4th OAI Workshop

Overview of OAI Work in BUPT

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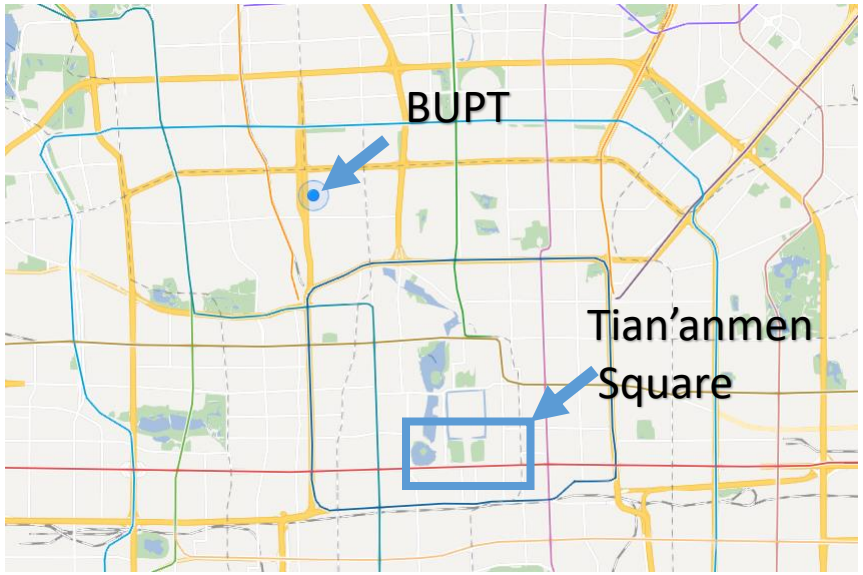
北京郵電大學

Introduction of BUPT group

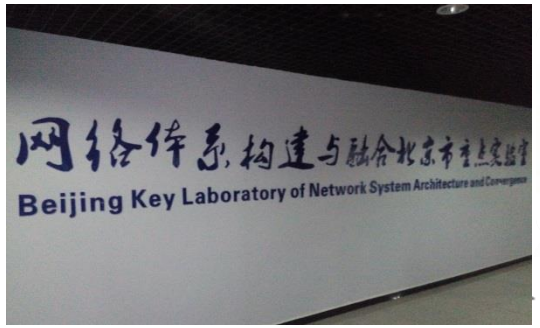
- BUPT——Beijing University of Posts and Telecommunications
  Like **Télécom ParisTech** in France, but a bit bigger

  Faculty: 2100+, Professors: 959, Students: 22000



- Beijing Key Lab of Network System Architecture and Convergence

  Focus on:
  - RAN architecture and technologies
  - Core and Bearer Network Architecture and Technologies
  - Wireless Enabled Vertical Services



Introduction of BUPT group

- Joint BUPT-Eurecom Open5G Lab
  - 2016-Dec, ,Eurecom and BUPT decided to make joint efforts to build and operate a joint Open 5G Lab.
  - Mission of Open5G Lab
    - ✓ Research and Develop on OAI, and evolution to Open Source 5G
    - ✓ Build Testbed for OpenAirInterface
    - ✓ Disseminating OpenAirInterface (Mainly in China area)
  - The 3rd OAI workshop was held jointly by BUPT and Eurecom in Beijing, April 2017.



BUPT Works around OAI

- SDN enabled LTE WiFi convergence, implemented with OAI and SWAN network, 2015-2016 Archived
- Non-Othogonal Multiple Access based on OAI, cooperated with ChinaTelecom, 2015-2016 ←
- C-RAN System based on OpenAirInterface, up to now √
- Research and Develop of 5GS Service-based Architecture, up to now √
- LTE CASE and Outdoor testbed for OpenAirInterface, up to now ←
- OAI enabled remoting driving, a proof of concept for Internet of Vehicles, up to now ←

