
EXPERIENCES BUILDING AN ENVIRONMENT

FRIENDLY ITS IN THE CITY OF HUAINAN

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ABSTRACT

Huainan is a former mining city with about 3 million inhabitants which means in China a classification as a “third-tier” city. In this class of city are more than 200 other cities in China, which shows the great potential that Huainan has to act as a pioneer and possible blueprint for other cities. During the application phase, the progressive ideas of the city government led to experts from DLR being invited to integrate sustainable and environmental protection aspects into the project, subsumed in the “German Innovation Package”. The project to set up the new ITS was planned for 2 years (2018-2020) plus a phase of 3 years for maintenance which was also used for optimization and enhancements. This contribution describes the main results und experiences of the overall project and new core functionalities of the integrated modules developed by DLR, namely a traffic and environment dashboard and weekly/monthly reports about the ITS situation, all integrated in the established web-portal KeepMoving.

INTRODUCTION

As a result of the rapidly growing motorized traffic in China, cities more and more have to face increasing traffic problems and are dependent on innovative and individual solutions. Huainan City is one of many third-tier cities in China facing similar problems. In 2018, the city of Huainan started a project to build an intelligent transportation system using a loan from KfW-Bank.

GOALS TO ACHIEVE WITH THE NEW ITS HUAINAN

The project had the overall objectives of alleviation of city traffic congestions and improvement

of the operation efficiency of city traffic, strengthening the prevention of traffic accidents, to improve the public transport service, to promote low carbon traffic and decrease traffic pollution. Through climate protection and improvement of the environment the living conditions of the population shall improve and the economy grow. The ITS measures of the project shall have positive effects on the environmental-friendliness of the Huainan urban transport system concerned. The improved traffic management shall result in more fluent traffic flows which allow for reduced fuel consumption of road vehicles and thus less harmful emissions. First steps setting up the new ITS have been already published in (1) while the key achievements of the project and DLR's components are addressed in this contribution.

THE GERMAN INNOVATION PACKAGE

The German Aerospace Center (DLR) has worked since 2004 in the Anhui province and has implemented several Floating Car Data (FCD) projects in China (see e.g. (2)). The “German Innovation Package - Traffic and Environment Monitoring System” is the result of ITS research addressing the ideas of low carbon and green traffic systems and is also a demonstrative and pioneering application in the field of domestic ITS construction in the city of Huainan, China. As part of the new Huainan ITS, the traffic environment monitoring system functions to measure traffic pollution and uses advanced technologies to improve the environment. The construction of the traffic environment monitoring system includes two parts: one is to monitor the traffic environment of Huainan; the other is to put forward the corresponding improvement measures against traffic pollution.

