

Millbrook

November 2018



Our Vision

Our vision is to be a leading global provider of test services to the industries that we serve

We will realise this vision through a relentless focus on our Priorities

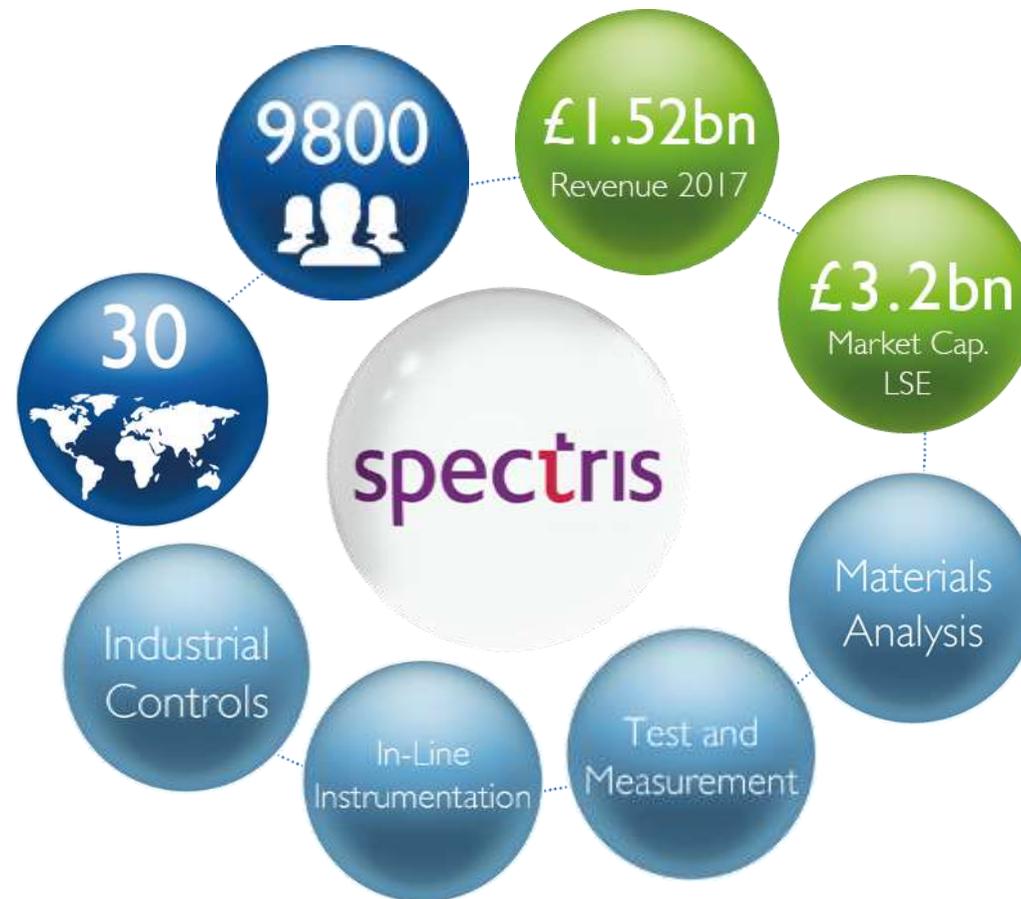


Locations



Spectris Overview

