

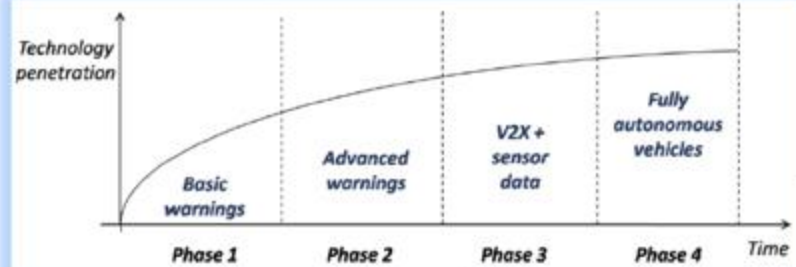
Mobile SDN

- Challenges and Directions

(A Vehicular Networking View)

Dijiang Huang, Ankur Chowdary, and Bing Li
Arizona State University, AZ

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Representative use cases

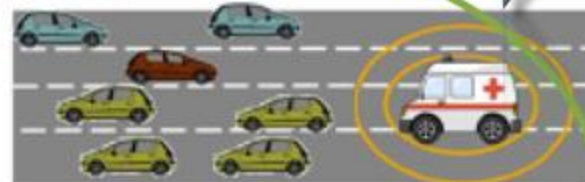
**We are testing now:
(Sensing and warning)**

Main enabling standards and technologies

Phase 1



Traffic jam ahead warning



Emergency vehicle warning

IEEE 802.11p/ITS-G5,
WAVE
(Today-Morning)

Phase 2



Crash notification

IEEE 802.11p/ITS-G5,
WAVE + DCC +
GeoNetworking + Multi-
channel operations
(Today-Afternoon)

Phase 3

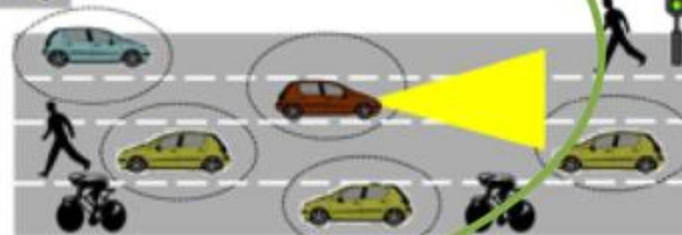


Platooning

IEEE 802.11p/ITS-G5,
WAVE + DCC
GeoNetworking + Multi-
channel operations, LTE,
LTE-A, D2D, white
spaces, VLC, 5G
(Tomorrow)

