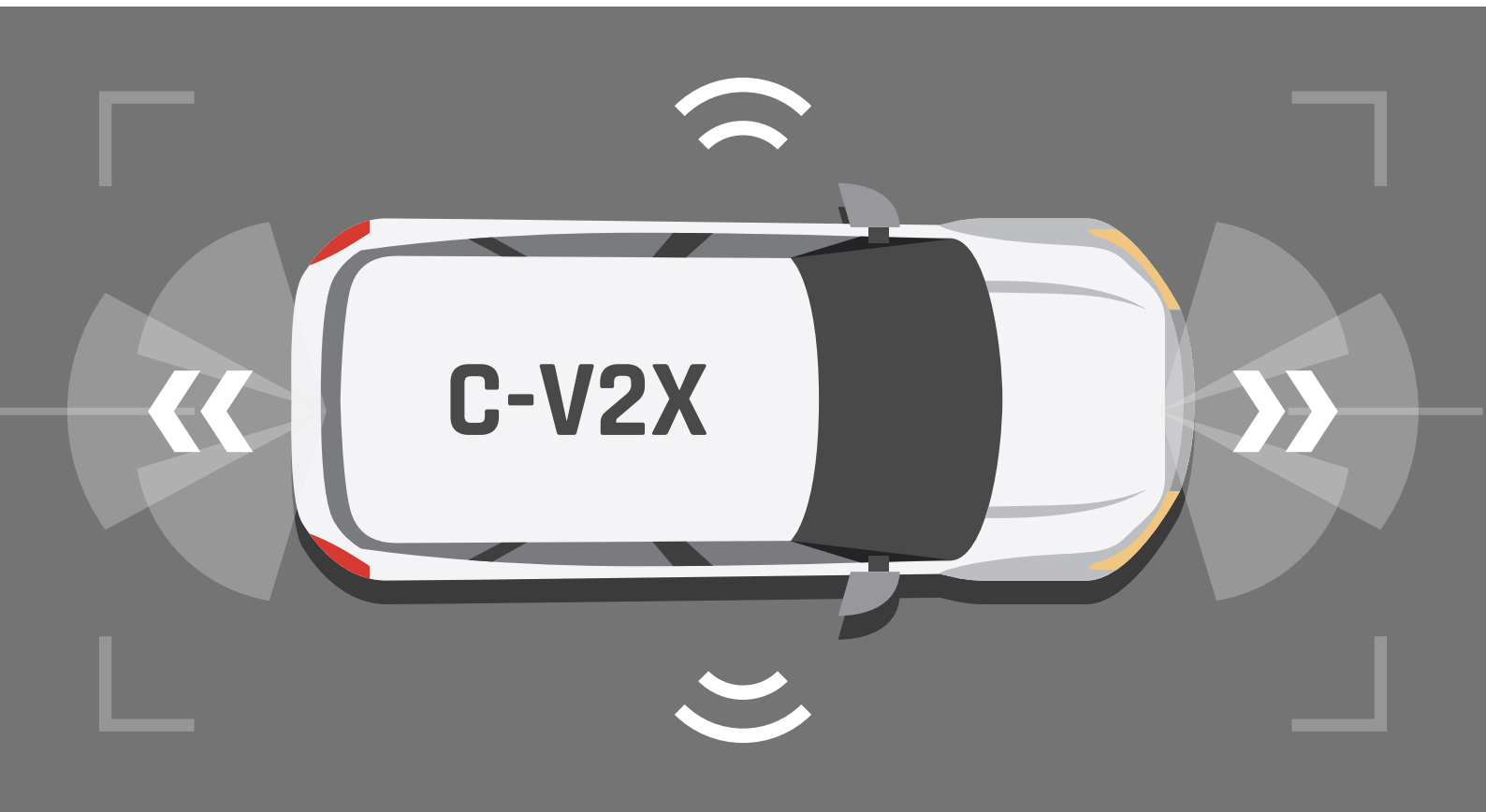
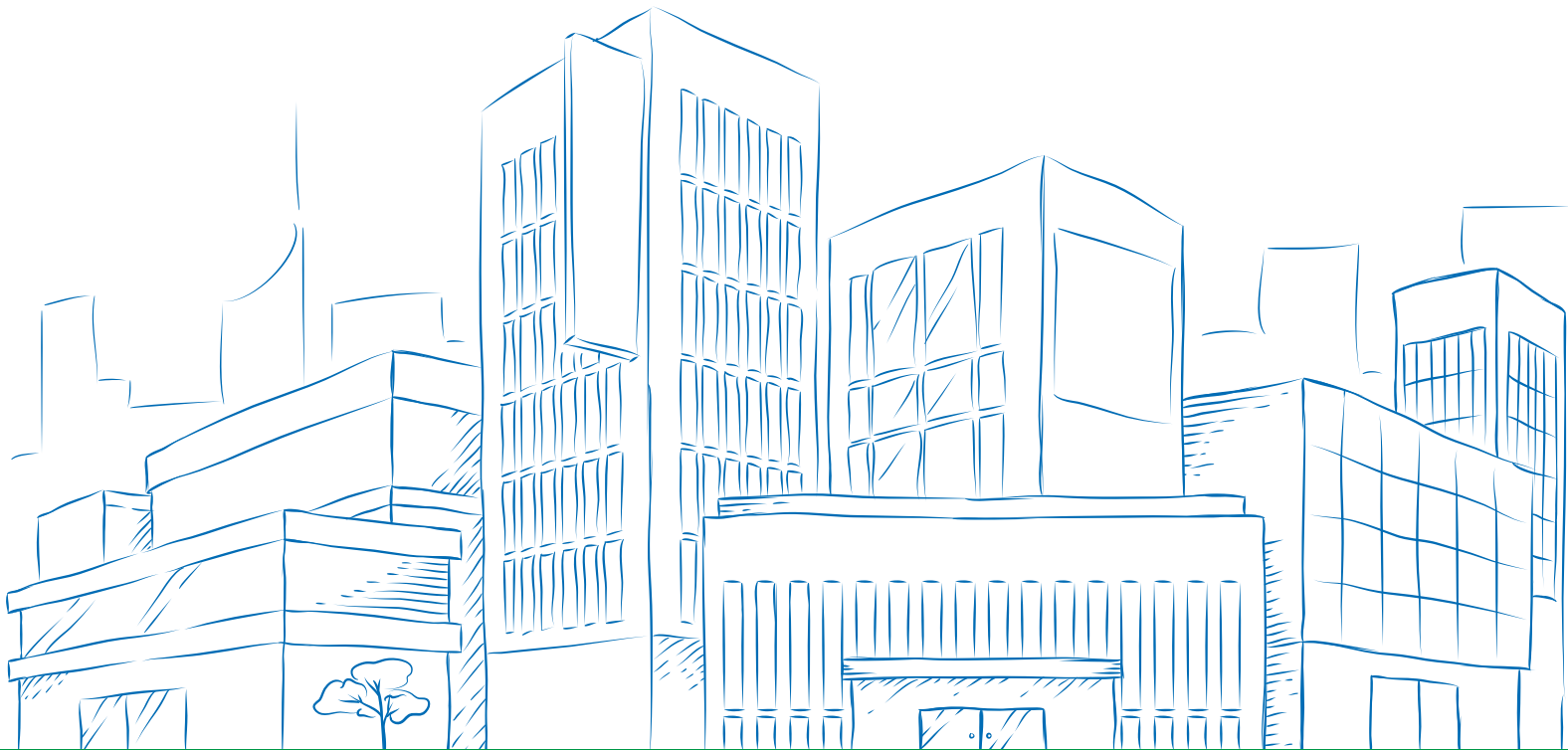