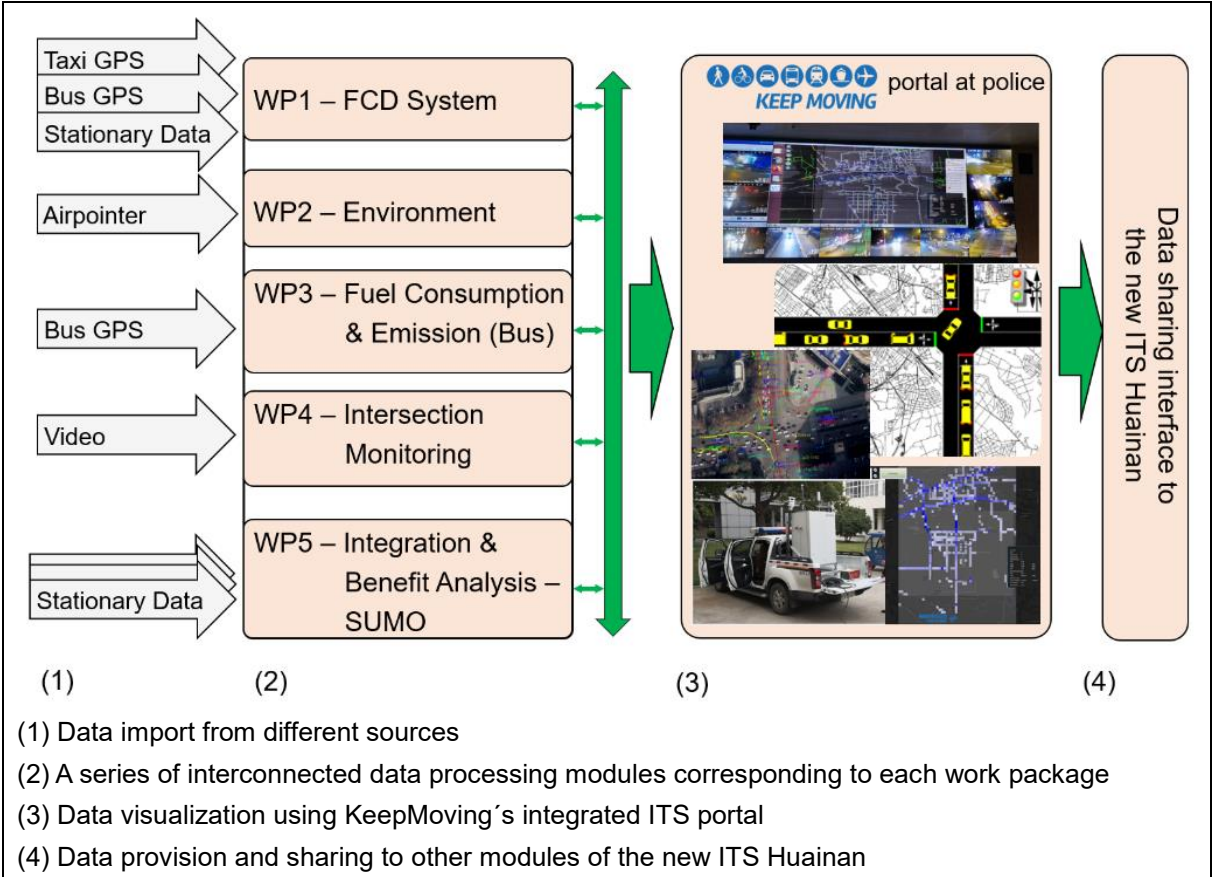


Figure 1 System overview on the German Work Packages contributing to the new ITS

The construction content of traffic pollution monitoring includes a hardware and a software part: Among them, the hardware part was to purchase two sets of portable engine and flue gas analyzers, the software part to set up a traffic pollution monitoring software of atmospheric pollution model which is based on transportation and stationary pollution, as well as the one set of estimation model of fuel consumption which is based on FCD bus and taxi. The key components of DLR's package are the following (see also **Figure 1**):

- DLR's KeepMoving Portal - Combination of area wide traffic information based on FCD and stationary sensor data with a coverage as shown in **Figure 2** and environmental monitoring
- DLR's online calibration process with SUMO (3) - Real-time monitoring of city-wide road traffic
- Intersection monitoring delivers conflict parameters and trajectories
- Big Data Analysis of long-term traffic performance
- Analysis of the long-term impact of ITS and scenario analyzes
- Environmental impact evaluation of the new ITS

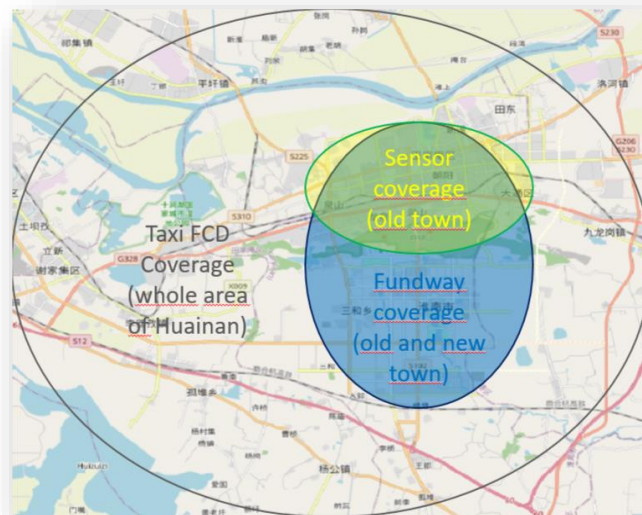


Figure 2 Coverage of input data for the new ITS Huainan

FURTHER IMPLEMENTATIONS OF THE GERMAN INNOVATION PACKAGE

Basic functionalities of the KeepMoving portal by DLR have already been published in (1) (zoomable maps of current and predicted traffic states based on the multiple data sources as well as emission and air quality maps and especially the setup of environmental monitoring and modelling together in connection with the microscopic simulation SUMO). In addition to emission and air quality values related to road segments and raster cells of the city visualised in a map, meanwhile city-wide key values have been developed to give traffic operators the possibility to observe its development over time and create weekly and monthly reports. **Figure 3** shows the main visualisations concerning these issues. In the screenshot (**Figure 3** top) the

current development is visualized as time series of the city-wide values of the AQI as average values as well as below the number of cells with worse to worst values realised as a stacked diagram to give a clear impression about the variation over the day. In weekly reports (Figure 3 bottom-left) these diagrams are summarized together with the average values of each day, its standard deviations, the 5-minute maximum values and another visualisation of number of cells with worse to worst values which makes an easy comparison between the values of different days possible. For monthly reports (Figure 3 bottom-right) the same values are listed except for the diagrams but with weekends highlighted to make it easy to see similar effects on same weekdays.