Millbrook is part of the Test and Measurement business segment of Spectris plc

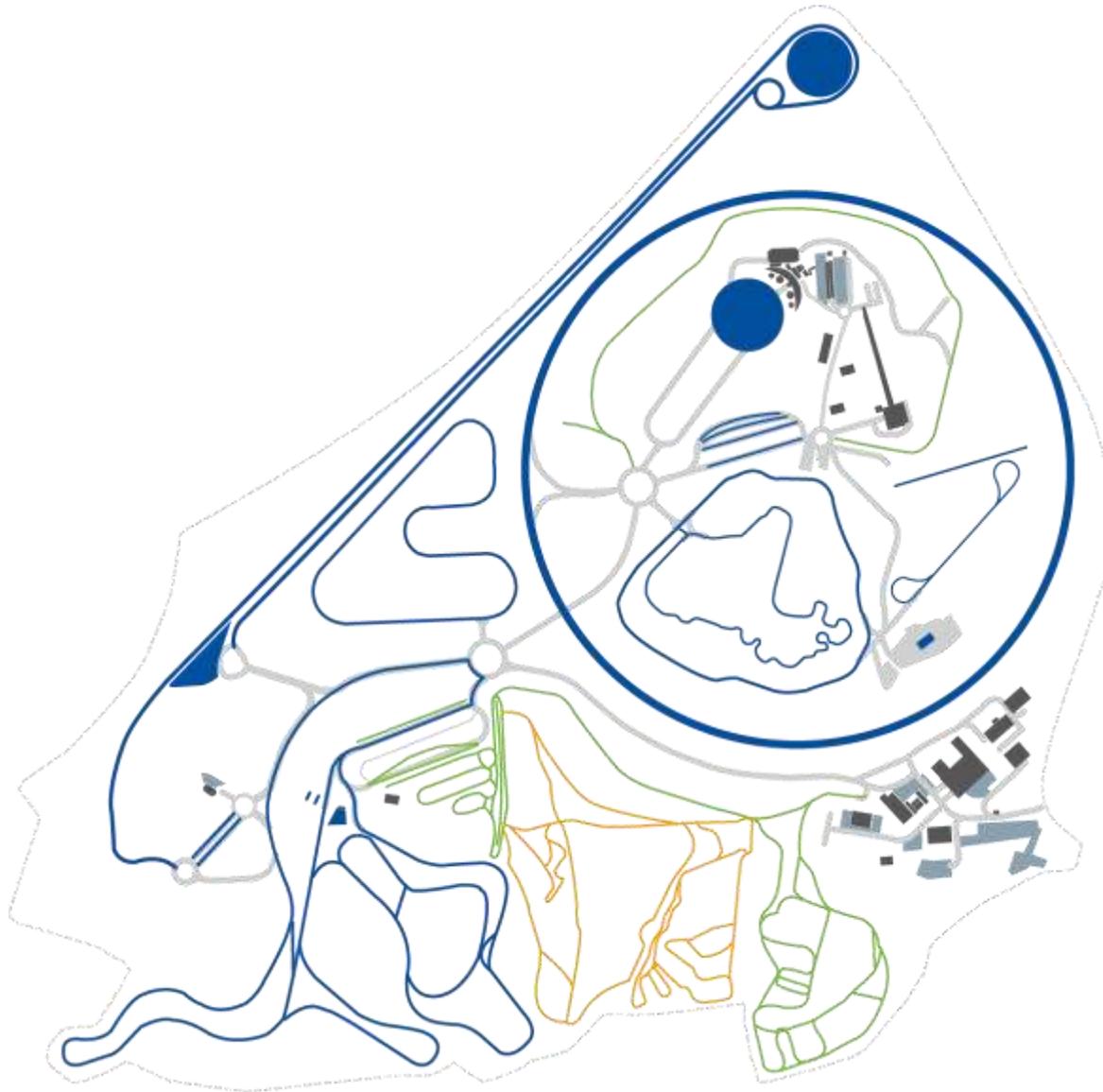


Spectris Overview

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Track Testing – UK

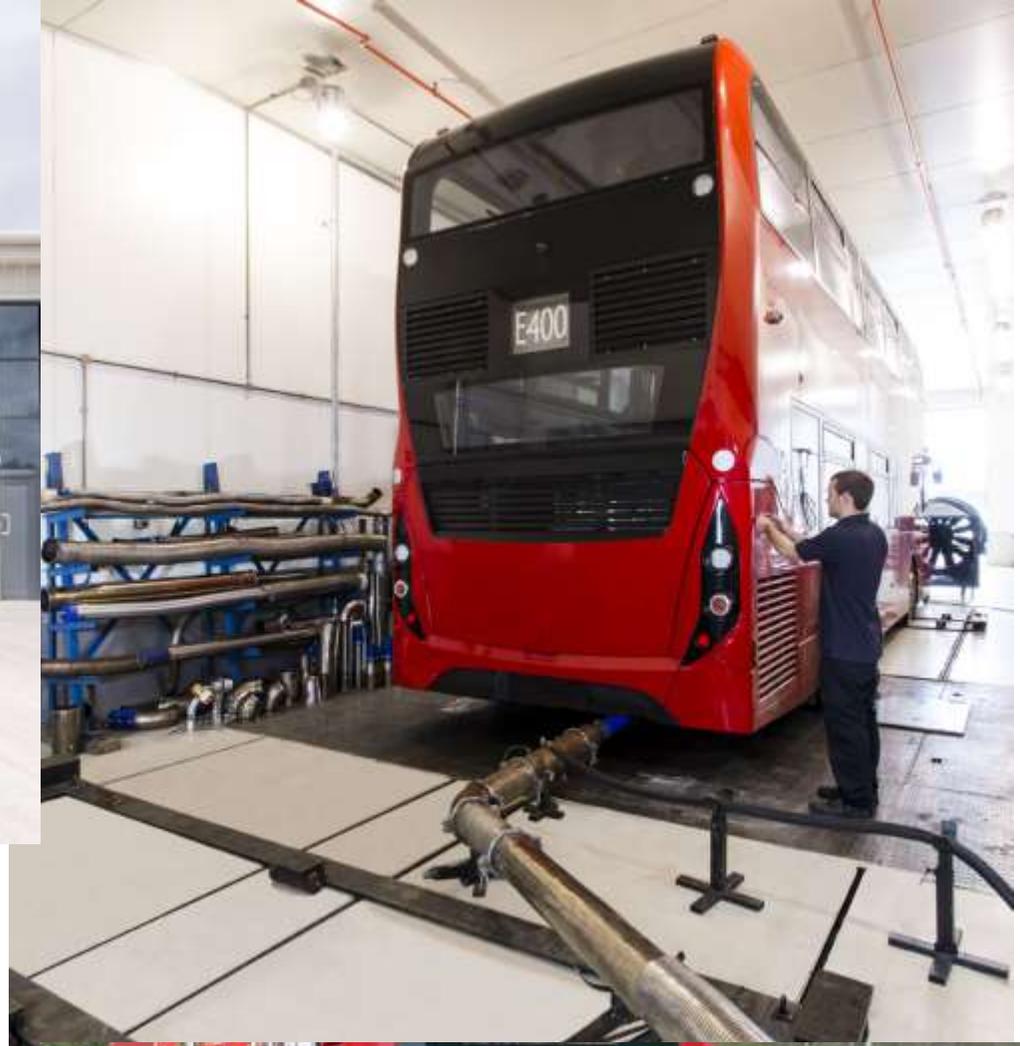


1000m





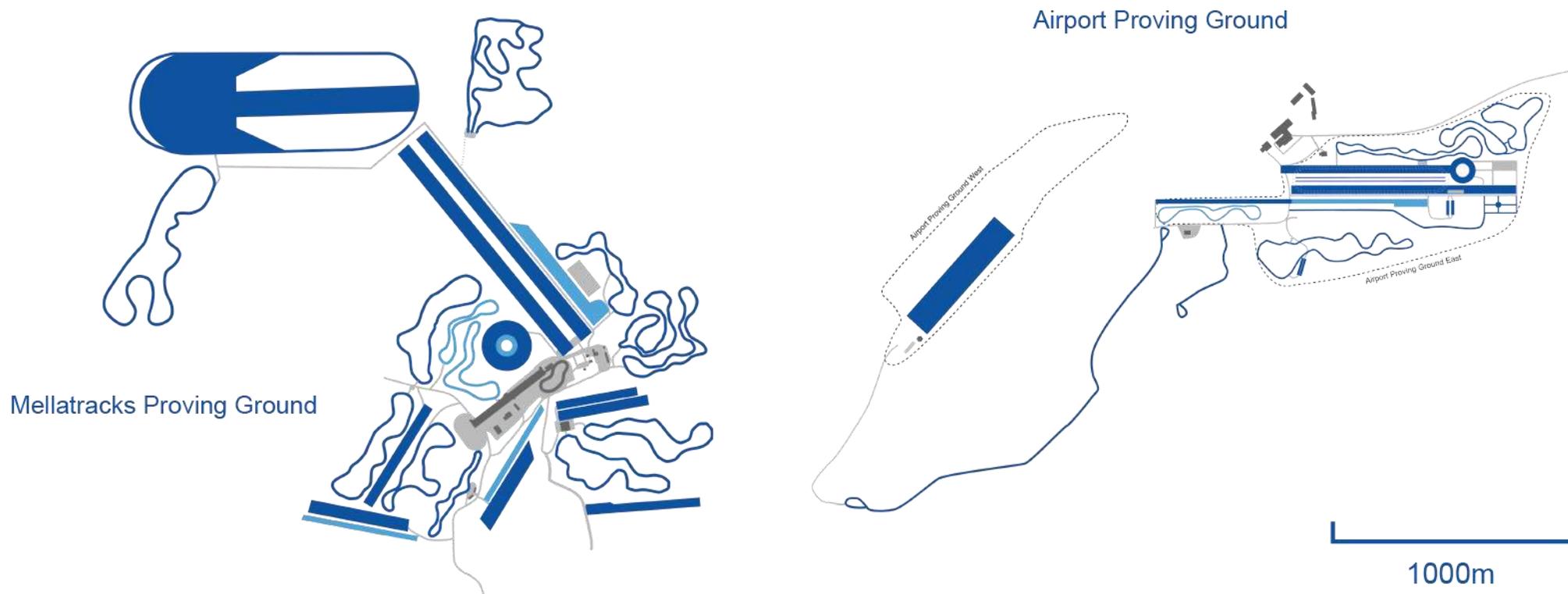




