

Mô phỏng thông báo khẩn cấp khi xảy ra tai nạn dựa trên mạng VANET sử dụng NS3 và SUMO

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GVHD: TS. Nguyễn Văn Hiếu

Tháng 11, 2025

Mục lục

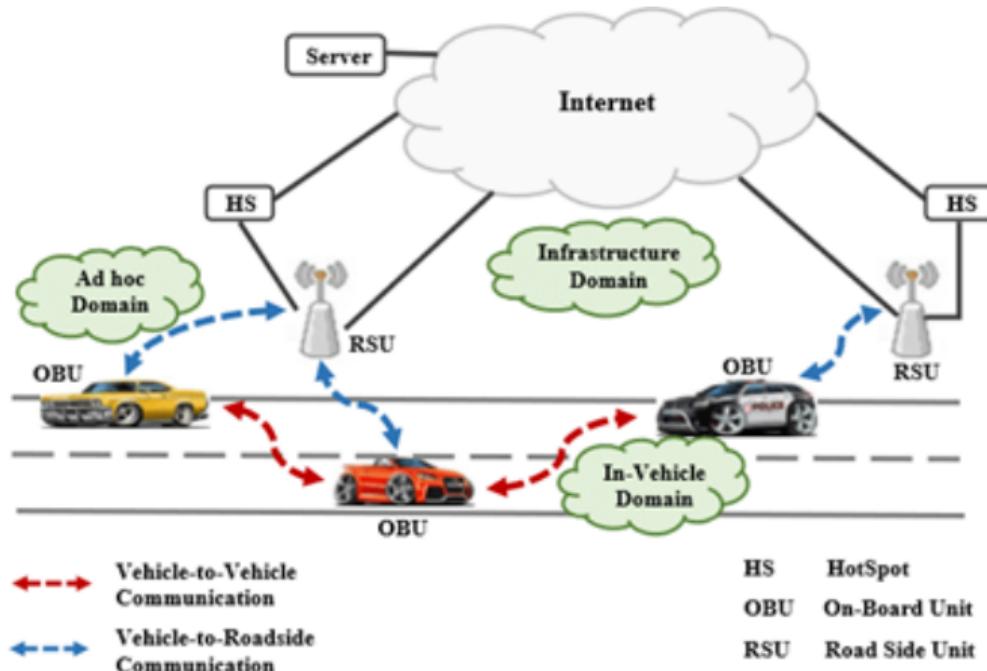
- 1 Giới thiệu mạng VANET
- 2 Mô hình hệ thống
- 3 Mô phỏng và phân tích kết quả

Mục lục

- 1 Giới thiệu mạng VANET
- 2 Mô hình hệ thống
- 3 Mô phỏng và phân tích kết quả

Giới thiệu mạng VANET

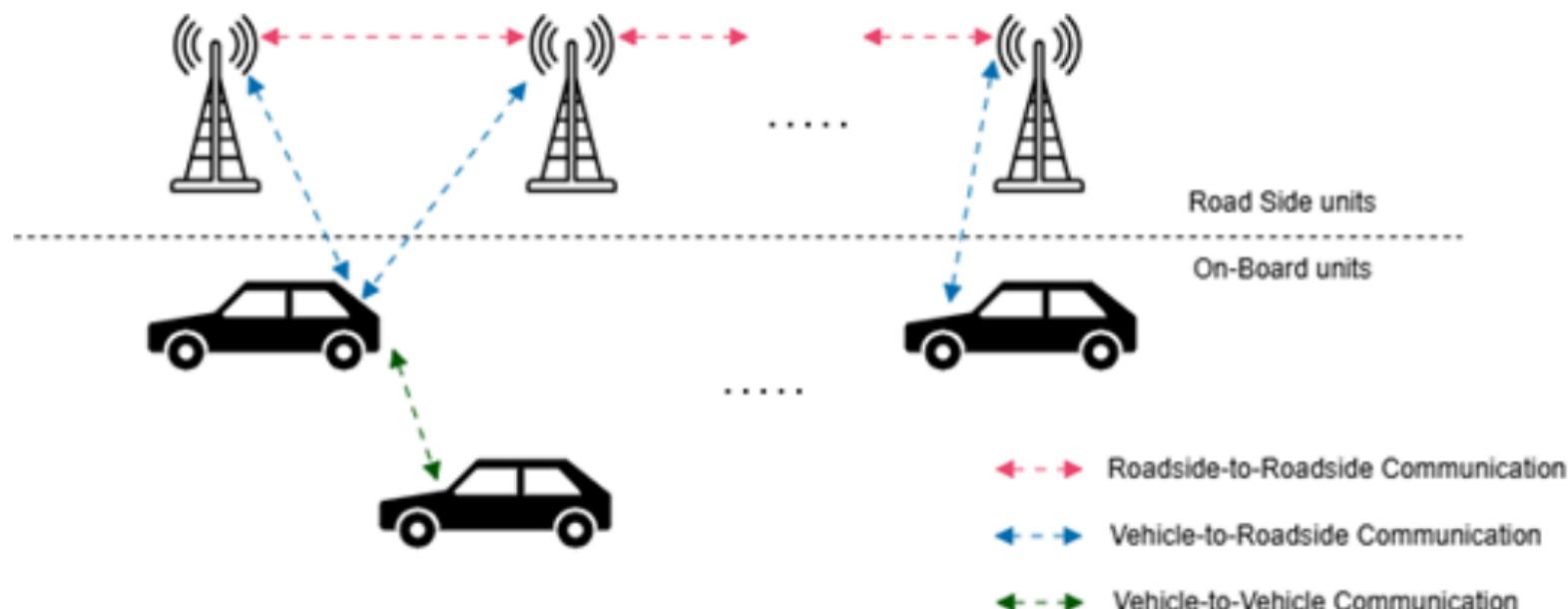
- Vehicular ad hoc Network
- Mục đích:
 - Cung cấp sự an toàn
 - Định vị trên đường
 - Dịch vụ ven đường