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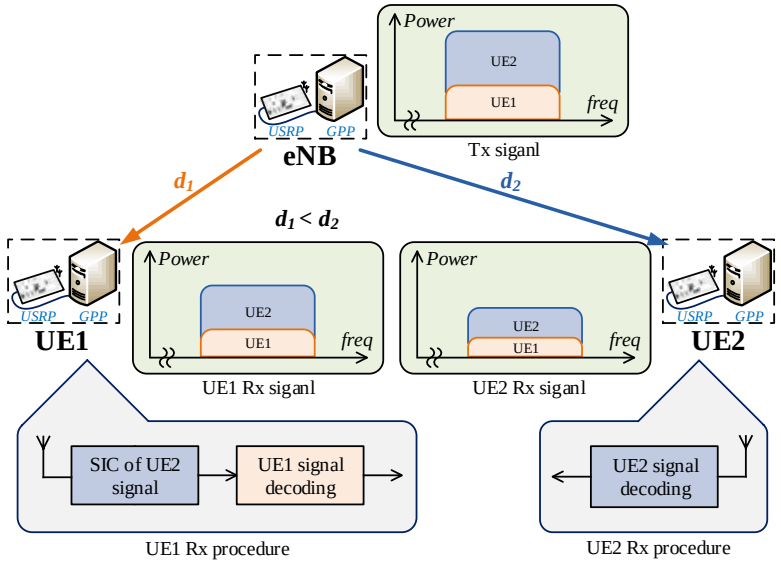
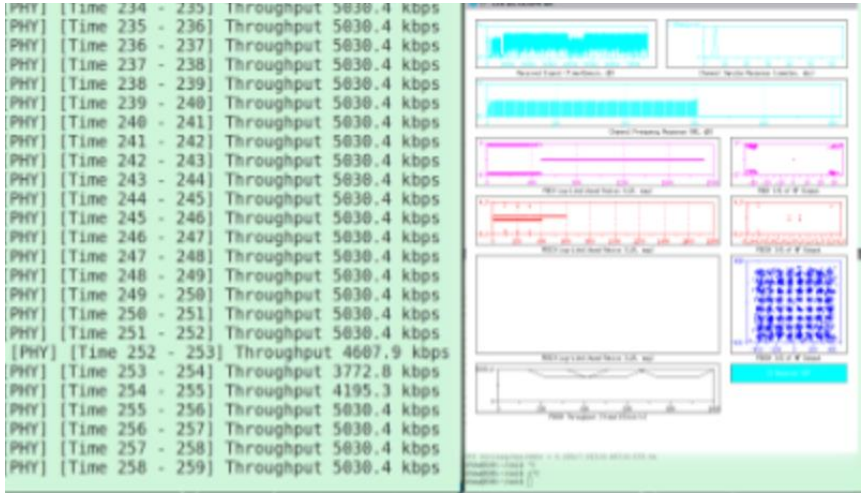
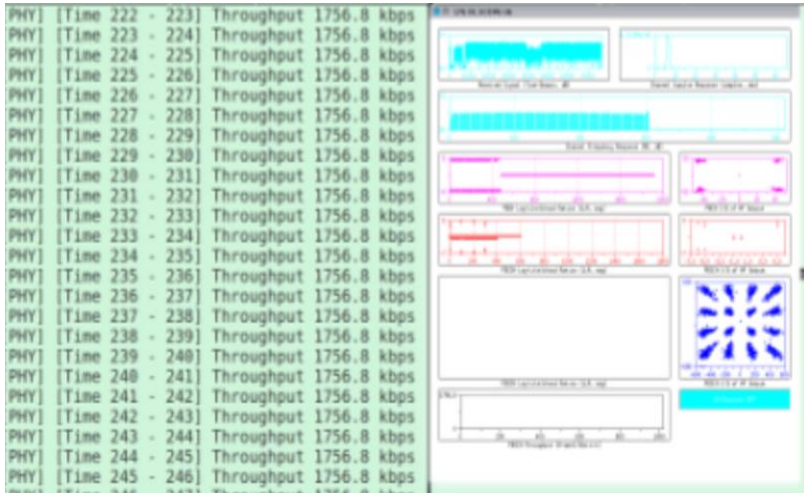
OAI based NOMA

- LTE R14 MUST WI is based on NOMA.
- 5G NR will also introduce NOMA, and NR NOMA SI has been started from March 2017.
- In OAI based NOMA, 2 UE's signals are modulated onto same resource block, SIC receiver is used in near UE.
- NOMA show a 40% gain over traditional orthogonal multiple access technologies.