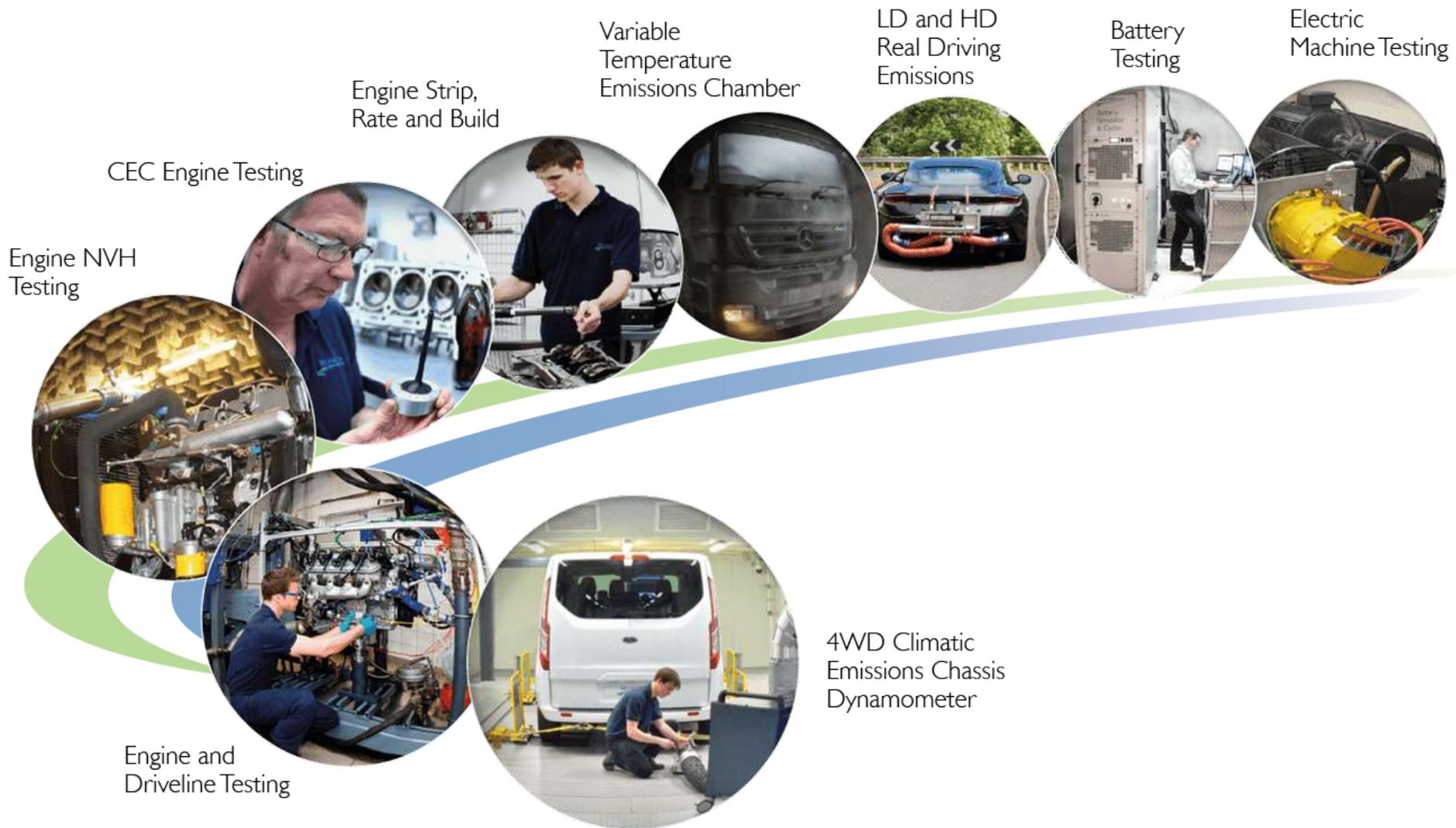




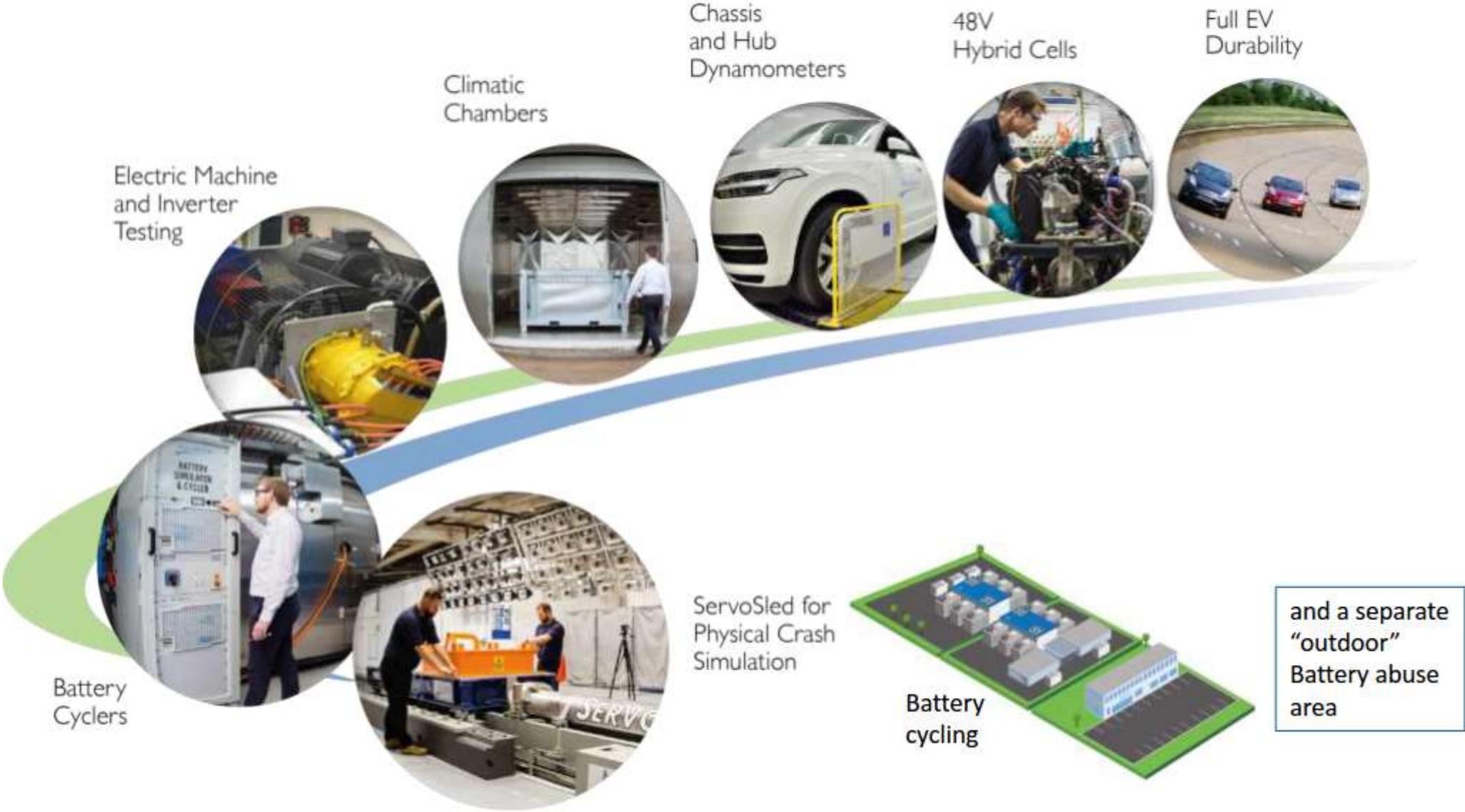
Track Testing – Finland



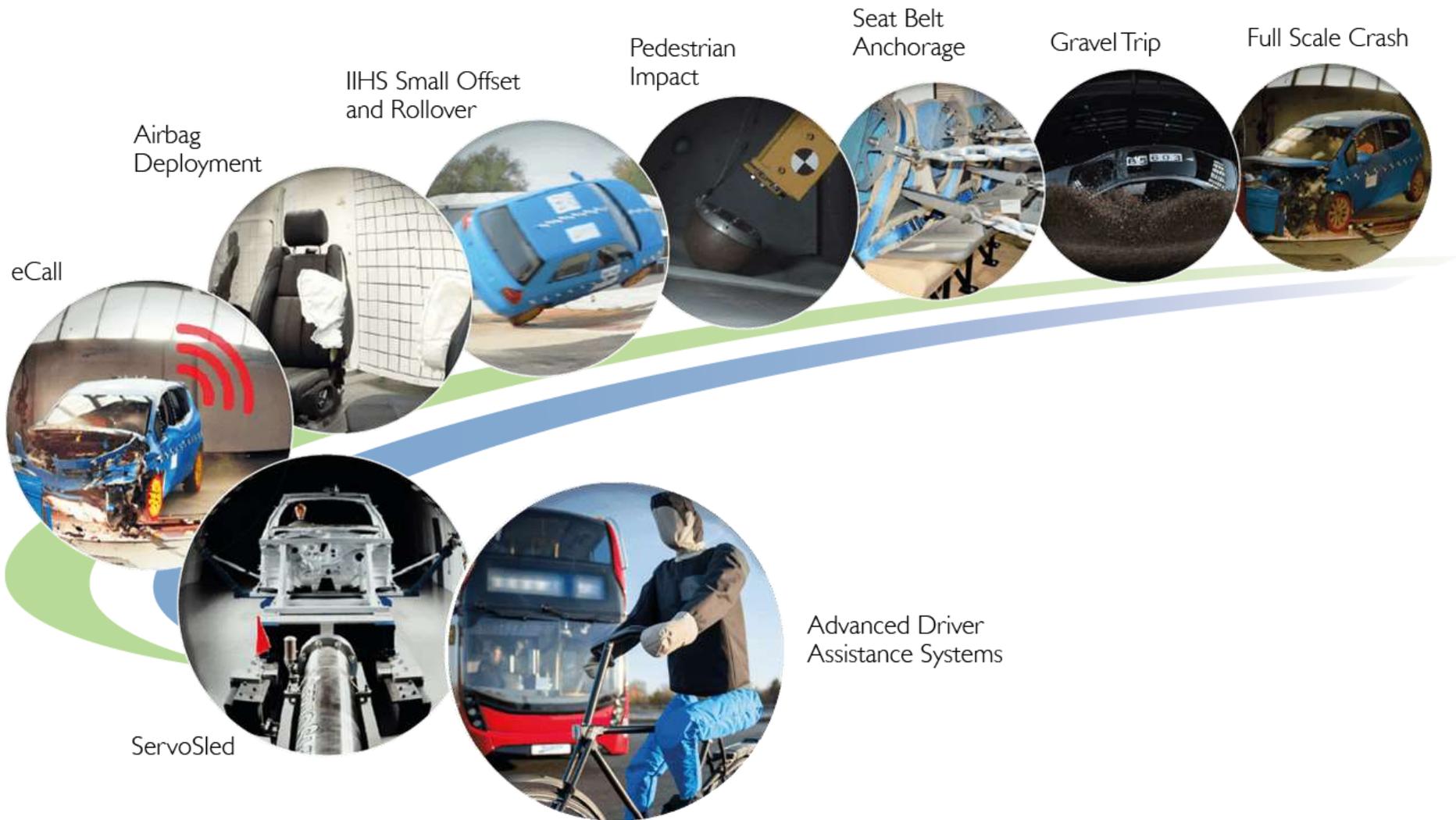
Propulsion Testing



Overview of Battery Test capabilities



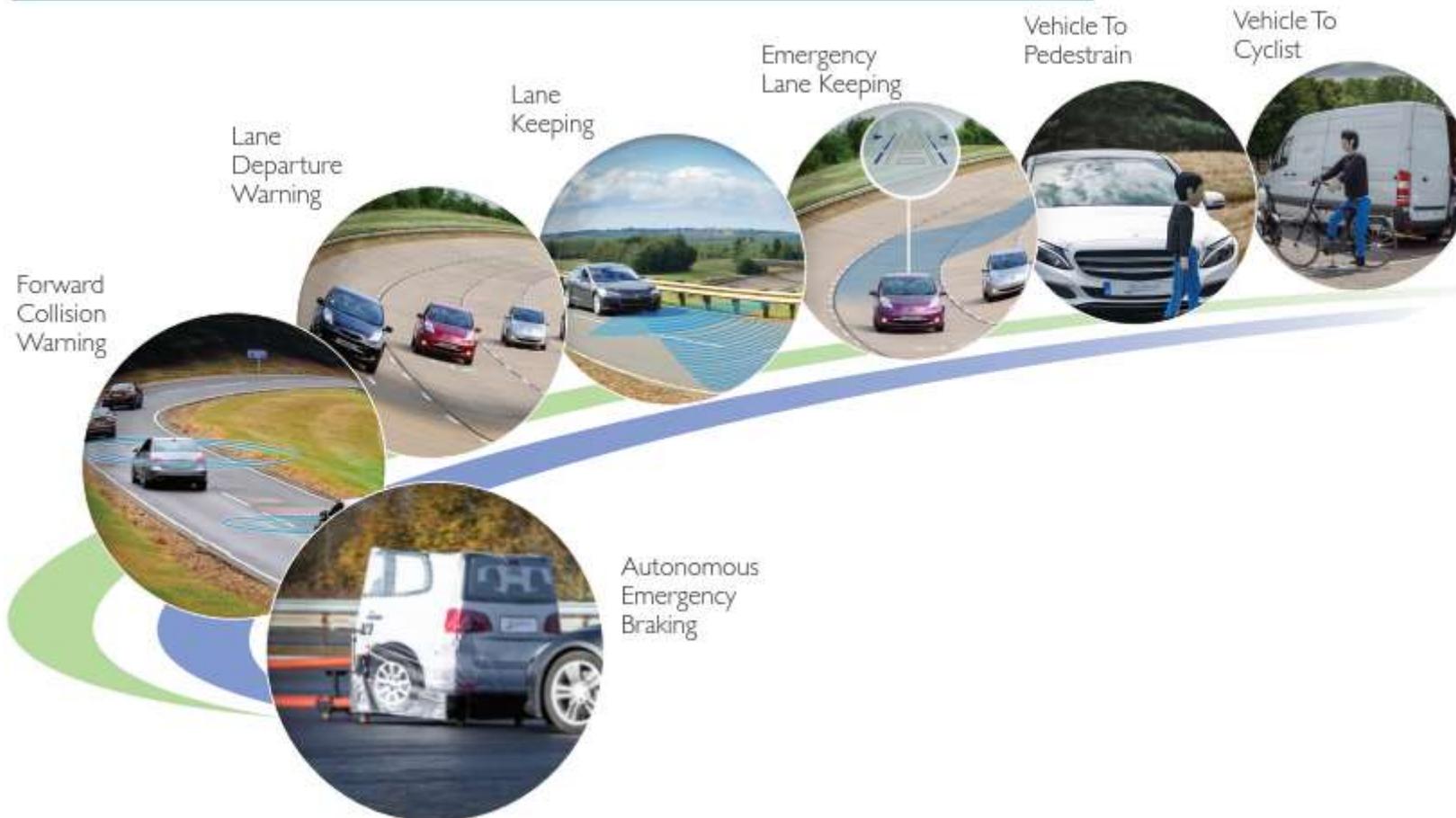
Safety Testing