Mục lục

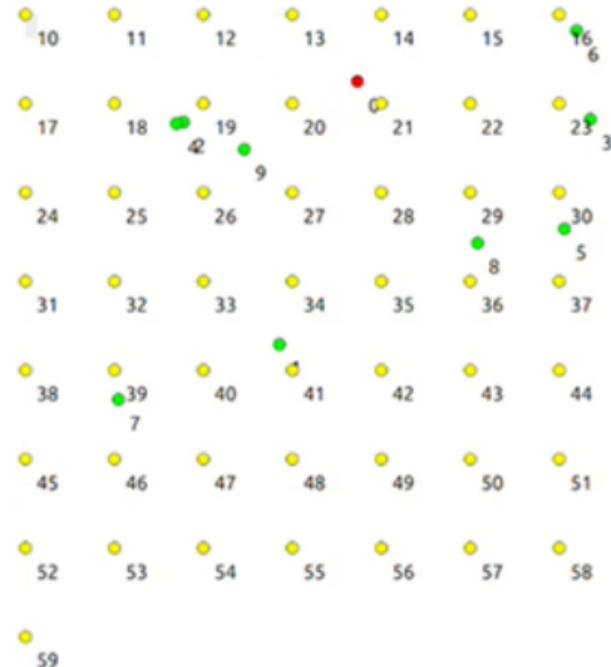
- 1 Giới thiệu mạng VANET
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- 3 Mô phỏng và phân tích kết quả

Mô hình mạng theo thực tế



Mô hình mạng mô phỏng

- Gồm 10 node Car (màu xanh).
- 50 node RSU được đặt cố định theo dạng lưới $150\text{m} \times 150\text{m}$ (màu vàng).
- Mục tiêu: gửi cảnh báo từ node Car 0 (màu đỏ).