Phase 4

Autonomous driving

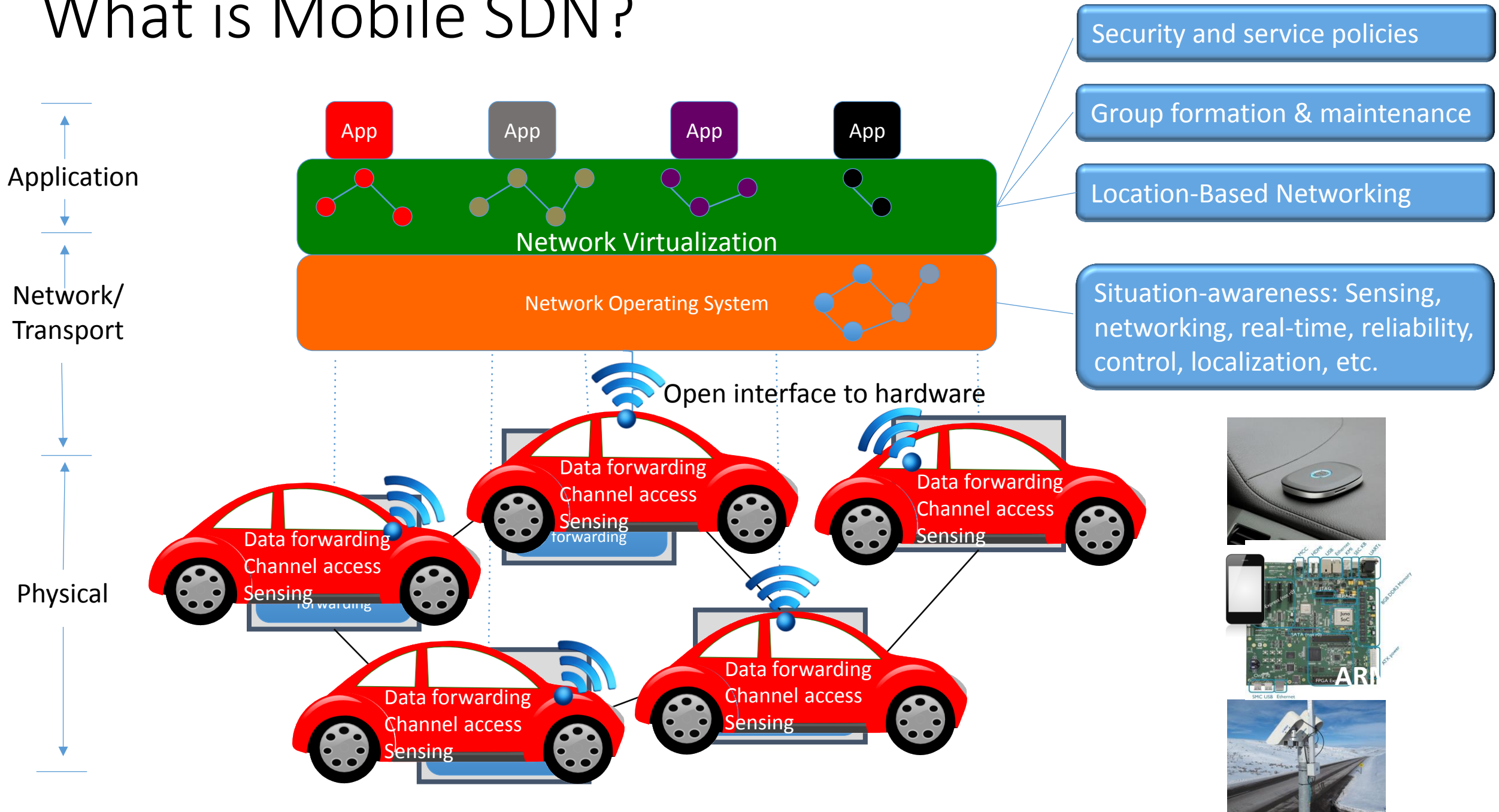


**We are researching and
developing:
Collaborating,
Coordination,
Heterogeneity.**

Mobile SDN (A Vehicular Networking Perspective)