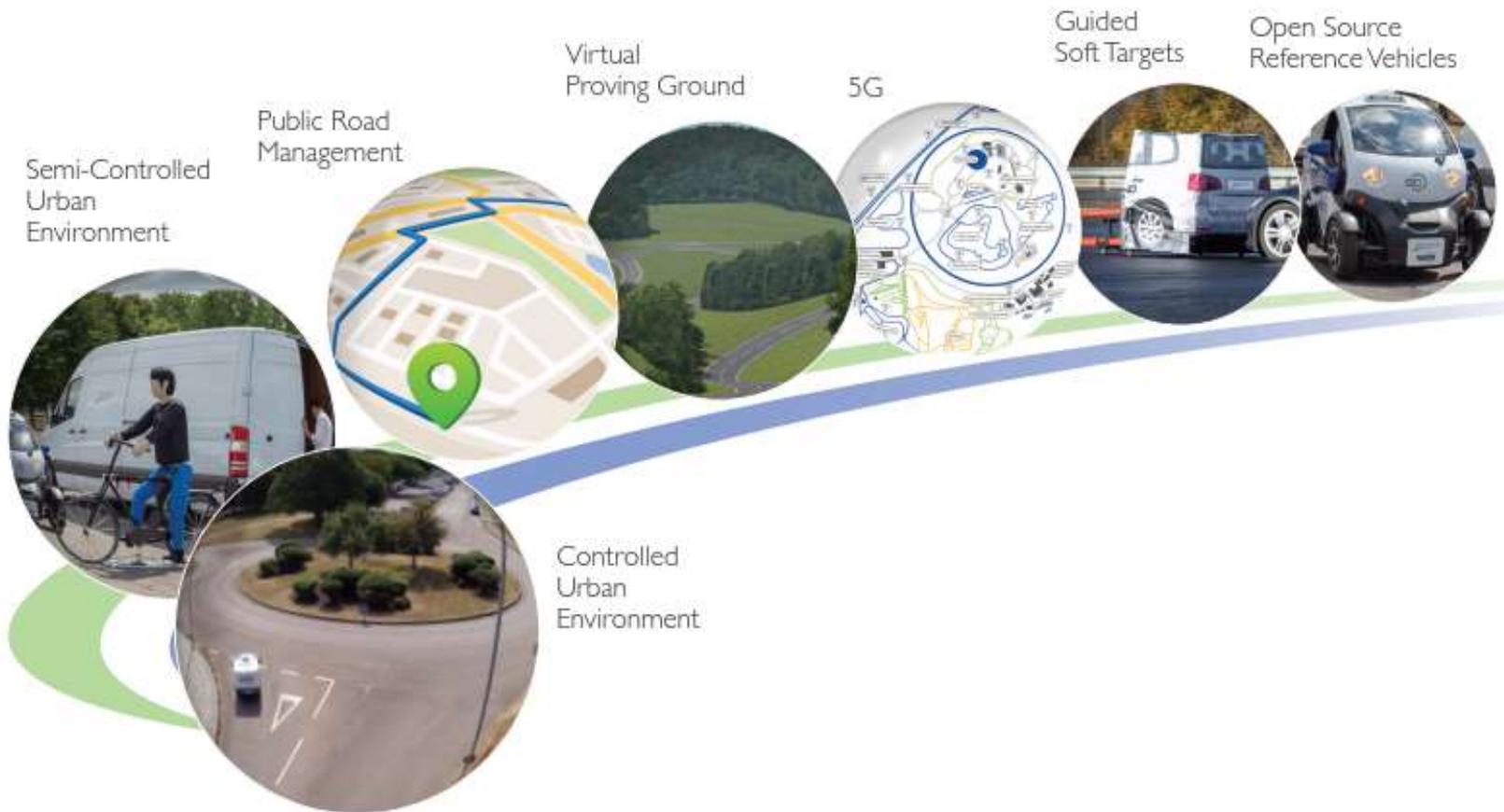
Vehicle Testing



Active Safety



CAV Testing



1. Your Project

- Test services to the CAV industry
- New test facilities
 - Improved physical infrastructure
 - Simulation suite
 - V2X capability
 - DCMS 5G Testbed
- Already testing CAV's