Các tầng của gói tin thông báo



Application Layer

Transportation Layer

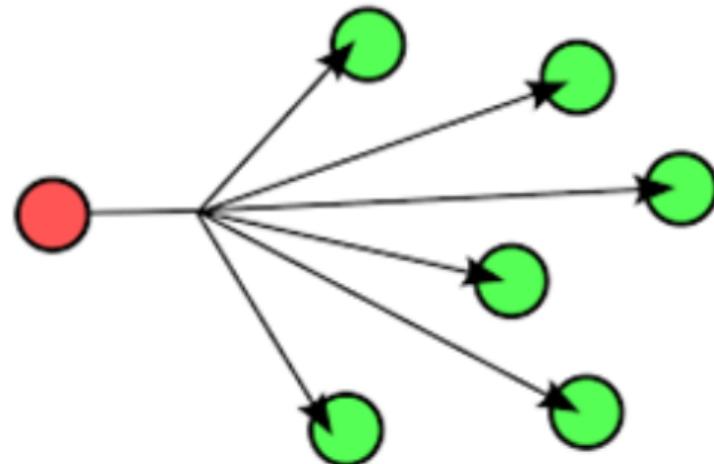
Network Layer

Data Link Layer

Physical Layer

Cách thức truyền tin

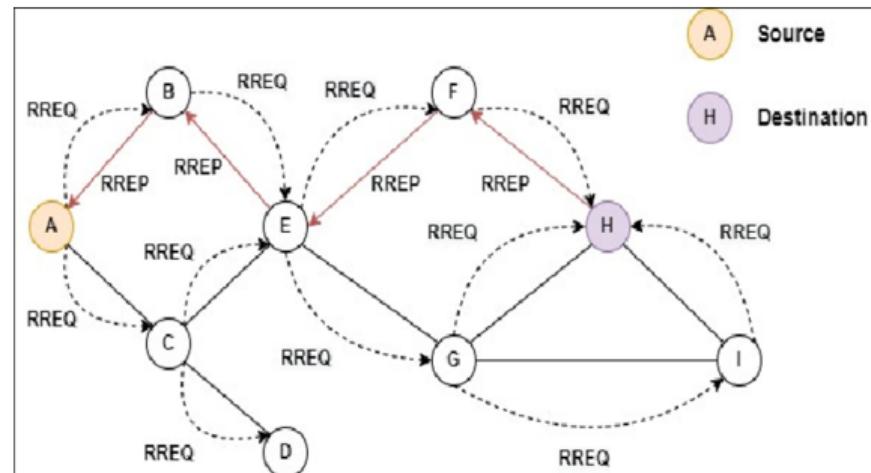
- Truyền tin theo 2 cách:
 - Broadcast
 - Giao thức định tuyến AODV