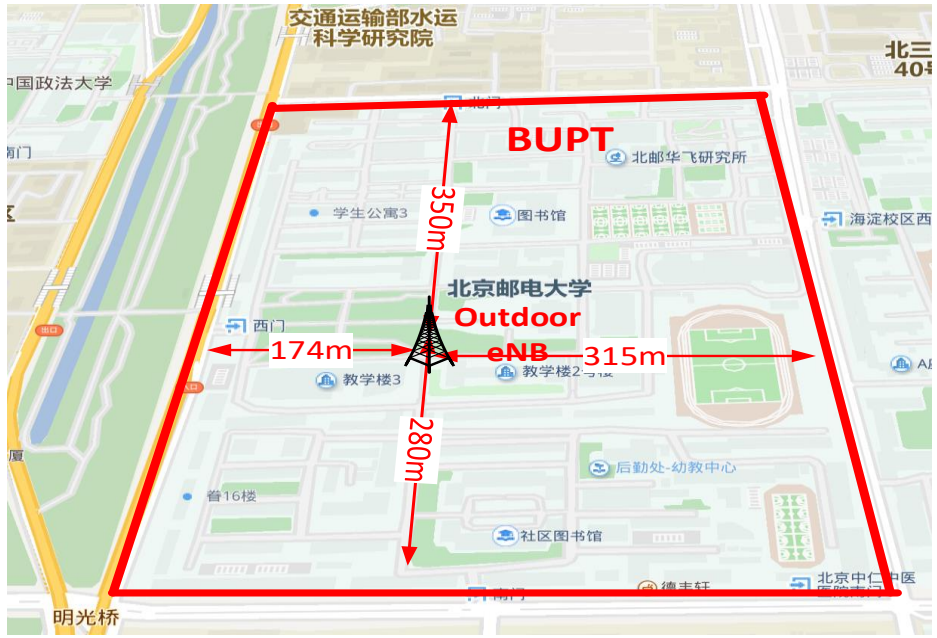


LTE CASE and Testbed for OAI

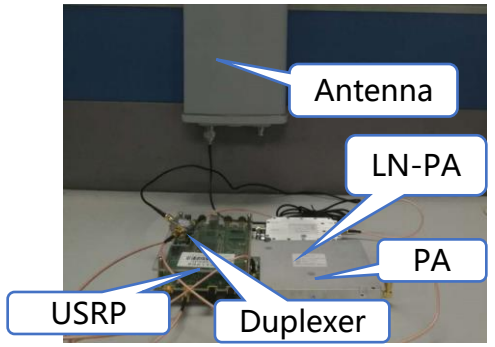
- OAI is deployed in indoor and outdoor environment,

Aims to:

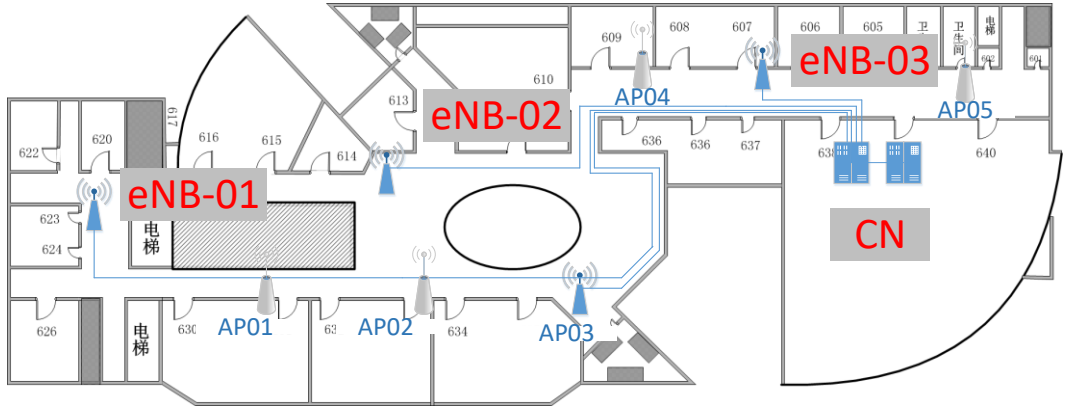
- ➢ Test the stability of OAI
- ➢ Test the performance of OAI
- ➢ Test the compatibility of new SDR on OAI
- ➢ Provide a demo for new users in China