2. What's innovative about it?

- Clear path to on-road operation
- Open to all players
- Link to UK testbeds via Meridian
- No IP threat or compromise

3. The services you can offer?

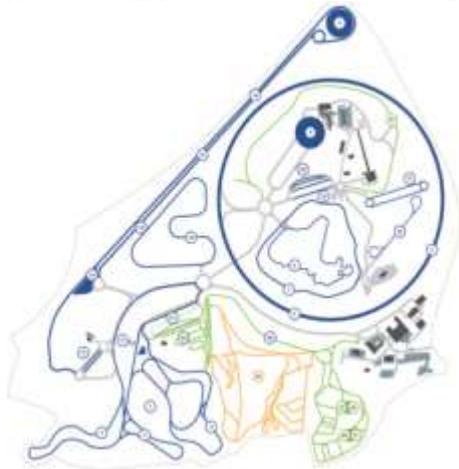
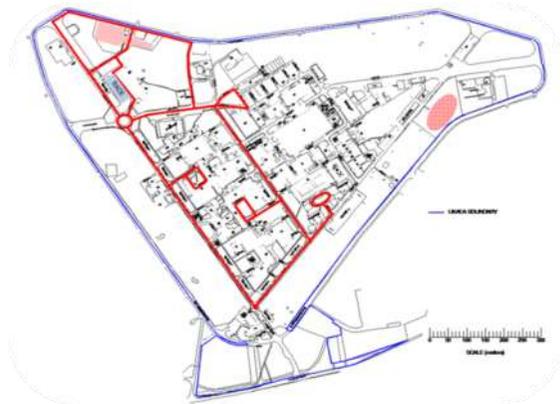
- Development, trials, test, demonstration
- Vehicles, components and systems
- 80km tracks, 900 acres. Endless scenarios with and without other road users

4. The customers you seek?

- Start up's, SME's, OEM's, consortia
- On or off road testing. Static or dynamic
- City, urban, interurban users, virtual players

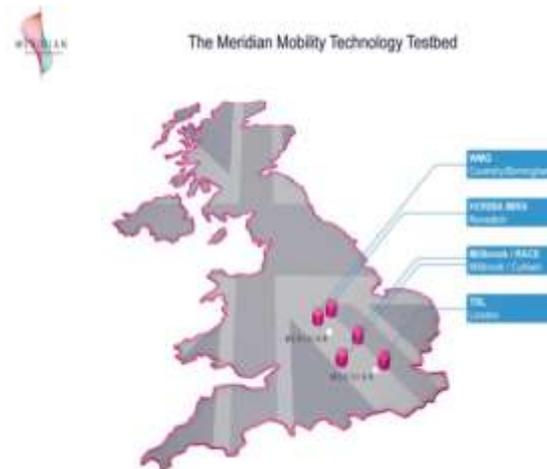
Future UK Testbed Investment and Operation

The UK's Controlled Urban Testbed – partnership with UK Atomic Energy Authority



- Groundbreaking collaboration across the urban mobility test sector
- Access to controlled sites with urban simulation
- Initial development at Millbrook, more mature development at RACE
- Culham site has 2,000 staff and semi-controlled urban test routes
- Linkage to UK CAV Testbed Ecosystem
- Under construction Q2, 2018, complementing existing facilities

- Full connectivity to high speed wifi, mobile and 5G emulation
- Co-located simulation suite on Millbrook site
- Provision of open source reference vehicles
- Latest technology traffic management systems
- Open to all, open all hours



Open all hours

- Open to all
- Open now
- Available to all
- Available now
- Not an IP threat
- Trusted and independent
- Impartial, safe and secure
- Experienced
- 100% British
- Ease of entry
- Reducing barriers to entry
- SME and start up friendly
- Outward facing
- Hills, valleys, curves, straights and streets



Additional ADAS equipment

To update and expand current ADAS offer into CAV's:

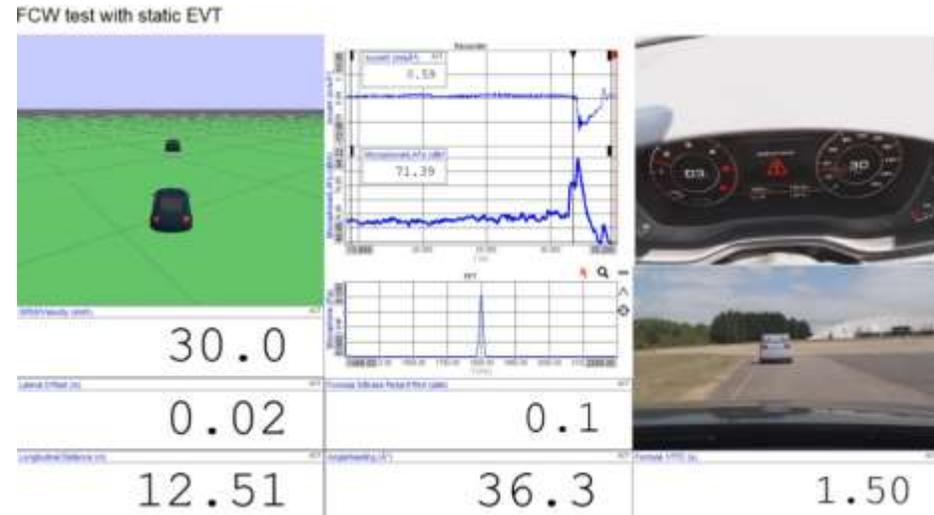
- Data management equipment
- Inertial navigation and positioning (Datron)
- Additional targets (Moshon & ABD)
- Steering robot (ABD)
- Braking robot (ABD)

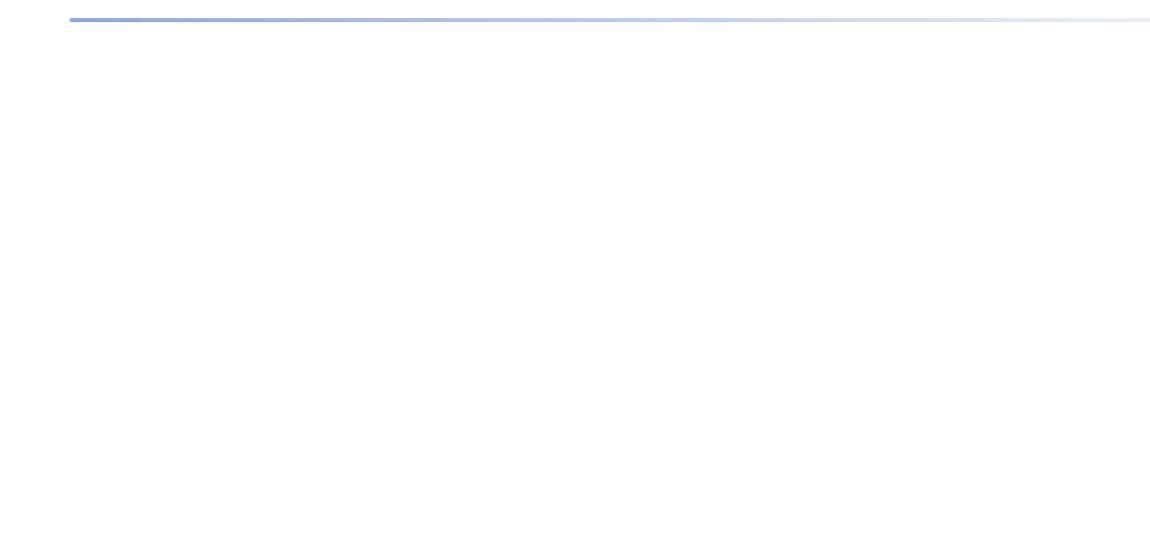


Data Acquisition & Positioning

Further equipment in addition to previously mentioned soft targets and driving robots:

- Data acquisition software
 - Polygon visualisation tool
- OxTS RT3003 inertial & navigational measurements
- High positional accuracy;
 - Proving Ground wide Racelogic RTK corrections to 2cm
 - Local OxTS RTK Base station to 1cm
 - NTRIP mobile network corrections on public road
- Vehicle-vehicle data links
- Multiple camera views
- Additional sensors can include;
 - Microphones for acoustic feedback
 - Accelerometers for haptic feedback
 - Vehicle CANbus parameters
 - Pedal position & force
 - Brake line pressures
 - Steering wheel angle & torque





Key Partner: Streetdrone

Open source reference vehicle

Available to all customers.