Broadcast

Cách thức truyền tin

- Truyền tin theo 2 cách:
 - Broadcast
 - Giao thức định tuyến AODV



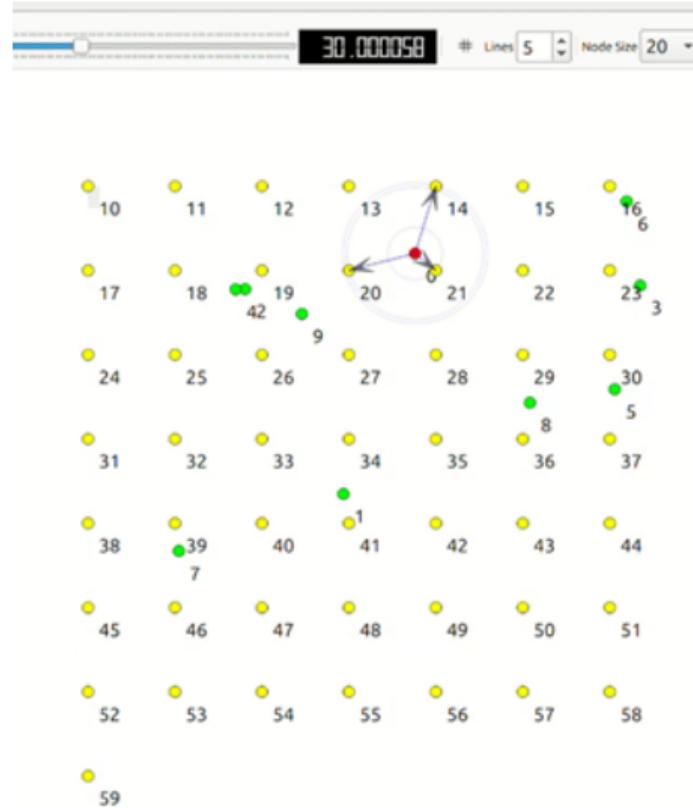
Giao thức định tuyến AODV

Mục lục

- 1 Giới thiệu mạng VANET
- 2 Mô hình hệ thống
- 3 Mô phỏng và phân tích kết quả

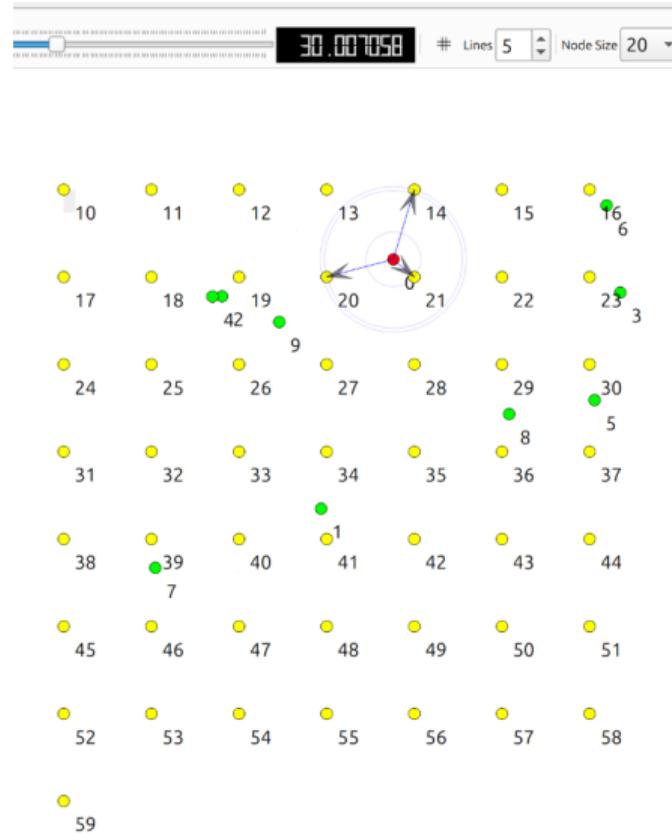
Kích bản mô phỏng

- Broadcast:



Kích bản mô phỏng

- Giao thức định tuyến AODV:



Gói tin cảnh báo Broadcast

```
- IEEE 802.11 Data, Flags: .....
  Type/Subtype: Data (0x0020)
- Frame Control Field: 0x0800
  .... .00 = Version: 0
  .... 10.. = Type: Data frame (2)
  0000 .... = Subtype: 0
- Flags: 0x00
  .... .00 = DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0 From DS: 0) (0x0)
  .... .0.. = More Fragments: This is the last fragment
  .... 0... = Retry: Frame is not being retransmitted
  ....0 .... = PWR MGT: STA will stay up
  ..0. .... = More Data: No data buffered
  .0... .... = Protected flag: Data is not protected
  0.... .... = +HTC/Order flag: Not strictly ordered
.000 0000 0000 0000 = Duration: 0 microseconds
Receiver address: Broadcast (ff:ff:ff:ff:ff:ff)
Transmitter address: 00:00:00_00:00:01 (00:00:00:00:00:01)
Destination address: Broadcast (ff:ff:ff:ff:ff:ff)
Source address: 00:00:00_00:00:01 (00:00:00:00:00:01)
BSS Id: 00:00:00_00:00:01 (00:00:00:00:00:01)
  .... .... .... 0000 = Fragment number: 0
  0000 0000 0000 .... = Sequence number: 0
[WLAN Flags: ....]
```

Data Link Layer - IEEE 802.11p

Gói tin cảnh báo Broadcast

- IEEE 802.11 Data, Flags.
- Logical-Link Control
 - DSAP: SNAP (0xaa)
1010 101. = SAP: SNAP
.... ...0 = IG Bit: Individual
 - SSAP: SNAP (0xaa)
1010 101. = SAP: SNAP
.... ...0 = CR Bit: Command
 - Control field: U, func=UI (0x03)
000. 00.. = Command: Unnumbered Information (0x00)
.... ..11 = Frame type: Unnumbered frame (0x3)
Organization Code: 00:00:00 (Officially Xerox, but
Type: IPv4 (0x0800)

Data Link Layer - Logic-Link Control

Gói tin cảnh báo Broadcast

```
Internet Protocol Version 4, Src: 10.0.0.1, Dst: 255.255.255.255
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    0000 00.. = Differentiated Services Codepoint: Default (0)
    .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 60
Identification: 0x0000 (0)
Flags: 0x0
    0.... .... = Reserved bit: Not set
    .0... .... = Don't fragment: Not set
    ..0. .... = More fragments: Not set
    ...0 0000 0000 0000 = Fragment Offset: 0
Time to Live: 64
Protocol: UDP (17)
Header Checksum: 0x0000 [validation disabled]
[Header checksum status: Unverified]
Source Address: 10.0.0.1
Destination Address: 255.255.255.255
```

Network Layer

Gói tin cảnh báo Broadcast

- ▼ User Datagram Protocol, Src Port: 49153, Dst Port: 80
 - Source Port: 49153
 - Destination Port: 80
 - Length: 40
- ▼ Checksum: 0x0000 [zero-value ignored]
 - [Checksum Status: Not present]
 - [Stream index: 0]
- ▼ [Timestamps]
 - [Time since first frame: 0.000304000 seconds]
 - [Time since previous frame: 0.000000000 seconds]
- UDP payload (32 bytes)

