

# 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

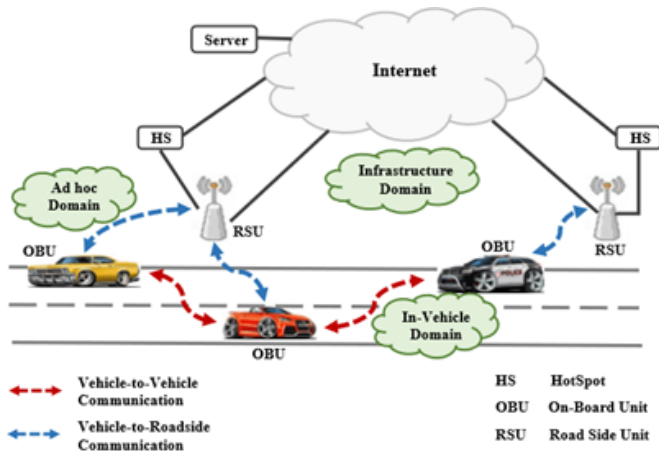
Tháng 11, 2025

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

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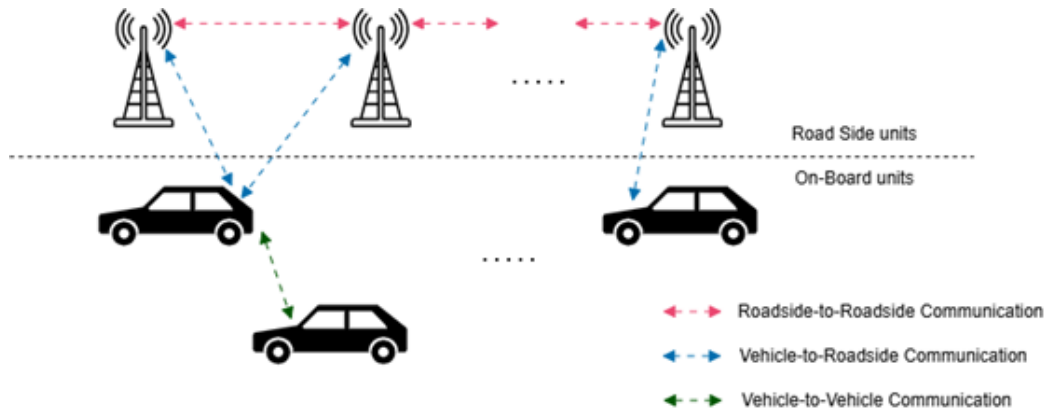
# Giới thiệu mạng VANET

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



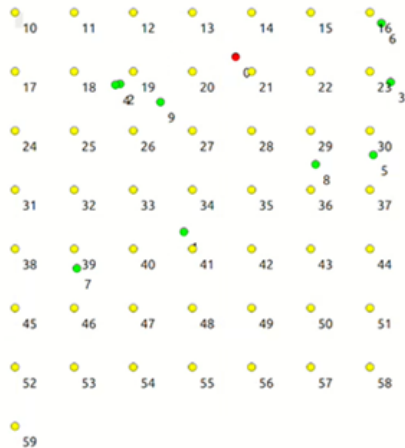
- 1 Giới thiệu mạng VANET
- 2 Mô hình hệ thống**
- 3 Mô phỏng và phân tích kết quả