Configurable vehicle characteristics

Prefit with sensors, optional LIDAR

Available Q3, 2018



Specification

- Drive-by-Wire
- CAN bus interface
- Control of vehicle ancillaries
- Auxiliary Power Additional 12V system
- Autonomous Ready
- AV Platform NVIDIA DRIVE PX2
- AV Software NVIDIA DriveWorks
- Functional Safety
- Emergency Stop Button
- Data Server FreeNAS 4TB
- Option: 4G, Bluetooth Connectivity
- Front, roof, side and rear sensor mounting
- points
- Flat roof mounting area for LiDAR and GPS
- Flexible wiring options
- GPS
- IMU
- Wheel Speed Sensors
- Steering Angle Sensors
- Power Performance Diagnostics
- Actuator Monitoring
- Cameras 4 x GMSL FOV 60 2MP, 3 x GMSL FOV 120 2MP

Options

- GPS Bounding
- Remote Kill Switch
- LiDAR Velodyne Puck LITE™
- RADAR Continental ARS510
- 360 Camera Samsung Gear 360



VEHICLE ARCHITECTURE

StreetDrone ONE is supported by Renault as part of the Telys FOM (Platform Open Mind) program. The Telys is a versatile, lightweight foundation platform which provides simple reliable modular base on which to build an innovative test platform.

Key Statistics - Specs		Key Statistics - Options	
Max Power	10kW / 13kW	Battery Type	Lithium ion
Max Torque	57Nm	Capacity	6.7 kWh
Max Speed	50km/h	Charge time	3.5 Hours
Range*	50km	Max charge	10K
Max Payload	75kg	Standard payload	3.0 kWh/kg

POWERED BY RENAULT

STREETDRONE



Road signage

To offer fixed and variable road signage for CAV development:

- Traffic sign recognition
- Fixed signage with covers
- Digital variable signs



Implicit Speedlimits					
	France	Germany	Netherlands	Sweden	United Kingdom
HIGHWAY AND/OR MOTORWAY					

Proving Ground Scanning

Full 3D surface models
in high resolution:

- Key partner: rFPro
- All tarmac and concrete tracks
- 1mm resolution
- Engineered surface and high graphics
- Suitable for simulation for CAV's and dynamics
- Saleable commodity on it's own
- Will be expanded to RACE @ Culham



Simulator Suite

Co-located at the trackside:

- Full range of simulation:
- Software in the loop
- Modelling in the Loop
- Hardware in the Loop
- System in the Loop
- Human in the Loop
- Vehicle in the Loop

- Complete framework being developed for CAV development and Validation
- Certification routes being explored

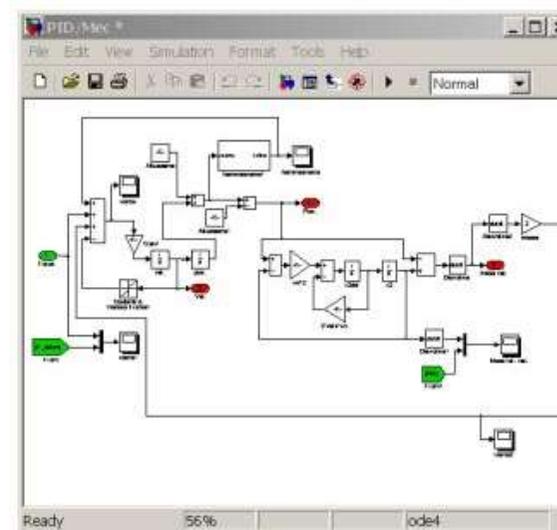


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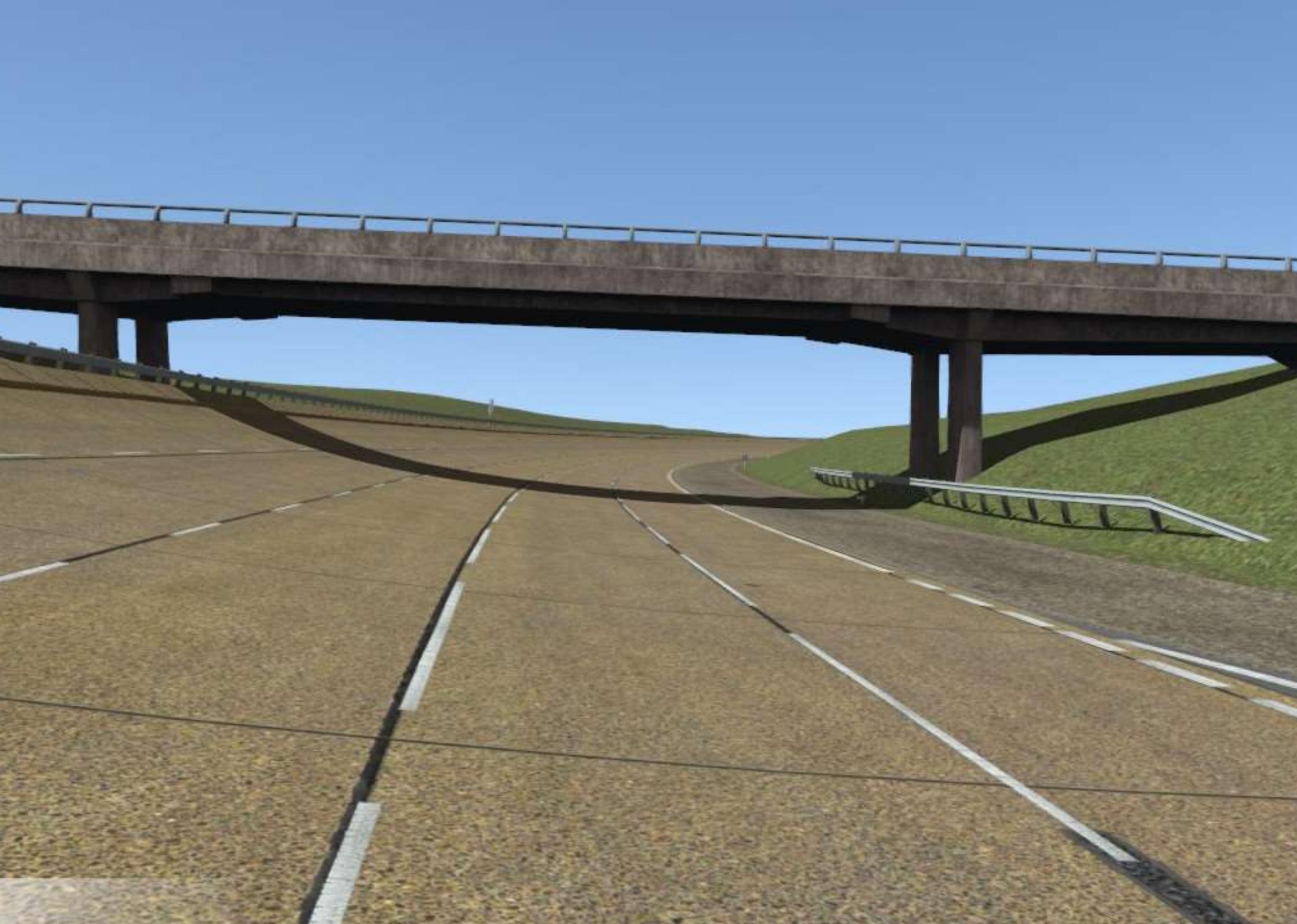
uchar chassa_storage[2800];  apd[20];
uchar chassa_storage[2800];  alfa[22];
uchar chassa_storage[2800];  tmp[22];
uchar chassa_storage[2800];  llr[256];

void perform_layers_decoding(int start_idx)
{
  uchar llr_curr, alfa_curr;
  uchar beta, llr_prev, output;
  alpha = vint(-32); beta = vint(-32);
  int mem_pointer = start_idx;
  // forward
  for(int i=@mem; i++)
  {
    llr_prev = llr[mem_pointer];
    llr_curr = apd[mem_pointer++];
    llr_curr = llr_curr - llr_prev;
    alfa[i] = alfa_curr;
    llr_tmp[i] = llr_curr;
    alfa_curr = vq(alfa, llr_curr);
  }
  // backward + output
  for(int i=@mem; i--;)
  {
    alfa_curr = alfa[i];
    output = vq(alfa_curr, beta);
    apd[mem_pointer] = output;
    llr_curr = tmp[i];
    output = output + llr_curr;
    beta = vq(beta, llr_curr);
    llr[mem_pointer] = output;
  }
}