Transportation Layer

Gói tin cảnh báo Broadcast

- ▼ Data (32 bytes)

Data: 436172203020686173206163636964656e742e2048454c502c20504c45415345

Text: Car 0 has accident. HELP, PLEASE

[Length: 32]

Data Field

Gói tin cảnh báo giao thức định tuyến AODV

```
▼ IEEE 802.11 Data, Flags: .....
  Type/Subtype: Data (0x0020)
  ▼ Frame Control Field: 0x0800
    .... ..00 = Version: 0
    .... 10.. = Type: Data frame (2)
    0000 .... = Subtype: 0
  ▼ Flags: 0x00
    .... ..00 = DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0 From DS: 0) (0x0)
    .... .0.. = More Fragments: This is the last fragment
    .... 0... = Retry: Frame is not being retransmitted
    ...0 .... = PWR MGT: STA will stay up
    ..0. .... = More Data: No data buffered
    .0... .... = Protected flag: Data is not protected
    0.... .... = +HTC/Order flag: Not strictly ordered
  .000 0000 0101 0100 = Duration: 84 microseconds
  Receiver address: 00:00:00_00:00:15 (00:00:00:00:00:15)
  Transmitter address: 00:00:00_00:00:01 (00:00:00:00:00:01)
  Destination address: 00:00:00_00:00:15 (00:00:00:00:00:15)
  Source address: 00:00:00_00:00:01 (00:00:00:00:00:01)
  BSS Id: 00:00:00_00:00:01 (00:00:00:00:00:01)
    .... .... 0000 = Fragment number: 0
  0000 0010 0011 .... = Sequence number: 35
  [WLAN Flags: ....]
```

Data Link Layer - IEEE 802.11p

Gói tin cảnh báo giao thức định tuyến AODV

Logical-Link Control

DSAP: SNAP (0xaa)

1010 101. = SAP: SNAP

.... ...0 = IG Bit: Individual

SSAP: SNAP (0xaa)

1010 101. = SAP: SNAP

.... ...0 = CR Bit: Command

Control field: U, func=UI (0x03)

000. 00.. = Command: Unnumbered Information (0x00)

.... ..11 = Frame type: Unnumbered frame (0x3)

Organization Code: 00:00:00 (Officially Xerox, but
Type: IPv4 (0x0800))

Data Link Layer - Logic-Link Control

Gói tin cảnh báo giao thức định tuyến AODV

```
Internet Protocol Version 4, Src: 10.0.0.1, Dst: 10.0.0.11
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    0000 00.. = Differentiated Services Codepoint: Default (0)
    .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
Total Length: 60
Identification: 0x0000 (0)
Flags: 0x0
    0.... .... = Reserved bit: Not set
    .0... .... = Don't fragment: Not set
    ..0. .... = More fragments: Not set
    ...0 0000 0000 0000 = Fragment Offset: 0
Time to Live: 64
Protocol: UDP (17)
Header Checksum: 0x0000 [validation disabled]
[Header checksum status: Unverified]
Source Address: 10.0.0.1
Destination Address: 10.0.0.11
```

Network Layer

Gói tin cảnh báo giao thức định tuyến AODV

- ▼ User Datagram Protocol, Src Port: 49153, Dst Port: 80
 - Source Port: 49153
 - Destination Port: 80
 - Length: 40
- ▼ Checksum: 0x0000 [zero-value ignored]
 - [Checksum Status: Not present]
 - [Stream index: 67]
- ▼ [Timestamps]
 - [Time since first frame: 0.000000000 seconds]
 - [Time since previous frame: 0.000000000 seconds]
- UDP payload (32 bytes)

Transportation Layer

Gói tin cảnh báo giao thức định tuyến AODV

- ▼ Data (32 bytes)

Data: 436172203020686173206163636964656e742e2048454c502c20504c45415345

Text: Car 0 has accident. HELP, PLEASE

[Length: 32]