BUPT Outdoor deployment

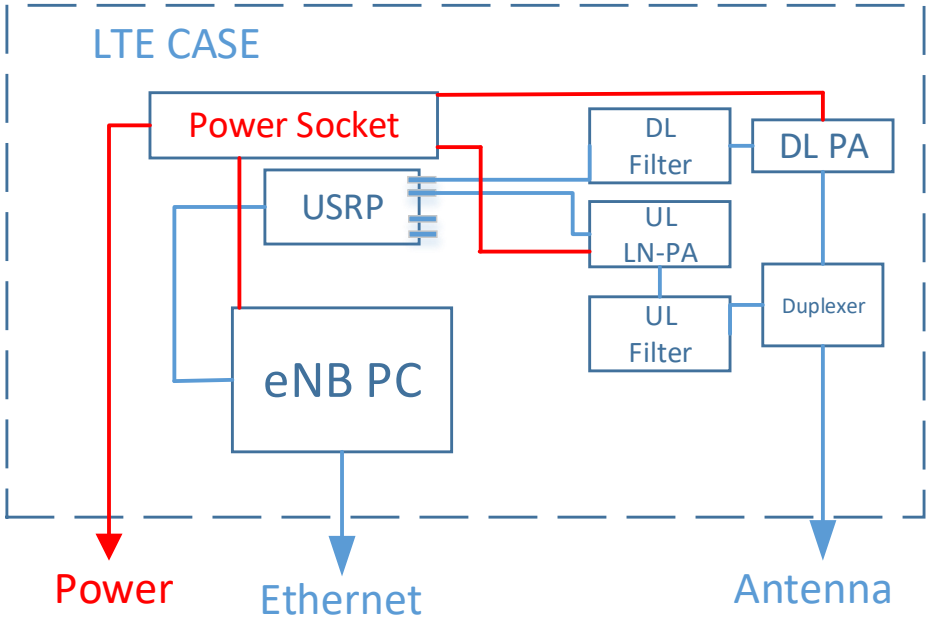


BUPT build-3 Indoor deployment



LTE CASE and Outdoor testbed for OAI

- LTE CASE is a portable LTE eNB equipment, and can provide long range coverage, includes:
  - ✓ 1 eNB PC
  - ✓ 1 Downlink power amplifier
  - ✓ 1 Uplink low noise power amplifier
  - ✓ 2 Filters (uplink and downlink)
  - ✓ 1 Power socket array



