Mixed Reality Visualization in Automotive SDR Networks

Sharon Ladron de Guevara Contreras[1], Meghan Clark[2], Augusto Vega[1], John-David Wellman[1], Pradip Bose[1], Prabal Dutta[2]
[1]IBM T. J. Watson Research Center — [2]University of California, Berkeley

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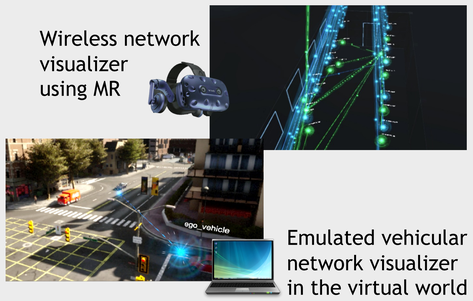
The Need for Mixed Reality Visualization in Wireless Networks

- **Mixed reality (MR)** is a combination of virtual and real objects in a common display. Network visualization using MR improves the user-network interaction:
  - Enables users to **intuitively** understand traffic patterns and nodes relationships in wireless network settings
  - Allows temporal **real-time** observations of wireless networks' behaviors



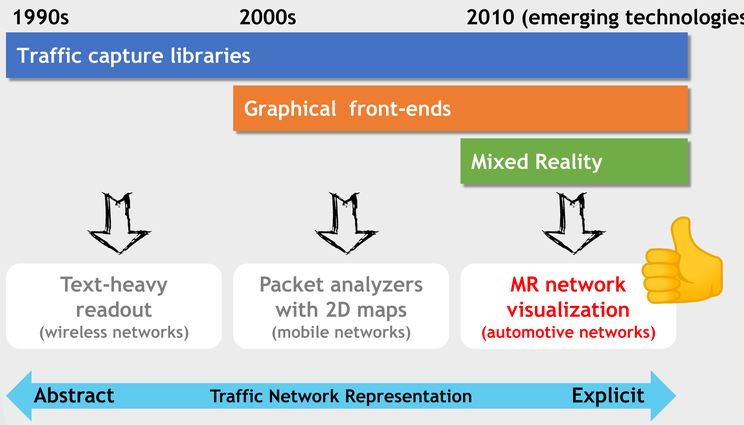
- Increasingly mobile
- Ad hoc interactions

Mixed Reality

A level of introspection that is not possible using traditional network analyzers

But Why Now?

- Lack of explicit visualization tools for SDR networks
  - *Abstract* or *static* representation of networks traffic [1][2]

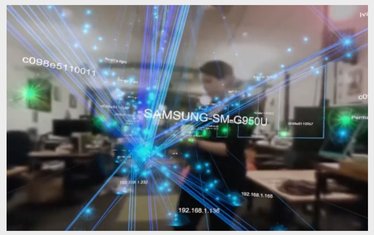


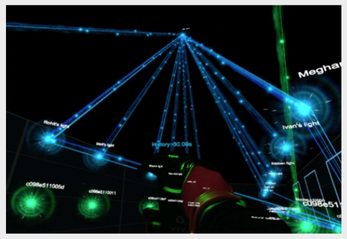
- Visualization of highly dynamic networks can only be performed by real-time intuitive visualizers

[1] Sahin, C., et al. "Wireless communications engineering education via Augmented Reality." 2016 IEEE Frontiers in Education Conference (FIE).
[2] Kim, I. et al. "SDR-based 5G NR Control Channel Analysis Equipment for Network Monitoring." 2020 International Conference on Information and Communication Technology Convergence (ICTC).

