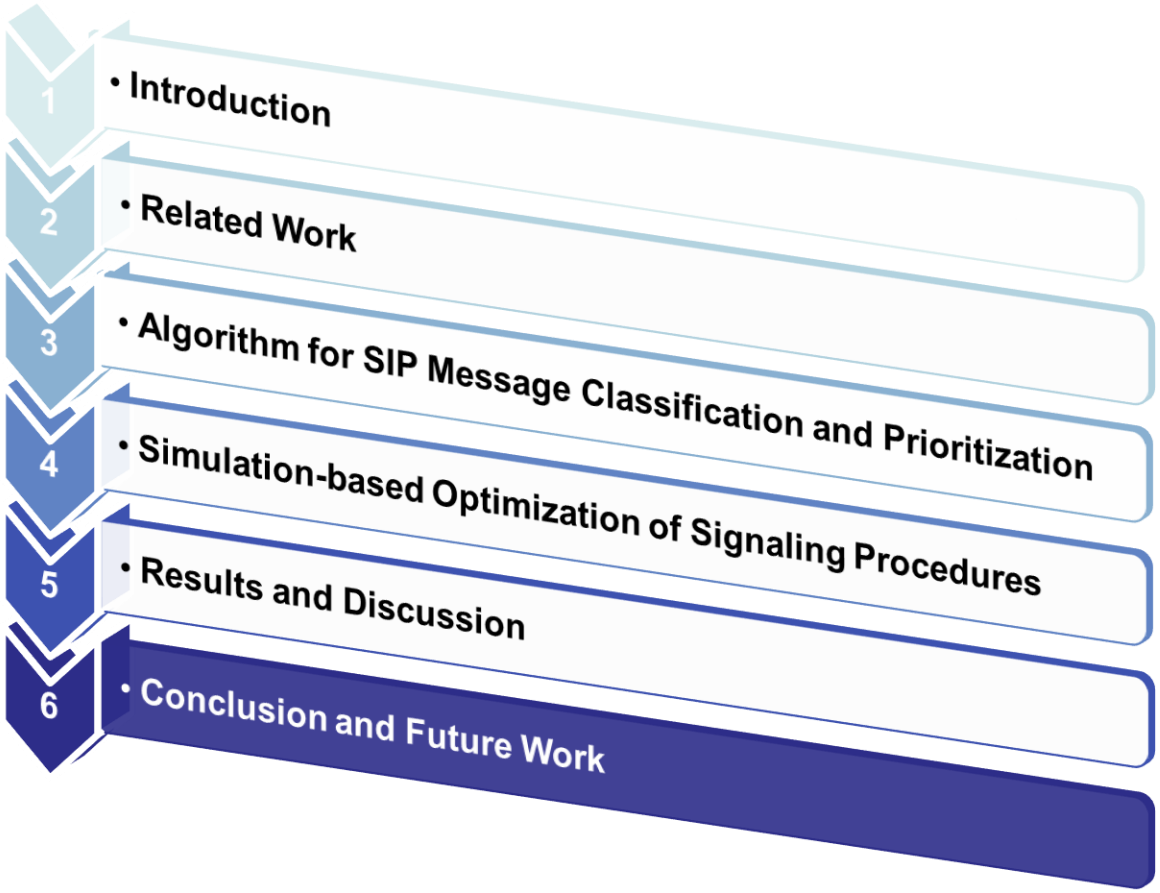

Conclusion

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- SIP message classification and prioritization scheme is implemented in ns-2
- Simulation-based optimization of SIP signaling procedures is performed
  - Simulation results are analyzed in terms of RRD, SRD, SDD
  - Assiging high priority value to SIP messages that terminate existing sessions may reduce network congestion and improve QoS
  - Assiging low priority value to SIP messages that establih a new sessions may improve QoE

Future Work

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- Development and deployment of algorithm for SIP message classification and prioritization in experimental environment
- Three-priority level classification of SIP messages
  - Enables the prioritization of different types of services
    - Useful in emergency situations
      - All SIP messages of one type of service (e.g., instant messaging) may be prioritized over all SIP messages of another type of service (i.e., voice calls)
    - This could not be simulated due to the limitations of used SIP module
    - This will be tested in experimental environment in future research activities

Thank you for attention.

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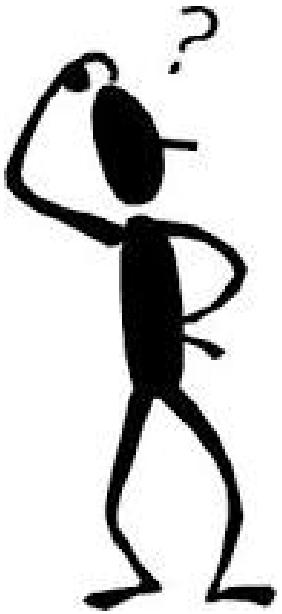

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