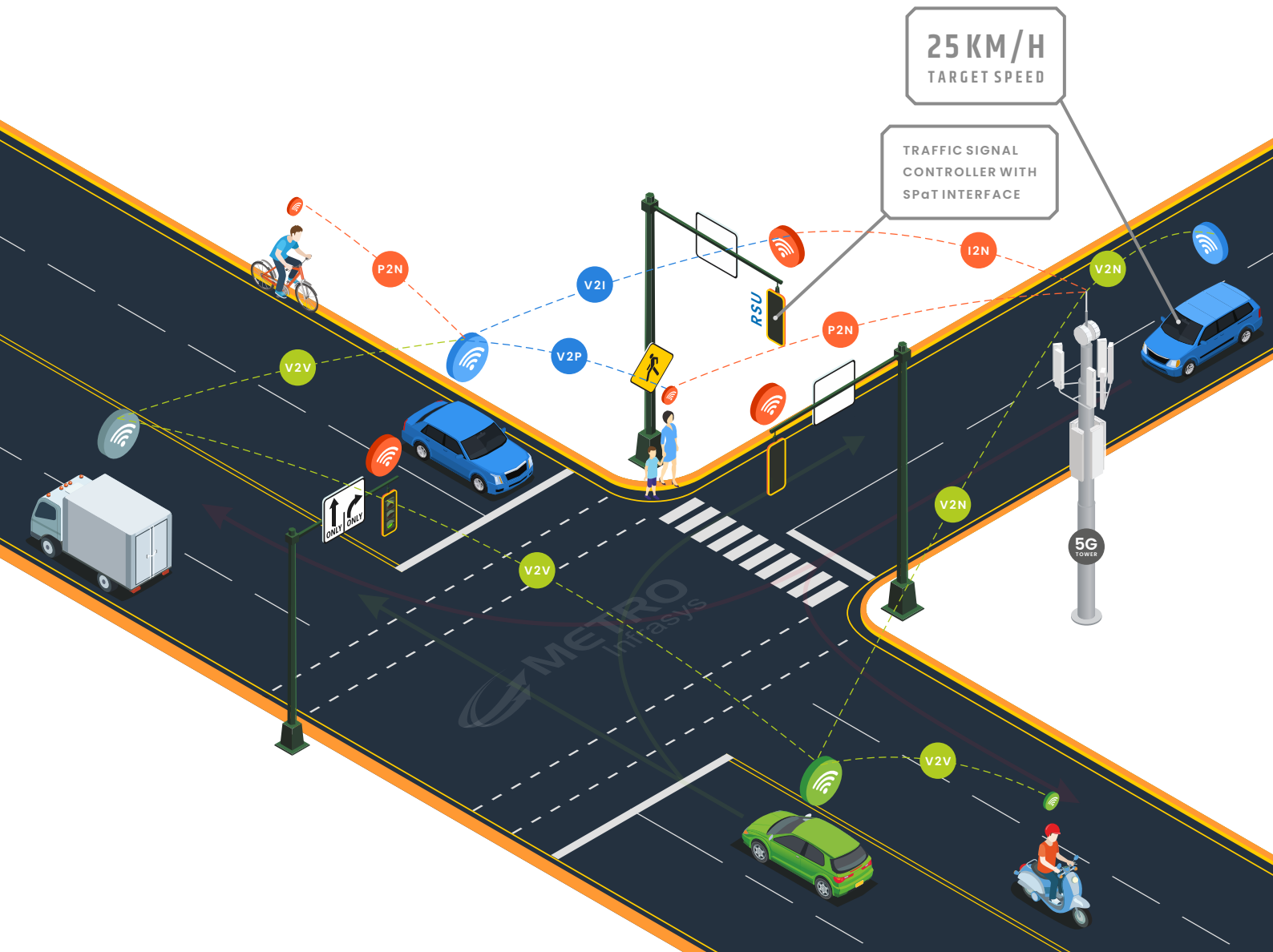