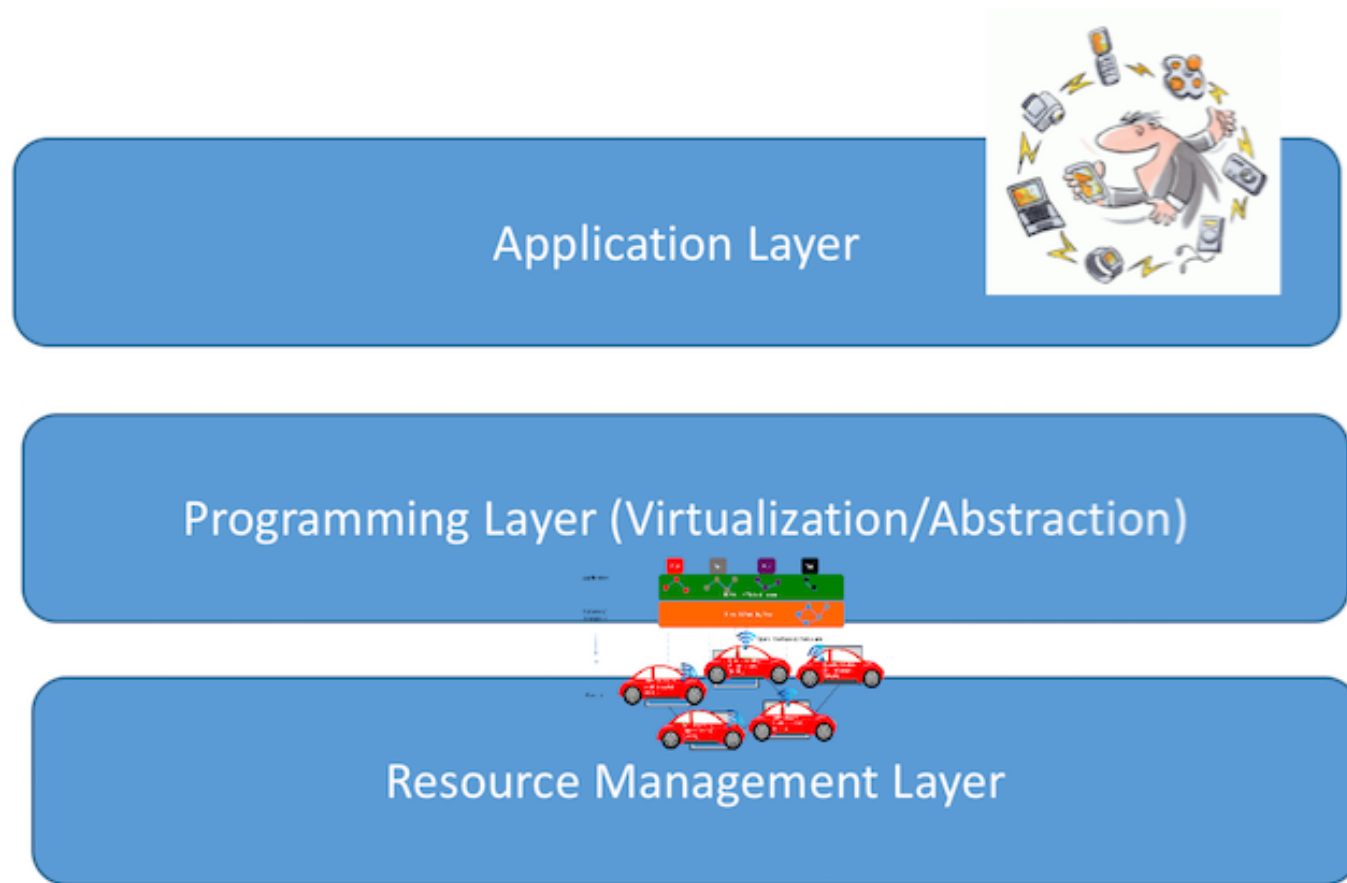
Features	Examples of Existing Approaches	Issues	Layers	SDN
Security	Shared key, public key	Trust/key management, location verification, revocation, reputation, DoS, etc.	Application Layer	SDN-enabled applications: Programmable “Geo-networking” Isolation/Grouping Centralized or decentralized control
Safety	Emergency, collision-avoidance, hazard detection, etc.	Lack of global information (e.g., pre-warning)		
Collaboration/Coordination	Platooning, autonomous control, surveillance, etc.	1. Reliable ✓ 2. Real-time ✓ 3. Localization ✗ 4. Group-based operations ✓ 5. Guaranteed services ✓		
Networking	Broadcasting, Point-to-Point, MANET, etc.	Overhead (or efficiency), mobility, single-hop vs multi-hop	Network Layer	Control Plane
Access	802.11p, IEEE 1609.4, Bluetooth, WiFi, 2/3/4/5G, etc.	Channel access (contention vs dedicated), control channel isolation	MAC Layer	Data Plane
Radio	DSRC, Cognitive Radio, Software-defined Radio, etc.	Heterogeneity, manageability	Physical Layer	Physical layer resource provisioning
Sensing	LIDAR, Video, Radar, GPS, etc.	Line-of-sight, Distance coverage		

What is Mobile SDN?



Mobile SDN Research Challenges

- Location, Location, Location...
 - Location accuracy
 - Location verification/validation
 - Moving Femto Cell
- Group based operation
 - Trust/key management
 - Group formation, control, communication & maintainence
- Collaboration/coordination
 - Sensing
 - Control
 - Heterogeniety
 - Realtime/Guaranteed networking services
- APIs (Ideas)
 - Can service oriented soution to address the scalability of vast numbers of interfaces?
 - What about the layered structure? (Here tunneling may have different meaning, e.g., distance can be a measurement)



How to incorporate the control in the MAC layer?

- Direction 1: Add additional layer
 - Idea borrowed from Mobile NDN (e.g., Navigo): create a 2.5 layer to incorporate the location service module (interests, geo-based service).
 - Directly change the Media access control (e.g., channel access to provide prioritized and guaranteed communication and networking services).
- Direction 2: Design the control protocol
 - Allow layer-2 clustering (grouping), and leader selection (controller).
 - Design the situation awareness module to collect the system states from mobile nodes.
- Direction 3: Design trust model and security protection
 - Attack models: passive/active, internal/external, Jamming, location verification, etc.
 - Key management, revocation, etc.
 - Fail-safe strategies.

Beyond Vehicular Networking

- Mobile SDN in a bigger scope: Internet of Things

- Software programmability
- Re-configurability
- Virtualization/Abstraction
- Grouping (isolation)
- Geo-based Networking
- Control interfaces to applications
- Light-weight
- ...



It is all about secure and efficient resource management

Can we view it as an X-Cloud?