LTE CASE architecture

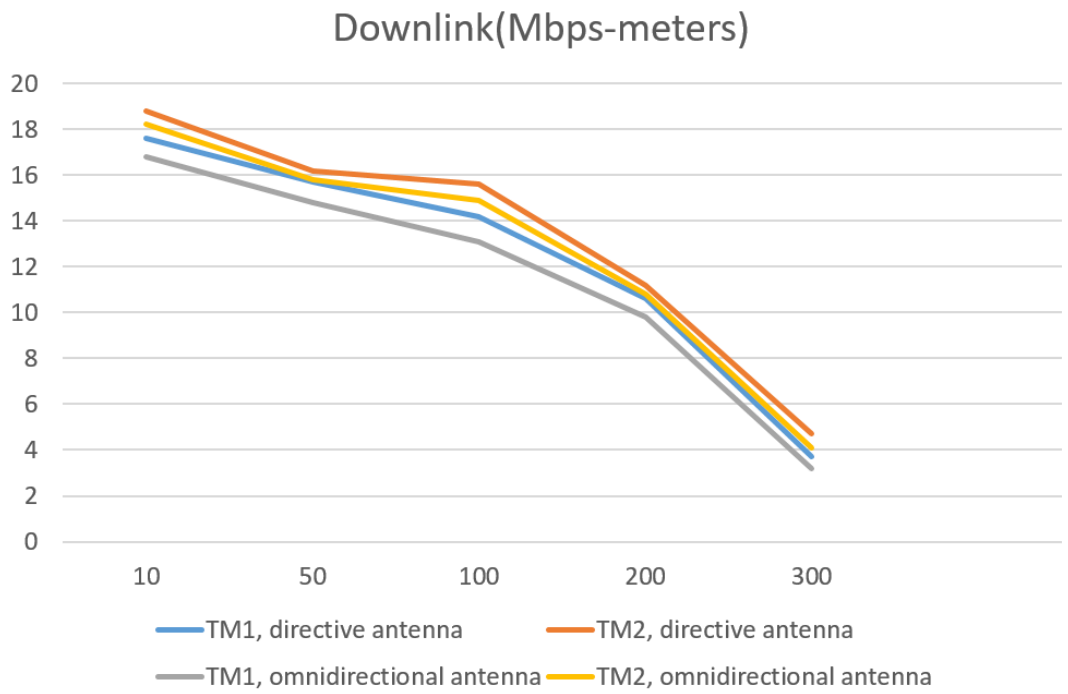
LTE CASE Outside

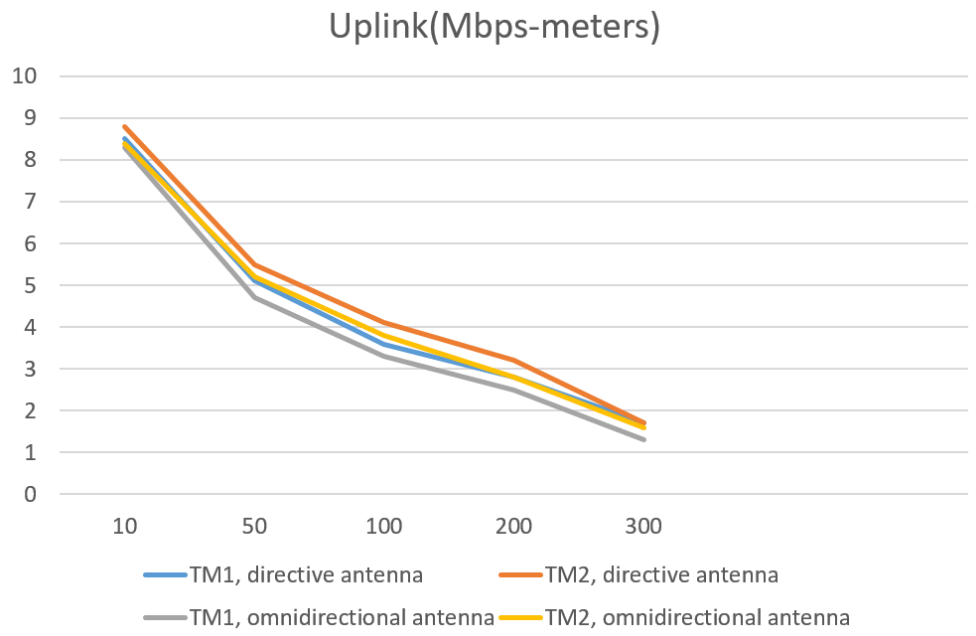
LTE CASE Insdie

LTE CASE and Outdoor testbed for OAI

- Outdoor Test Settings:
  - Power amplifier: 45 dB for band7, low noise power amplifier: 20dB for band7.
  - Antenna:
    - ✓ Directive Antenna: 15dBi, 60°, from 1700MHz to 2700MHz
    - ✓ Omnidirectional Antenna: 12dBi, from 1700MHz to 2700MHz
  - Transmission Mode:
    - ✓ TM1
    - ✓ TM2
- Outdoor Test Scenarios:
  - ✓ TM1+Directive Antenna
  - ✓ TM1+Omnidirectional Antenna
  - ✓ TM2+Directive Antenna
  - ✓ TM2+Omnidirectional Antenna
- Measurement tools:
  - ✓ SpeedTest
  - ✓ iperf

LTE CASE and Outdoor testbed for OAI





Test Results:

- Under current settings, the coverage range is about 300 meters
- TM2 with directional antenna performs a bit better than other combinations when considering throughput
- Uplink throught drops fast than downlink, may because of the uplink low noise power amplifier.
- Throughput drops fast when moving (< 20KM/h), may because of channel estimation algorithm?

OAI Enabled Remote driving

- V2X (Vehicle to everything) will be a very important scenario in 5G, like unmanned driving.
- In this research, we built a remote driving prototype. To give an example that OAI can facilitate the research in 5G vertical industrials.

What's remote driving?

Connected to cellular network

Remote cockpit

Video signal

Control signal

Unmanned Vehicle

OAI Enabled Remote driving

- To support remote driving, there're two 5G scenarios involved:
  - uRLLC for the control signal
  - eMBB for the video signal

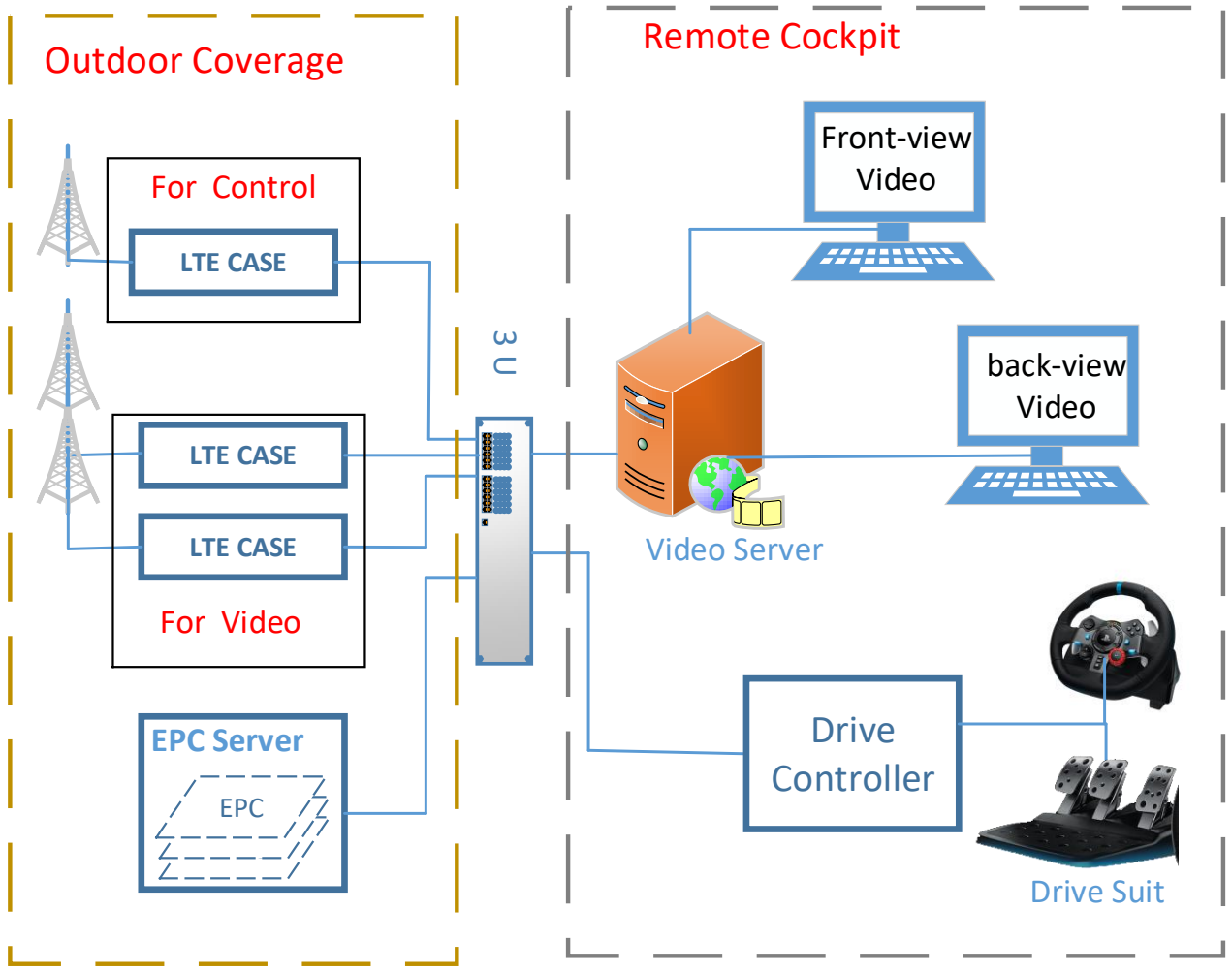
- In outdoor coverage:

1. For control signal, including 1 eNB and 1 EPC.
   - ✓ PLMN set to 110-01,
   - ✓ 5MHz bandwidth, DL: 2630MHz~2635MHz, UL: 2510MHz~2515MHz

2. For video signal, including 2 eNBs and 1 EPC.
   - ✓ PLMN set to 110-02, and 110-03
   - ✓ 10MHz bandwidth for each eNB, DL: 2620MHz~2630, 2660MHz~2670MHz, UL: 2500MHz~2510MHz, 2540MHz~2550MHz

- In Remote Cockpit:

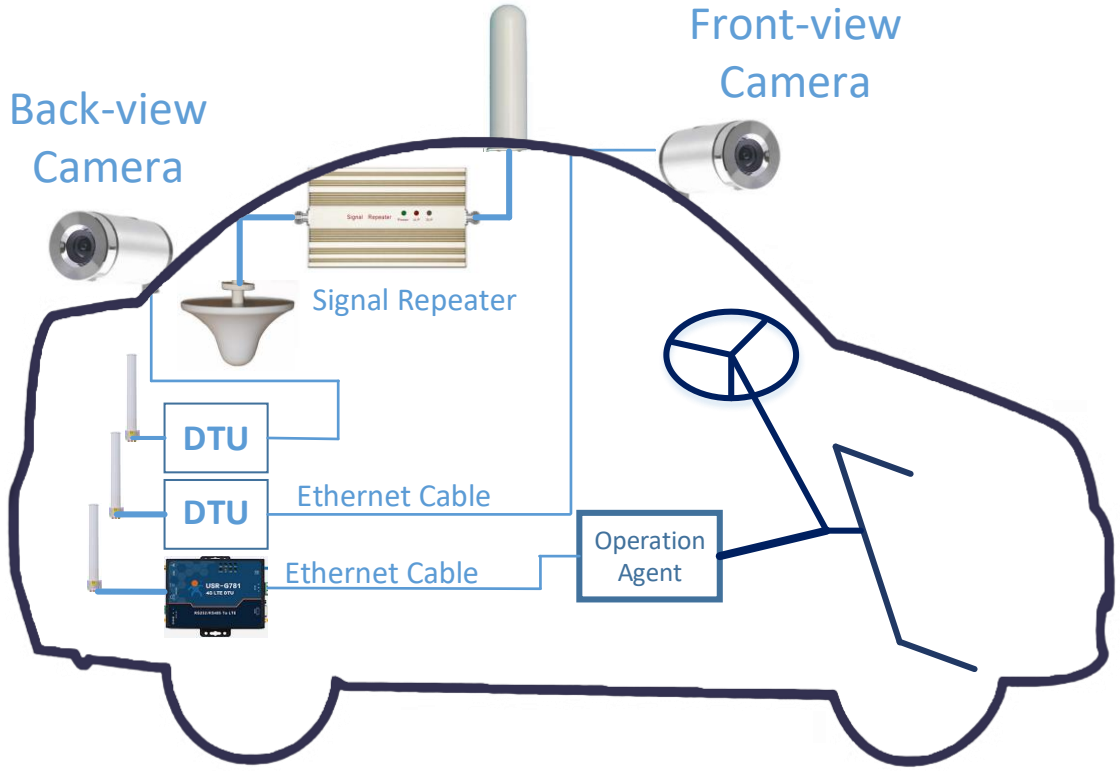
1. Two monitors, are used to monitor the front and back view from car.
2. Logitech Game Wheel is used to generate control signal, and transferred through Drive Controller.