Such report functionalities are also available for travel times on selected predefined arterial routes in the KeepMoving portal with daily variation of the travel times as well as average travel times over the day and number of daily hours in free-flow, slightly congested and congested states on each route.

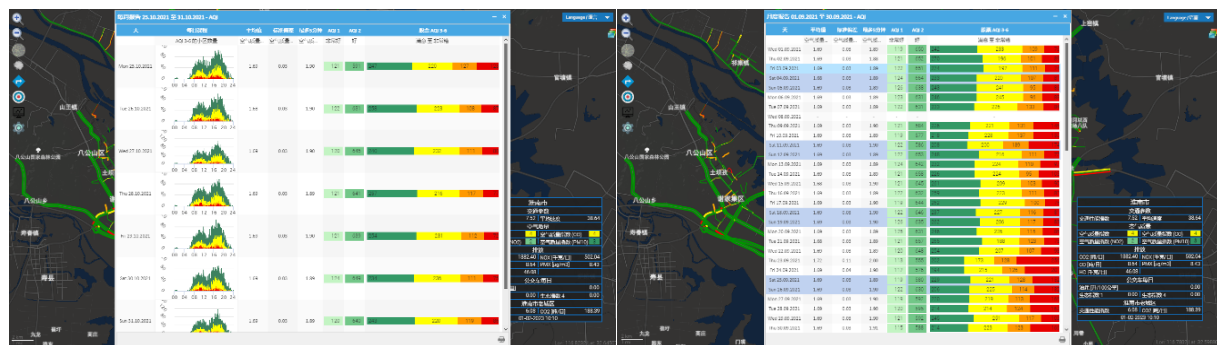
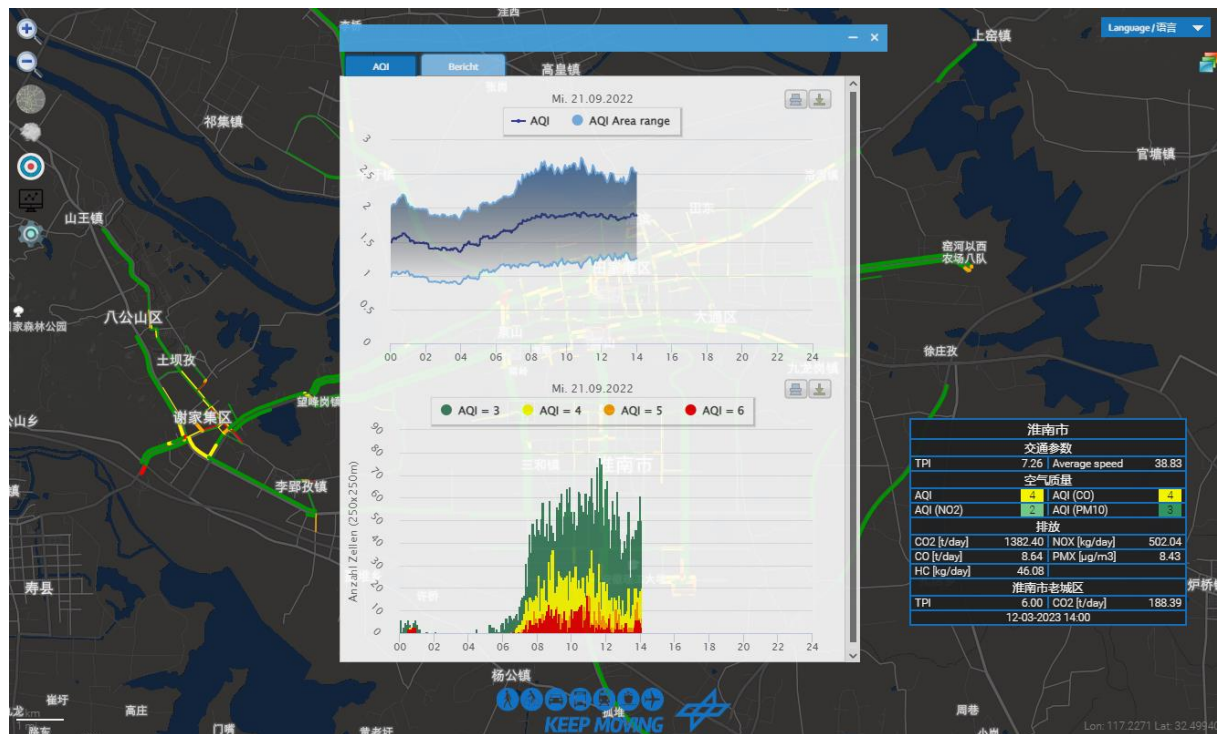


