Content Distribution and UAV Assistance in Vehicular Network
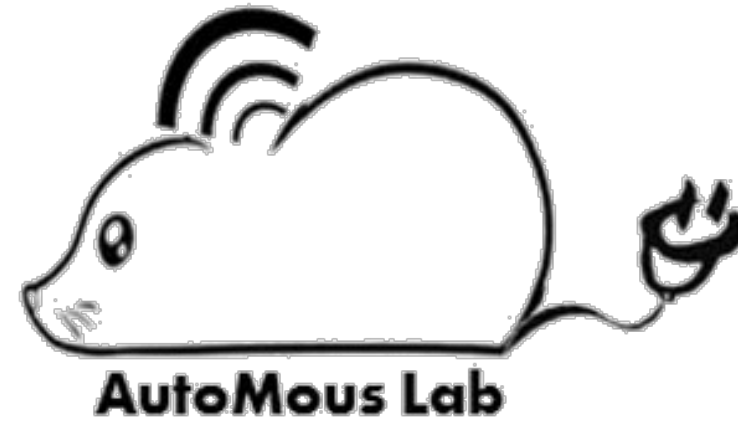
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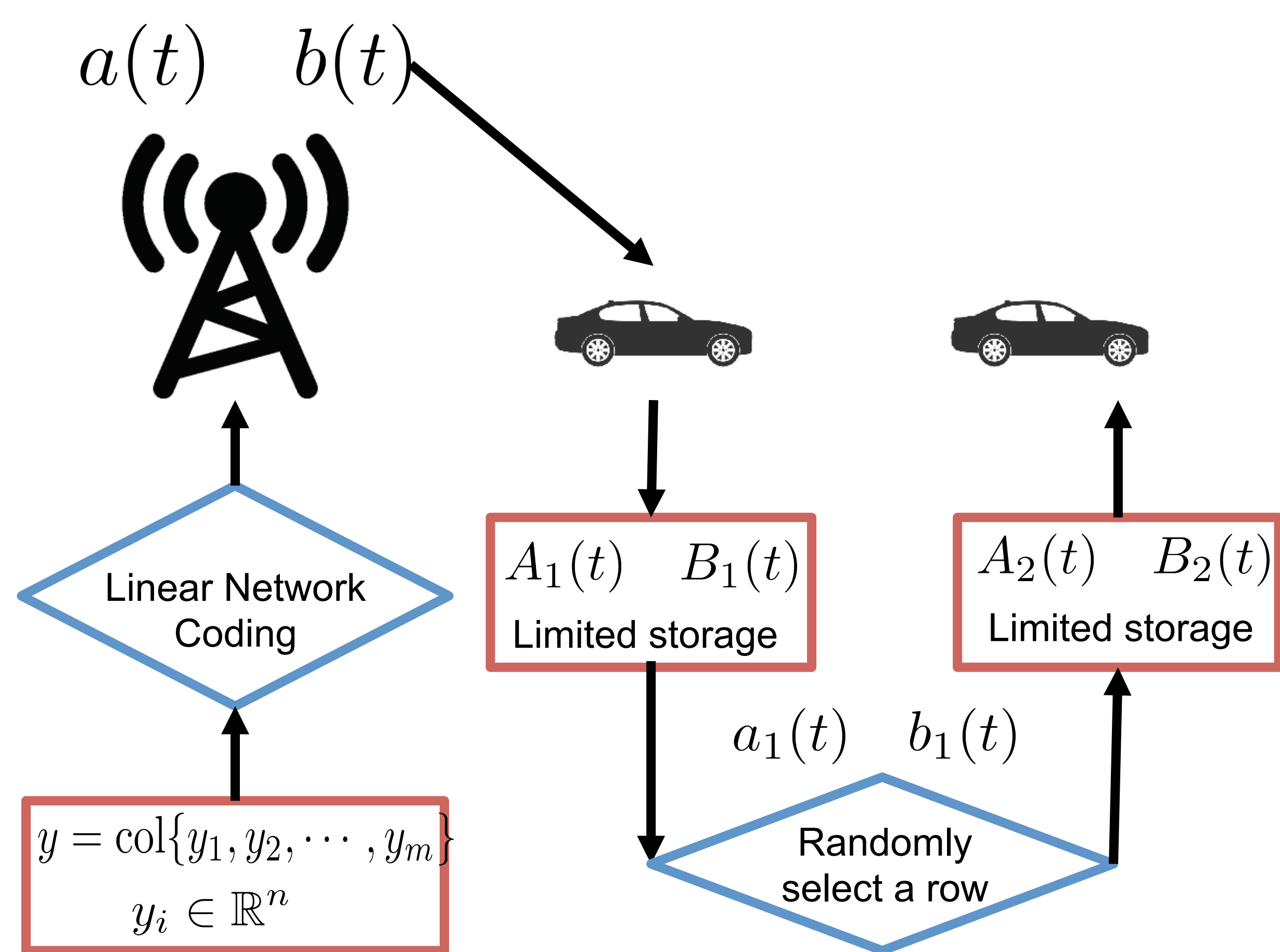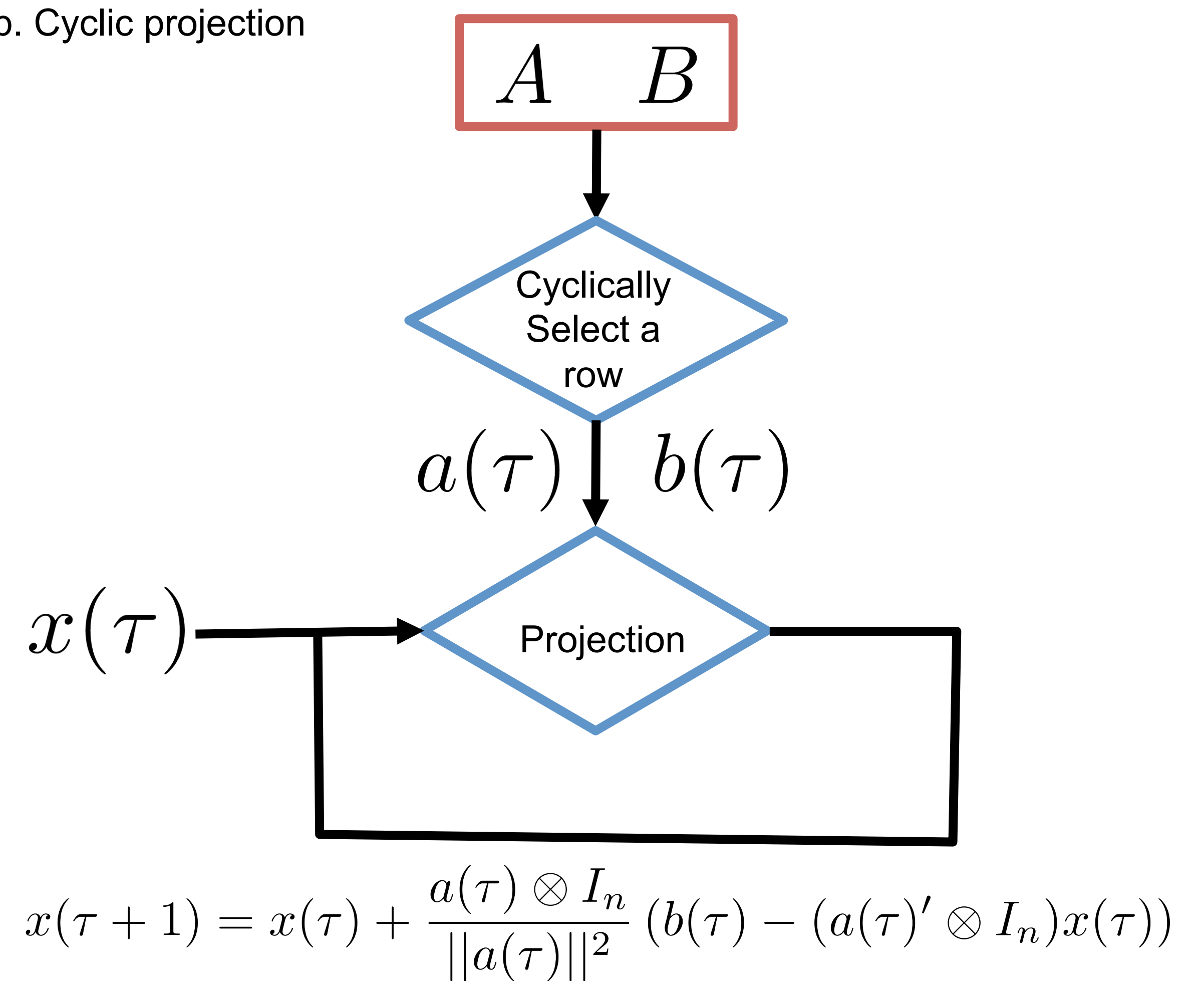
AutoMous Lab