# Mô hình mạng theo thực tế

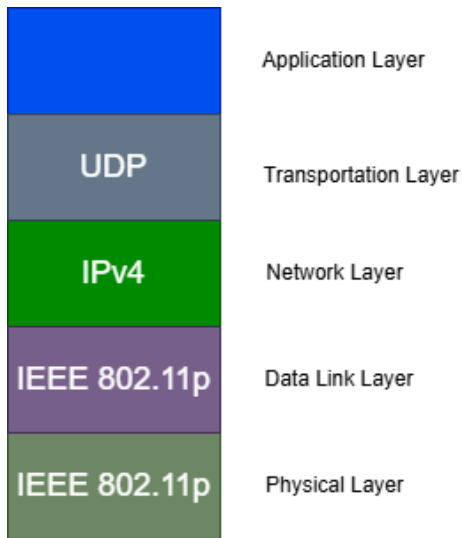


# Mô hình mạng mô phỏng

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



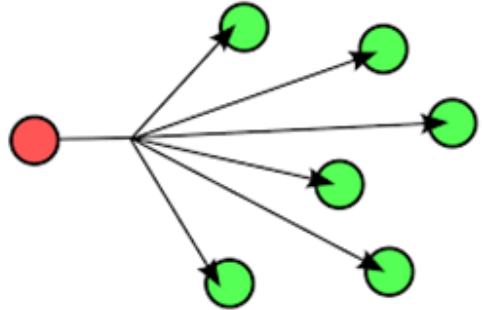
# Các tầng của gói tin thông báo





# Cách thức truyền tin

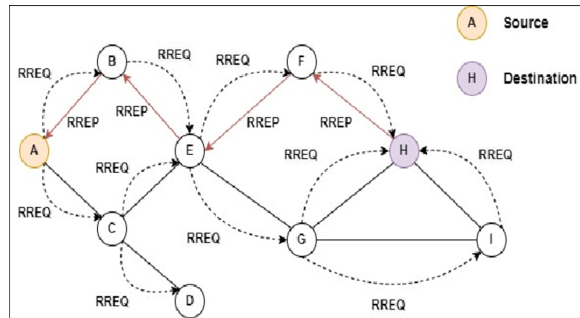
- Truyền tin theo 2 cách:
  - Broadcast
  - Giao thức định tuyến AODV



Broadcast

# Cách thức truyền tin

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

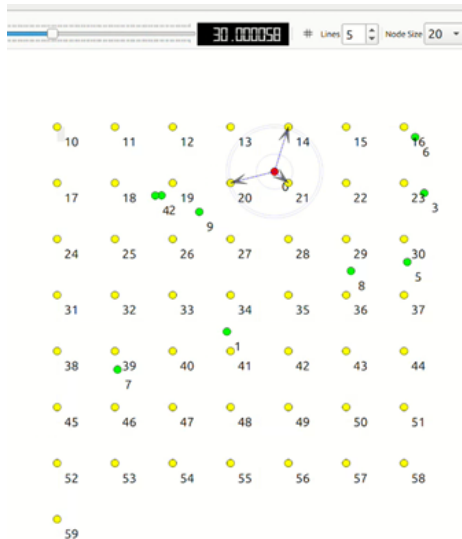


Giao thức định tuyến AODV

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

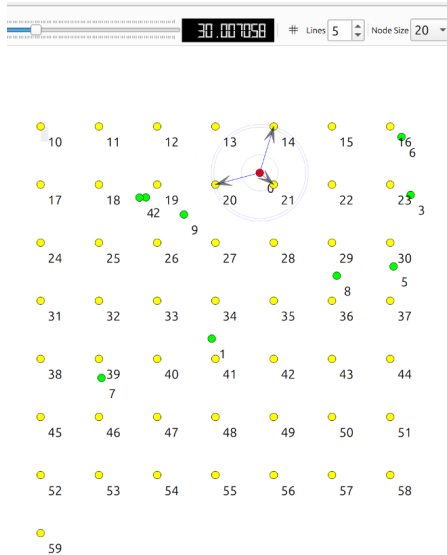
# Kịch bản mô phỏng

- Broadcast:



# Kịch 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)
  ▼ 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: 10.0.0.1
  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

▼ 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)
  - ▼ 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: 10.0.0.1
  - 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: 436172203020686173206163636964656e742e2048454c502c20504c454115345

Text: Car 0 has accident. HELP, PLEASE

[Length: 32]

Data Field

# Gói tin phản hồi của Processing Center

```
Frame 0217: 400 bytes captured on interface (00:00:00:00:00:00) on interface ethernet0, 0
▼ 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



## ▼ 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: 52535520726563656976656420616c6572742066726f6d2031302e302e302e31202833332206279746573290a
  Text: RSU received alert from 10.0.0.1 (32 bytes)\n
  [Length: 44]
```

Transportation Layer - Data Field

- 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	-	1262.47m s	-	674.943ms

So sánh các trường hợp mô phỏng

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

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