**CONNECTING VEHICLES.  
EMPOWERING MOBILITY.**



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# METRO C-V2X ECOSYSTEM



Cellular Vehicle-to-Everything (C-V2X) technology allows direct and network communication between vehicles and other road users, including vehicles, micro-mobility, pedestrians, and infrastructure. It uses cellular communication technologies (such as LTE and 5G) to transmit data between vehicles and other devices, such as location, speed, direction, and road conditions. By doing so, V2X technology is critical in helping vehicles avoid collisions and stay safe on the road, even when risks are not immediately visible. 5G-V2X utilizes the latest New Radio (NR) technology for Vehicle-to-Everything (V2X) communication. 5G-V2X ensures higher safety and efficiency on the road, with quicker and more reliable communication. The 5G-V2X enables new features, such as cooperative perception and manoeuvring, which enhance road safety.



# VEHICLE-TO-VEHICLE (V2V)



V2V Services enhance traffic safety by enabling vehicles to communicate and exchange driving behaviour data. Vehicles share information on speed, position, and direction to improve decision-making and overall traffic safety. Some of the use cases are as follows:

**Forward Collision Warning:** Alerting drivers to queues and improving traffic flow. Service RSUs gather queue information and inform approaching drivers

**Control Loss Warning:** Alerting drivers to avoid potential collisions caused by another vehicle's control loss.

**Wrong Way Driving Warning:** Alerting drivers of wrong-way driving helps them avoid potential collisions with oncoming traffic.