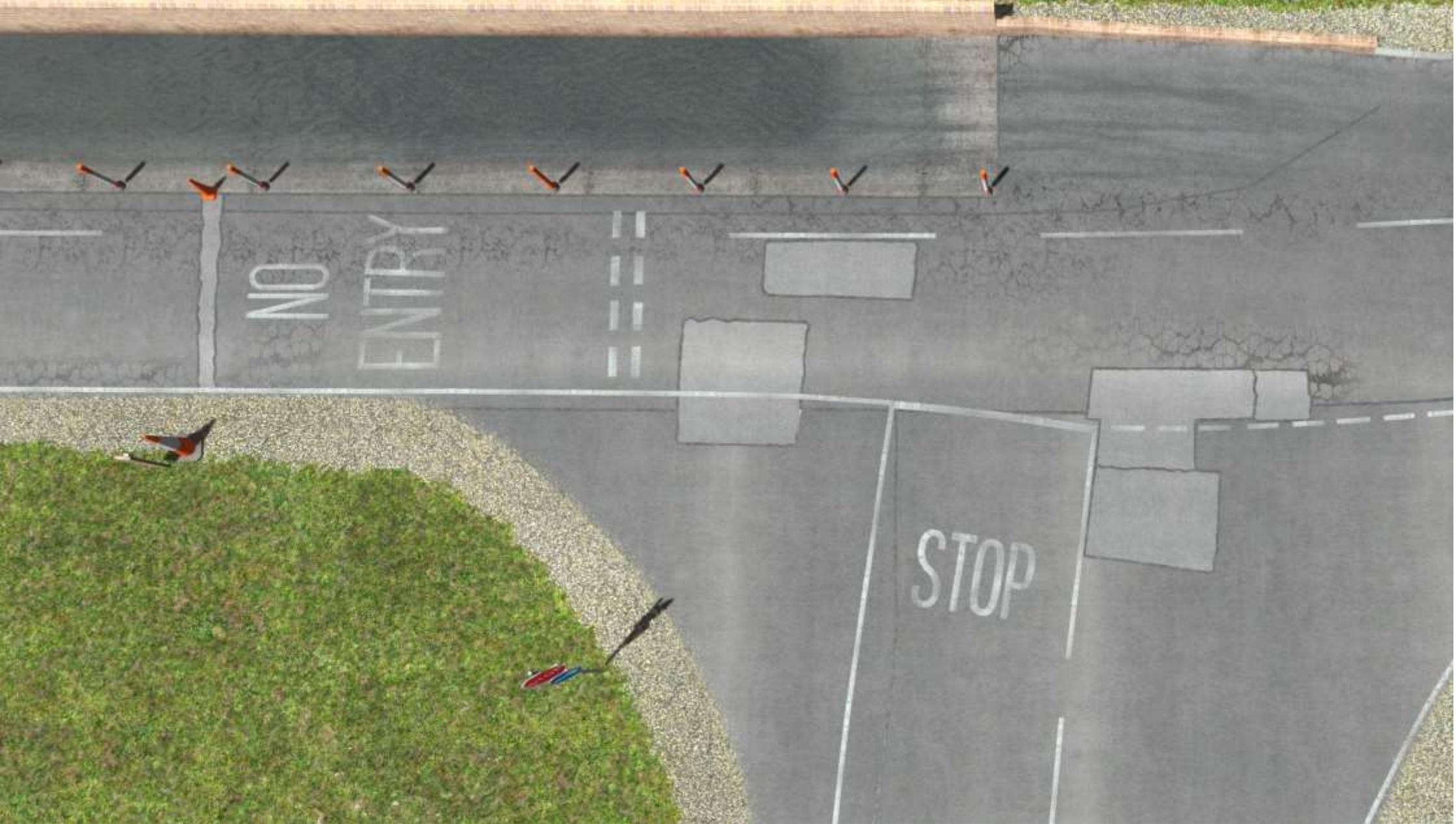
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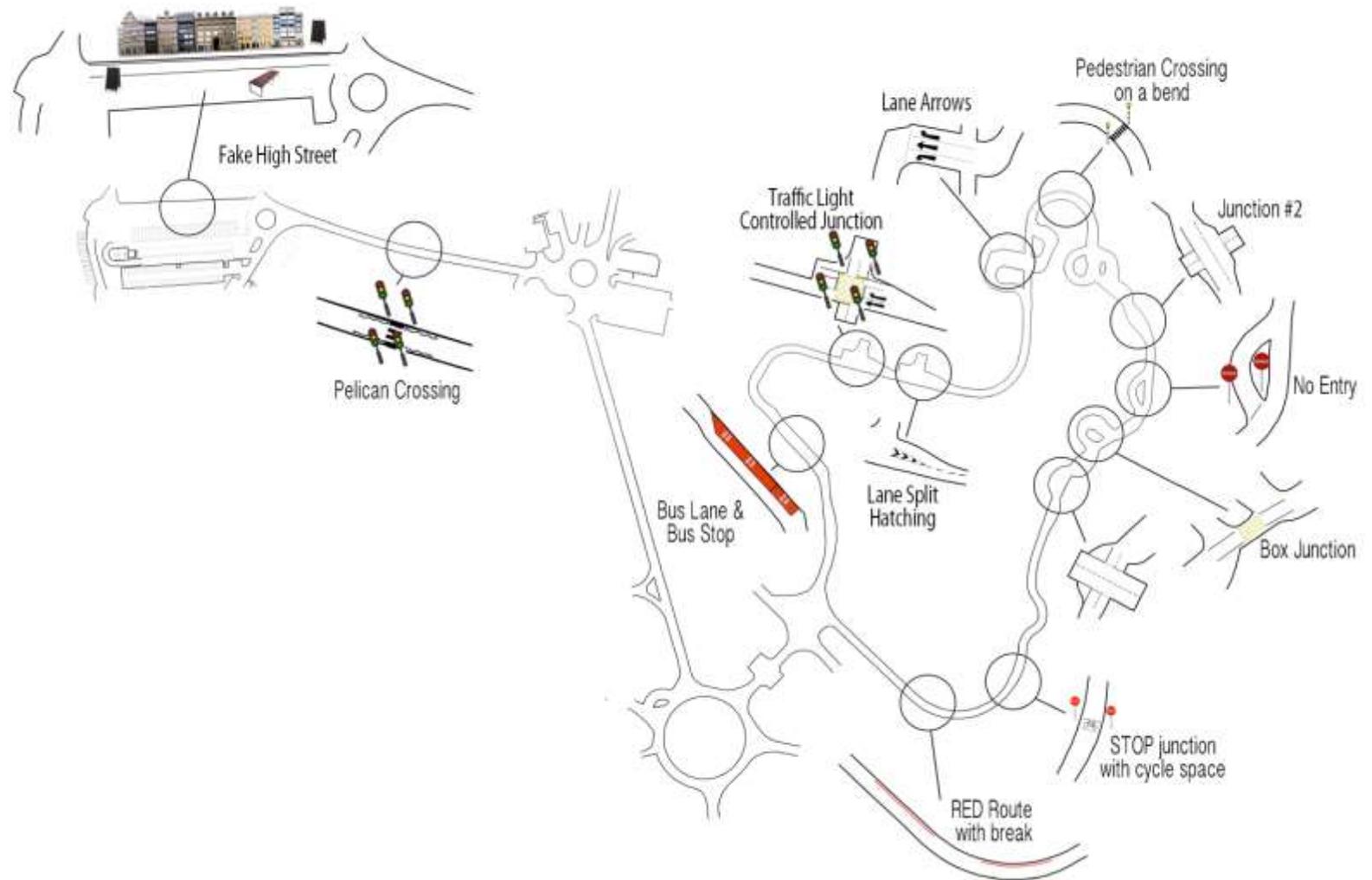