Figure 3 Current development as well as weekly and monthly reports of air quality values available in the KeepMoving portal

In the Huainan ITS project, measurements of greenhouse gas emissions are calculated by the established SUMO simulation model. As the SUMO model is up and running now for a while and meanwhile well calibrated, the output provides emission data related to the used basic road network, allowing the calculation of greenhouse gas (CO₂) emissions under real-time traffic conditions and historical statistics in Huainan. SUMO simulation calculates the emissions for each simulated vehicle and sums up over road elements and the whole city. The values can be viewed per road segment in the KeepMoving web portal and the daily development can be observed in a dashboard. As for the AQI with visualized daily time series, weekly as well as monthly reports can be generated at present. **Figure 4** shows an example for a monthly report as a clear overview with bars and min/max values indicating the development of the emissions over the days of the month. The CO₂ emissions are in the range of about 990 to 1400 tons per day which means a reasonable share of about 9.6% to 13.6% of the total CO₂ emissions in the city.

Tag	Tagessumme [t/day]	5 Minuten Min [t/day]	5 Minuten Max [t/day]
Mo. 01.08.2022	1079.36	155.04	2056.43
Di. 02.08.2022	1053.72	178.84	2009.88
Mi. 03.08.2022	1069.32	169.94	2054.56
Do. 04.08.2022	1340.78	159.64	3093.00
Fr. 05.08.2022	1096.73	156.58	2139.20
Sa. 06.08.2022	1089.28	165.87	2080.95
So. 07.08.2022	1099.45	169.67	5154.45
Mo. 08.08.2022	1096.84	156.64	2106.20
Di. 09.08.2022	1093.12	167.81	2113.18
Mi. 10.08.2022	1082.64	162.29	2089.90
Do. 11.08.2022	1120.47	169.56	2083.16
Fr. 12.08.2022	1081.91	180.60	2045.16
Sa. 13.08.2022	1081.37	177.00	2046.50
So. 14.08.2022	1091.18	171.34	6570.68
Mo. 15.08.2022	1072.41	162.33	2034.67
Di. 16.08.2022	1057.28	170.71	2032.39
Mi. 17.08.2022	1064.46	169.33	2027.27
Do. 18.08.2022	1071.90	165.30	2037.53
Fr. 19.08.2022	1073.02	167.38	2048.42
Sa. 20.08.2022	1101.42	168.39	2269.64
So. 21.08.2022	1087.08	158.66	2078.46
Mo. 22.08.2022	1103.14	159.21	2088.04
Di. 23.08.2022	1104.07	169.09	2096.90
Mi. 24.08.2022	1075.49	165.18	2044.30
Do. 25.08.2022	1070.42	173.37	2023.57
Fr. 26.08.2022	1077.10	172.56	2057.93
Sa. 27.08.2022	989.33	159.79	2062.81
So. 28.08.2022	1080.35	163.97	2077.69
Mo. 29.08.2022	1066.68	162.44	2107.28
Di. 30.08.2022	1097.20	162.52	2092.02
Mi. 31.08.2022	1076.50	164.98	2067.84

Figure 4 Monthly report for CO₂ emissions in the KeepMoving portal

As already briefly mentioned before, a dashboard was realized giving traffic operators an overview on relevant current traffic and pollutant key values within the city which is updated every few minutes whenever particular values change. **Figure 5** shows the dashboard a little bit more in detail. For the whole city and in particular for the area of the old center - which is still the most busy and congested region – the following key values are frequently actualized:

- Traffic performance index (TPI) ranging from 1 (jammed) to 10 (free flow) in the whole city of Huainan and in the area of the old center
- Average speed of vehicles in the city
- Current Air Quality Index values (AQI) in total and for different pollutants
- Selected current emission values; CO₂ especially in the area of the old center

淮南市			
交通参数			
TPI	7.26	Average speed	38.83
空气质量			
AQI	4	AQI (CO)	4
AQI (NO2)	2	AQI (PM10)	3
排放			
CO2 [t/day]	1382.40	NOX [kg/day]	502.04
CO [t/day]	8.64	PMX [$\mu\text{g}/\text{m}^3$]	8.43
HC [kg/day]	46.08		
淮南市老城区			
TPI	6.00	CO2 [t/day]	188.39
14-03-2023 07:00			