**Emergency Vehicle Warning:** Alerting drivers about the approach of an emergency vehicle and instructing drivers ahead to yield.



## Other Use Cases

- Blind Spot Alert
- Steep Slope Alert
- Door Opening Alert
- Car Reversing Alert
- Disabled Vehicle Alert
- Motorcycle Approaching Alert
- Intersection Collision Avoidance
- Pre-crash Sensing Warning
- Cooperative Adaptive Cruise Control



# VEHICLE-TO-PEDESTRIAN (V2P)



V2P services enable vehicles to communicate with nearby vulnerable road users (VRUs) like pedestrians, road users, and cyclists, ensuring safety and convenience even in low-visibility and non-line-of-sight situations. Some of the use cases are as follows:

**VRU Safety:** Enhancing safety by alerting drivers and VRUs of potential hazards through V2P communication, helping anticipate and mitigate risks.

**VRU Convenience:** Enhancing VRU's travel convenience by providing real-time traffic updates, collision information, and re-routing assistance.



## Other Use Cases

- Blind Spot Alert
- Visually Impaired Pedestrian Presence
- Pedestrian Collision Warning & Avoidance



# VEHICLE-TO- INFRASTRUCTURE (V2I)



V2I services enable vehicles to communicate with highway and urban road components like RFID readers, lane markers, traffic lights, cameras, streetlights, and signage for safety, mobility, or hazardous driving conditions. Some of the use cases are as follows:

**Queue Warning:** Enhance safety and traffic flow. Alert drivers about queues via RSU. Reduce dangers and lane disruptions for smoother traffic.

**Curve Speed Warning:** Alerting drivers to manage speed when approaching or leaving curves, reducing crash and collision risks.

**Road Works Alert:** Real-time alerts for road work, enhancing safety and enabling drivers to navigate and avoid hazards.

**Distance-based Tolling Notification:** Alerting drivers about the approach of an emergency vehicle and instructing drivers ahead to yield.



## Other Use Cases

- Smart Signboard Alert
- Emergency Stop
- Road Safety Services
- Point of Interest Notification
- Speed Limit Alert
- Road Bend Alert
- Right Turn Assistance
- Green Light Optimal Speed Advisory
- Carpark Information Notifications





# COMMUNICATION METHODOLOGY



The National Frequency Allocation Plan 2022 by the Department of Telecommunications (DoT), GoI, allows C-V2X deployment in the 5.9 GHz spectrum band, enabling fast and low-latency communication. It employs two complementary transmission modes:

**Network Communication**, also known as "Uu," enables communication with the network (V2N or I2N) for distances over 1 kilometre, known as Up/Downlink communication. It utilizes the conventional mobile network to inform vehicles about road conditions and local traffic.

**Direction Communication**, also known as "Pc5," enables the communication between vehicles (V2V) for shorter distances, under 1 kilometre, known as Sidelink communication. It allows direct communication between vehicles, infrastructure, and other road users, independent of cellular networks.



## Messaging Systems

- Basic Safety Message (BSM)
- Intersection Mapping (MAP)
- Signal Phase and Timing (SPaT)
- Road Safety Message (RSM)
- Signal Request Message (SRM)
- Collective Perception Messaging (CPM)
- Maneuver Coordination Message (MCM)



# METRO INFRASYS - C-V2X CONSULTANT



Transforming the future of road transportation in India, Metro InfrasyS is a leading consultant for V2X solutions. We offer expert C-V2X consultancy, development, and deployment services, empowering vehicles to operate safely and efficiently for all road users.

**Vast Toll Network:** Choose Metro InfrasyS for V2X deployment on Indian highways. Our extensive toll plaza network covers over 6,000 kilometres, supported by state-of-the-art TMS & ATMS infrastructure.

**Experience:** With a 24-year track record of customer-focused solutions and expertise in TMS & ATMS, Metro InfrasyS is India's leading integrated solution provider, excelling in technology, engineering, deployment, and operations.