Data Field

Gói tin phản hồi của Processing Center

```
- IEEE 802.11 Data, Flags: .....
  Type/Subtype: Data (0x0020)
  ▼ Frame Control Field: 0x0800
    .... .00 = Version: 0
    .... 10.. = Type: Data frame (2)
    0000 .... = Subtype: 0
  ▼ Flags: 0x00
    .... .00 = DS status: Not leaving DS or network is operating in AD-HOC mode (To DS: 0 From DS: 0) (0x0)
    .... .0.. = More Fragments: This is the last fragment
    .... 0... = Retry: Frame is not being retransmitted
    ...0 .... = PWR MGT: STA will stay up
    ..0. .... = More Data: No data buffered
    .0... .... = Protected flag: Data is not protected
    0.... .... = +HTC/Order flag: Not strictly ordered
    .000 0000 0101 0100 = Duration: 84 microseconds
  Receiver address: 00:00:00_00:00:0c (00:00:00:00:00:0c)
  Transmitter address: 00:00:00_00:00:0b (00:00:00:00:00:0b)
  Destination address: 00:00:00_00:00:0c (00:00:00:00:00:0c)
  Source address: 00:00:00_00:00:0b (00:00:00:00:00:0b)
  BSS Id: 00:00:00_00:00:0b (00:00:00:00:00:0b)
    .... .... .0000 = Fragment number: 0
    0000 0010 0010 .... = Sequence number: 34
  [WLAN Flags: ....]
```

Data Link Layer - IEEE 802.11p

Gói tin phản hồi của Processing Center

Logical-Link Control

DSAP: SNAP (0xaa)

1010 101. = SAP: SNAP

.... .0 = IG Bit: Individual

SSAP: SNAP (0xaa)

1010 101. = SAP: SNAP

.... .0 = CR Bit: Command

Control field: U, func=UI (0x03)

000. 00.. = Command: Unnumbered Information (0x00)

.... ..11 = Frame type: Unnumbered frame (0x3)

Organization Code: 00:00:00 (Officially Xerox, but
Type: IPv4 (0x0800))

Data Link Layer - Logic-Link Control

Gói tin phản hồi của Processing Center

```
Internet Protocol Version 4, Src: 10.0.0.11, Dst: 10.0.0.1
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
    Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
        0000 00.. = Differentiated Services Codepoint: Default (0)
        .... ..00 = Explicit Congestion Notification: Not ECN-Capable Transport (0)
    Total Length: 72
    Identification: 0x0000 (0)
    000. .... = Flags: 0x0
        0.... .... = Reserved bit: Not set
        .0.. .... = Don't fragment: Not set
        ..0. .... = More fragments: Not set
        ...0 0000 0000 0000 = Fragment Offset: 0
    Time to Live: 64
    Protocol: UDP (17)
    Header Checksum: 0x0000 [validation disabled]
    [Header checksum status: Unverified]
    Source Address: 10.0.0.11
    Destination Address: 10.0.0.1
```

Network Layer

Gói tin phản hồi của Processing Center

```
-- 
- User Datagram Protocol, Src Port: 80, Dst Port: 80
  Source Port: 80
  Destination Port: 80
  Length: 52
- Checksum: 0x0000 [zero-value ignored]
  [Checksum Status: Not present]
  [Stream index: 68]
- [Timestamps]
  [Time since first frame: 0.000000000 seconds]
  [Time since previous frame: 0.000000000 seconds]
  UDP payload (44 bytes)
- Data (44 bytes)
  Data: 52535520726563656976656420616c6572742066726f6d2031302e302e3120283332206279746573290a
  Text: RSU received alert from 10.0.0.1 (32 bytes)\n
  [Length: 44]
```

Transportation Layer - Data Field

Phân tích các thông số

- Các thông số dùng để đánh giá hệ thống
 - End-to-End Delay
 - Packet Delivery Ratio
 - Coverage Range
 - Route Discovery Time

Phân tích các thông số

Thông số	10 Nodes Car - Tai nạn 30s		10 Nodes Car - Tai nạn 50s		50 Nodes Car - Tai nạn 30s	
	Broadcast	AODV	Broadcast	AODV	Broadcast	AODV
End-to-End Delay	0.362 ms	20.998 ms	0.512ms	25.117ms	0.362 ms	17.866ms
Packet Delivery Ratio (PDR)	Car 0: 100% RSU 20: 33.33% RSU 19: 100%	Không xác định	Car 0:100% RSU 37: 20% RSU 29: 20% RSU 22: 100%	Không xác định	Car 0: 100%	Không xác định
Coverage Range	94%	-	58%	-	6%	-
Route Discovery Time	-	683.097 ms	-	1262.47ms	-	674.943ms

So sánh các trường hợp mô phỏng

**Cảm ơn thầy và các bạn đã
lắng nghe!**