ABSTRACT:
Vehicular network has draw a significant amount of research interests in recent years. Various applications of vehicular networks heavily depend on the capability of efficiently and quickly delivering important contents to all vehicles in the network. Due to the mobility of vehicle, unreliability of communications and security constraints, it is quite challenging for a vehicle to complete a full download of large content files from base stations. Based on the recently developed network coding, we developed a distributed algorithm which can deliver large content exponentially fast by coordination among nodes in a mobile network. The algorithm only requires memory low enough to store one row of linear equations. Vehicular network also relies heavily on sensors and communications to provide guidance for reducing accidents. To enhance the capability of sensing and robustness of communication, we propose introducing unmanned aerial vehicles (UAV) in the vehicular network.

Content Distribution:

a. Broadcast of Data

$a(t)$ $b(t)$

Linear Network Coding

$A_1(t)$ $B_1(t)$
Limited storage

$A_2(t)$ $B_2(t)$
Limited storage

$y = \mathrm{col}\{y_1, y_2, \cdots, y_m\}$
$y_i \in \mathbb{R}^n$

$a_1(t)$ $b_1(t)$
Randomly select a row

b. Cyclic projection

$A \quad B$

Cyclically Select a row

$a(\tau)$ $b(\tau)$

$x(\tau)$

Projection

$$x(\tau + 1) = x(\tau) + \frac{a(\tau) \otimes I_n}{||a(\tau)||^2} \left(b(\tau) - (a(\tau)' \otimes I_n)x(\tau)\right)$$

UAV Aided Autonomy:

Emergency Communication Network Construction
- Infrastructure station becomes unavailable due to unpredictable weather changes or cyber-attacks.
- Autonomous vehicles in the affected area release on-board UAVs to construct a temporary communication network .
- UAV-aided network expands the capability of autonomous vehicles so that they can gather information of the environment and extend their communication range to the next-available station.

———— : A2A Communication ———— : A2G Communication ✕: Offline Infrastructure
······· : V2V Communication ———— : V2I Communication
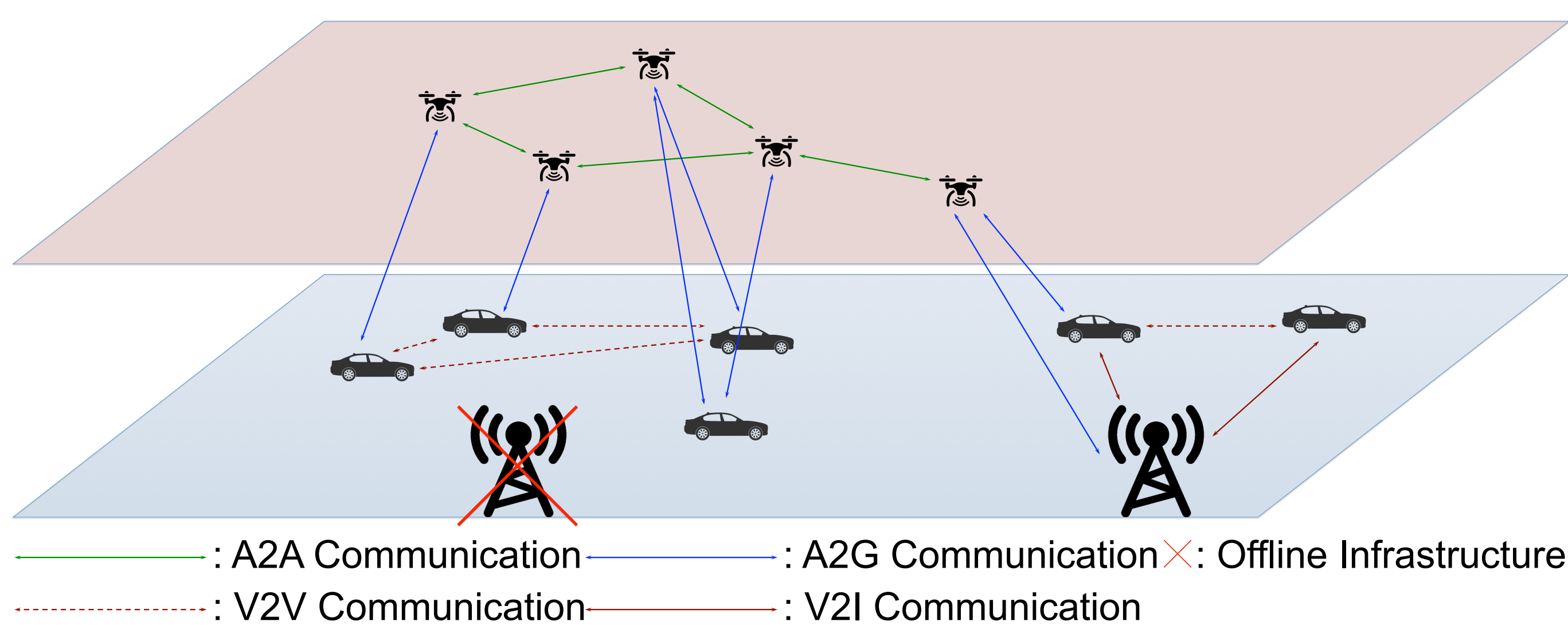
Pre-Drive and On-The-Fly Safety Inspection
- Pre-drive and on-the-fly external inspection of signaling lights, tire tread, etc.
- Rural area wildlife avoidance.
- City area pedestrian and cyclist avoidance.