## Core Solutions

- RFID-based Toll Collection System
- MLFF-based Toll Collection System
- Automatic Number Plate Recognition
- Automatic Vehicle Classification System
- Video Incident Detection System
- Red Light Violation Detection
- Adaptive Traffic Control Systems
- Automatic Traffic Counter & Classifier
- IoC | ITS Cloud Marketplace





**40+ Mn Vehicles  
Processed Each Year**

**100% Auditability  
Zero Pilferage**

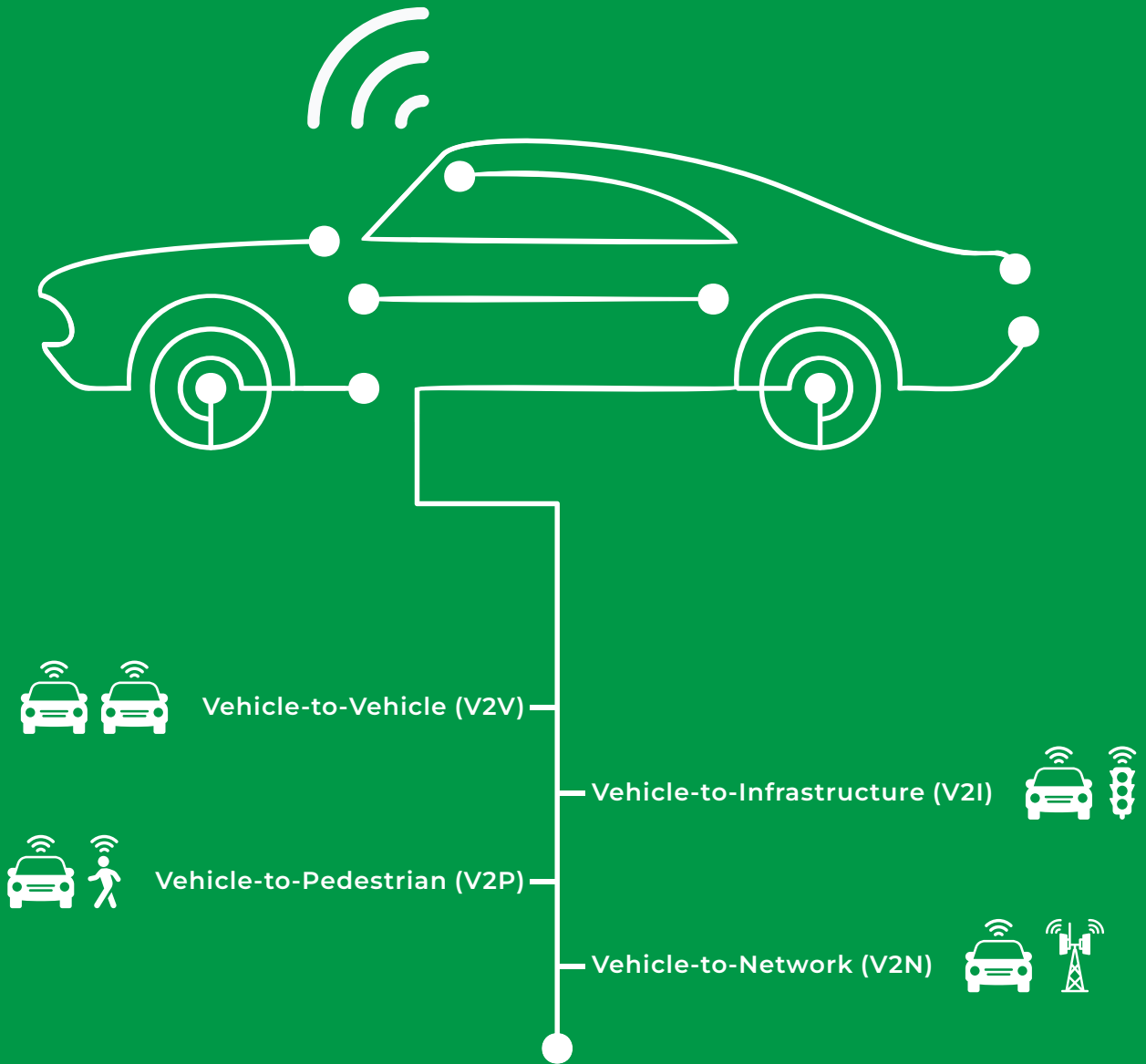
**\$600 Mn Collected  
in Toll Every Year**

**800+ Toll Lanes  
Created & Serviced**

**DRIVING INNOVATION  
TO INFRASTRUCTURE**

 **METRO**  
Infrasys





# CELLULAR

## VEHICLE-TO-EVERYTHING

Toll Management System

Advanced Traffic Management System

IOC | ITS on Cloud Solutions

Cellular V2X (C-V2X) Solutions



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