Figure 5 Dashboard for current traffic and pollutant key indicators

RESULTS AND BENEFITS OF THE NEW ITS

The following new ITS applications are widely used in the city of Huainan:

1. Data fusion of both static and dynamic information collection are used in the traffic information collection in order to make up for the deficiency of single detection methods and achieve real-time and accurate road information collection in a larger range.
2. In the aspect of signal control, the ratio of networking signals distributed at intersections was increased in order to optimize network control, achieve road traffic signal intelligent control and improve traffic efficiency. The increased efficiency of the road transport system reduces road travel times and increases reliability and thus benefits all road users, e. g. better punctuality of commuters and urban logistic services as well as improved reliability of public transport.
3. The construction of software and hardware of the integrated management platform subsystem were carried out in the construction of the command center.
4. The environment monitoring of traffic pollution was strengthened and the impact of traffic on environment can now be accurately grasped from the micro and macro level in order to provide a decision-making basis to promote the construction of a low-carbon city. For example, now the traffic management department can observe the driving track of vehicles (trucks) with congestion or high emissions based on the emissions-monitoring of certain road sections. In particular, the system provides the emission data based on EU standards to the municipal environmental department.
5. In the aspect of public transportation, public bicycle, as an environment-friendly transportation were carried out to increase public transportation. A total of 300 public bicycle rental service stations, 12.000 bike locks and 10.000 bicycles have additionally been built in the city. The government has also carried out a “one hour free” policy to meet the needs of the masses basically for the “last mile” of transport.

Since 2013, in Huainan the number of motor vehicles and drivers has risen by more than 500% and traffic accidents have increased in direct proportion to the traffic flow and transport volume. The original traffic management measures are backward and have no obvious effect in reducing

accidents and ensuring smooth traffic. After implementation of the project, the transport pressure in the urban area has been greatly alleviated, and the transport of people and vehicles is more smoothly. At the same time, with the addition of traffic lights and video cameras at intersections, the means of traffic management are stricter. With the rapid growth of vehicles, it will greatly help to reduce the rise of (heavy) traffic accidents. (According to statistics, on the premise of the increase in the number of traffic accidents in Huainan City in 2022, the number of injured people fell by 41.41%, and the number of deaths fell by 2.34%. Especially in Panji District (in the north to north-west part) of Huainan city, after the scientific and technological equipment for loan construction is in place, the supervise effect has been significantly improved. The number of deaths fell by an astonishing 35% compared with 2021.)

LESSONS LEARNT

It was observed that the Huainan urban transport system is under a high pressure of fast-growing car ownership and thus increasing road traffic. Although no statistics were available there is the danger that the positive effects of the ITS system will be negatively overcompensated by growing road traffic demand. Thus, the city administration is highly recommended to act for controlling the fast-growing private car traffic, e.g. by internationally well-established transport demand management measures, like strict enforcement of parking management, incentives to shift users to public transport through increased attractiveness of public transport systems (e.g. BRT or tram system) and public transport-oriented land use planning.

A comprehensive data collection and high data fusion quality is not only crucial for the success of each subsystem but specifically for higher level integrated functionalities on the management and the client level.

A close cooperation and collaboration of all bodies acting in the domain of ITS (police, road authority, public transportation company, planning department, ...) is crucial to guarantee the success and the benefit of Huainan ITS.

For a quick and appropriate reaction on unforeseen roadside incidents/accidents in real time particularly the adjustment and harmonising of separate measures of the different system operators is indispensable, thus avoiding contradicting impact on traffic.

The Huainan ITS provides a set of new functionalities which the existing personnel of the responsible departments are not educated for. A specific training concept for the staff later responsible for the system operation must be developed and implemented early enough to guarantee a successful operation of the system and also to support the test and the commissioning in an efficient way.

OUTLOOK

One of the main objectives to introduce and enhance the intelligent transportation system (ITS) in the city of Huainan is to achieve sustainable transport which is by now on a good way. To understand the benefits of the installed ITS evaluations in environment and traffic system performance a respective evaluation will be conducted in the last phase of the project in 2023.

Here, the simulation modelling with the software SUMO (see [(3)]) is adopted for a scenario analysis matching the following criteria following a BAU (Business As Usual) scenario according to the Huainan City 14th Five-Year Plan for Air Pollution Prevention and Control 2021-2025:

- Year targeted to analysis: 2025
- Share of E-cars: 20%
- Radius of public charging stations in urban areas less than 0.9km
- All conventional engine cars meet National III emission standard (equivalent to Euro III)

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