External safety check
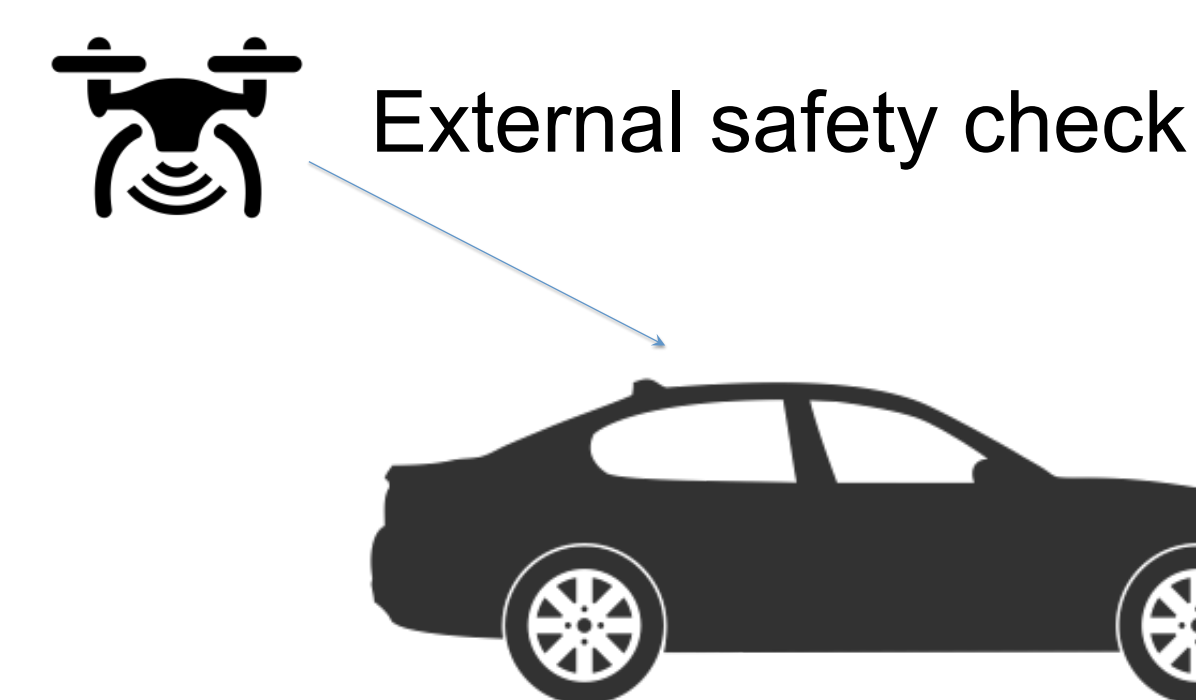
Problem Identification
- Distributed UAV formation maintenance and target tracking
- UAV landing on moving vehicle
- Sensing fusion
- UAV path planning and object identification