XRShark: Mixed Reality Network Visualization

- Mixed reality visualizer ideal for wireless mobile networks





- Shows host locations and traffic through augmented reality (AR) and virtual reality (VR) modes
- AR provides **real-time**, **in-place** network visualization
- VR provides historical and remote network visualization
- Mobile host locations updated dynamically

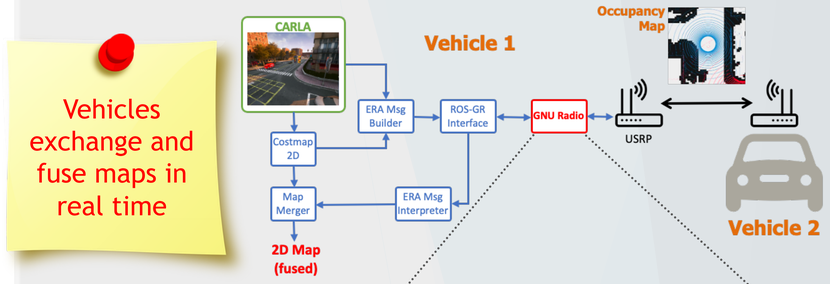
Demo Video! →

SCAN ME

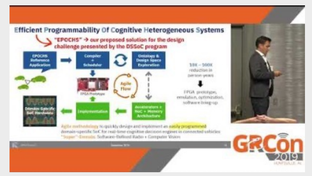
Automotive SDR Networks Using GNU Radio

- We demonstrated the use of SDR to enable **collaborative perception** in connected, autonomous vehicles [1]

Vehicles exchange and fuse maps in real time



Check out our GRCon'19 talk!

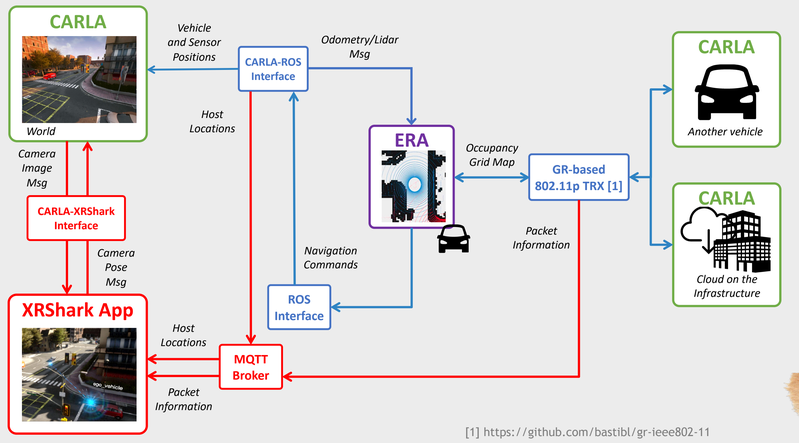


SCAN ME

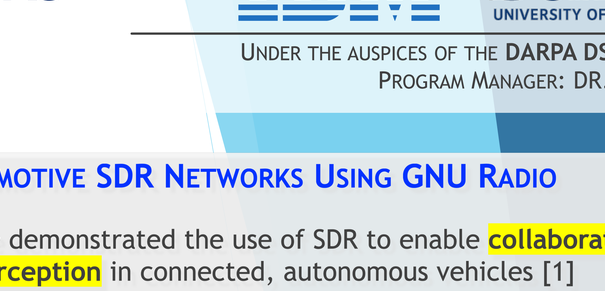
[1] Sisbot et al. Multi-Vehicle Map Fusion using GNU Radio. GRCon'19.
[2] https://github.com/bastibl/gr-ieee802-11

Mixed Reality Visualization for Automotive Networks

- **Our work:** We use XRShark mixed reality to visualize wireless network communications in ERA, a connected autonomous vehicles application



[1] https://github.com/bastibl/gr-ieee802-11



SCAN ME

Demo Video

- ERA (EPOCHS Reference Application) performs **collaborative perception on vehicular networks**
- Emulates **vehicle-to-vehicle (V2V)** and message exchange to the cloud through **vehicle-to-infrastructure (V2I)** communications

Contribute! https://github.com/IBM/era
https://github.com/lab11/xrshark-carla-scripts

Future Work

- Integration of **spectrum information** for frequency filtering and real-time analysis

- Application to cybersecurity aspects such as **threat detection** in cooperative automated vehicles [1]

[1] J. Petit, et al. "Potential Cyberattacks on Automated Vehicles." IEEE Transactions on Intelligent Transportation Systems. 2015.

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