OAI Enabled Remote driving

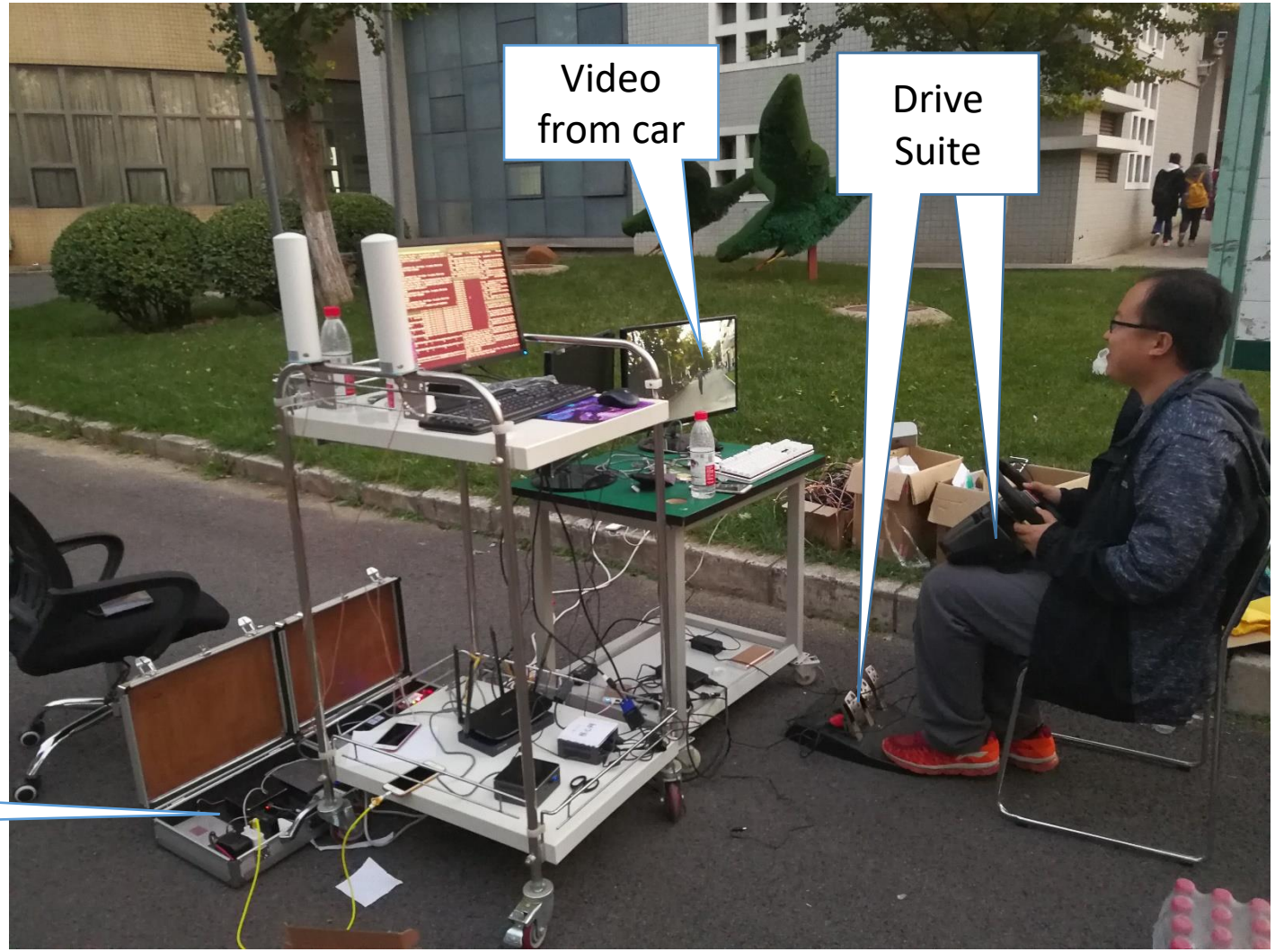
- In-car settings:

1. A signal repeater with one outdoor antenna and one indoor antenna. Gain: 30dB
2. DTU, transfer LTE to Ethernet; connect to operation agent, front-view camera, back-view camera, respectively.
3. Front-view camera, back-view camera; Resolution: 1280x720P, FPS: 25, Bit rate: 12Mbps
4. Operation Agent: receive control signal from remote controller, and drive the car



In-car settings

OAI Enabled Remote driving



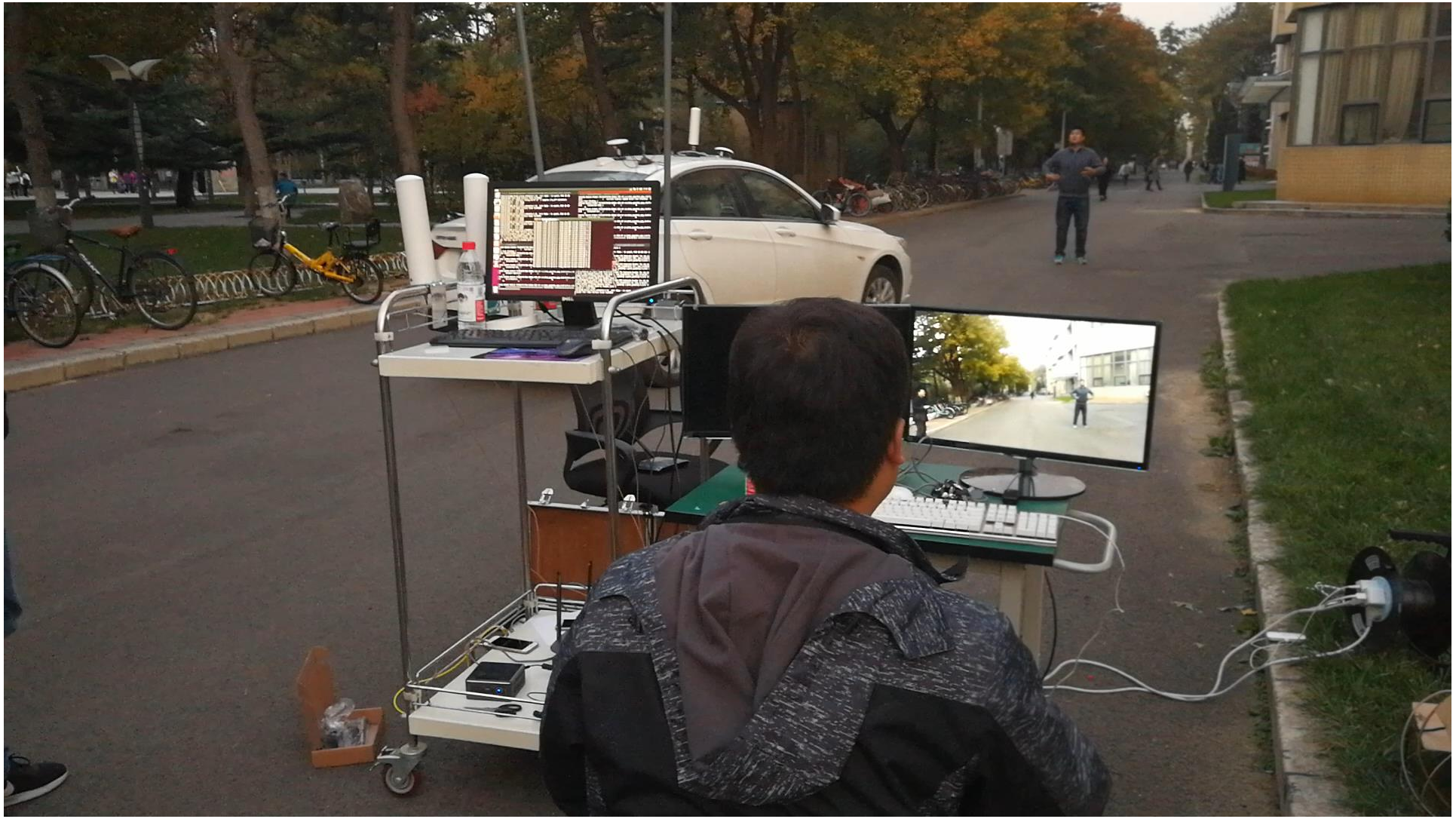
OAI Enabled Remote driving

Our Costumed Electric Car

Camera and Differential Positioning receiver

DTU and Operation Agent

OAI Enabled Remote driving



Thank you!

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