Local circuit modifications

Addition of real street layouts and furniture:

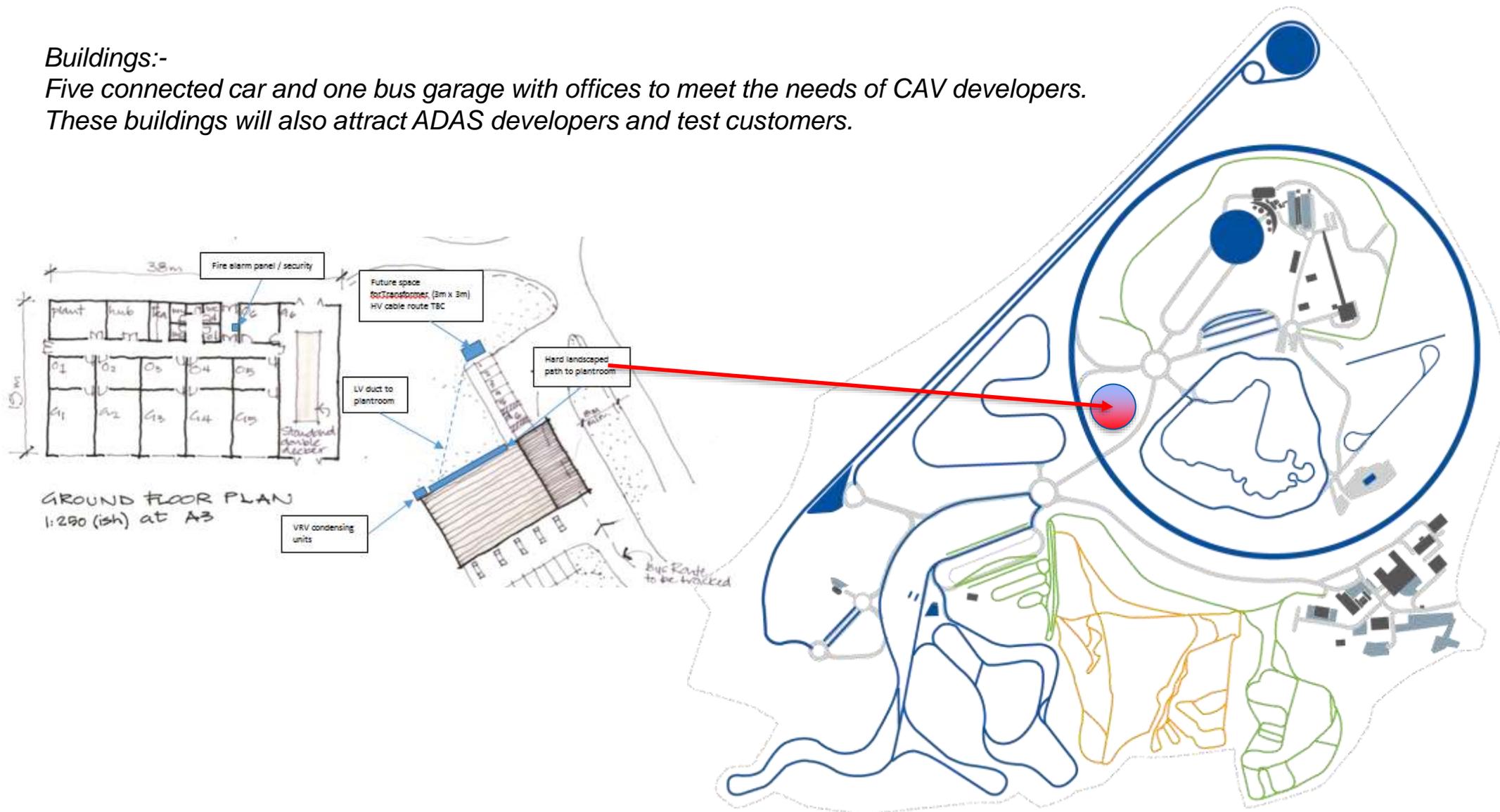
- Adaptation of City Circuit
- Working crossings
- To assist in testing and verification
- Flexible enough to adapt further



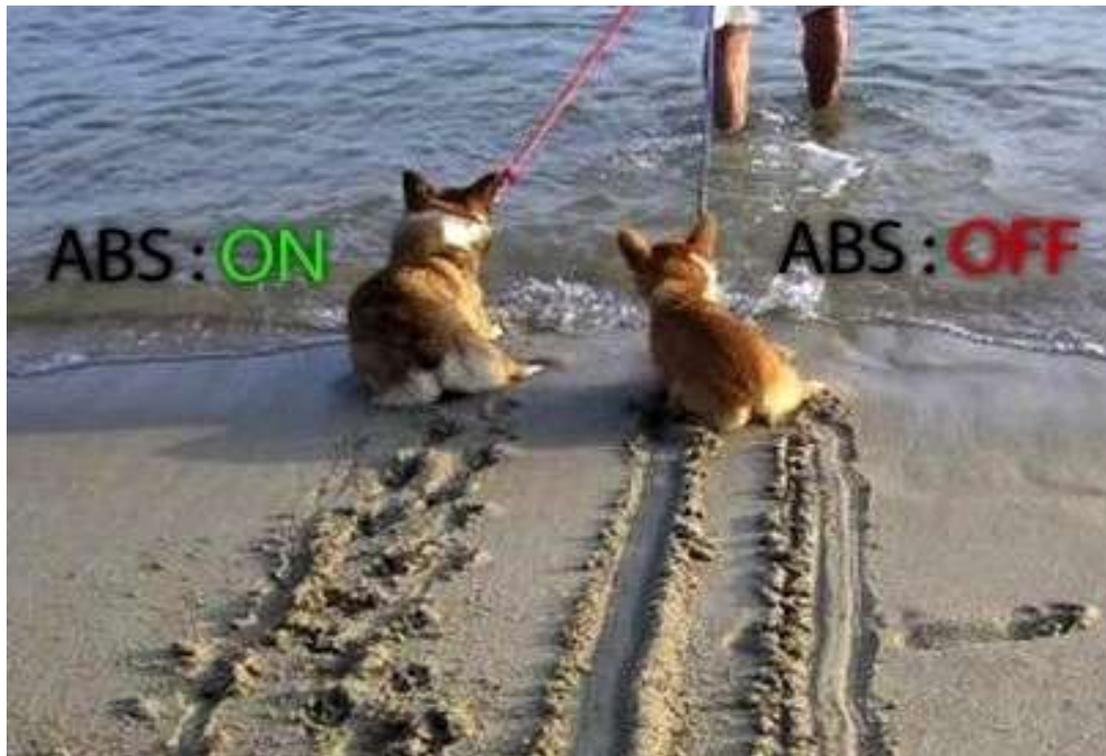
Autonomous Village and location

Buildings:-

Five connected car and one bus garage with offices to meet the needs of CAV developers. These buildings will also attract ADAS developers and test customers.



Control systems and embedded systems are core technologies to improve automotive safety and comfort



Electronic Stability Control (ESC)



Lane Keeping Assistance System (LKAS)

ADAS - Right here, right now

broad range of driver assistance functions already in production today

Standard features

- > Hold assist
- > Audi pre sense basic
- > Audi pre sense city
- > Park assist rear
- > Adjustable speed limiter
- > Cruise control system
- > Break recommendation function

Tour assistance package

- > Turn assist left
- > Adaptive cruise control
- > Audi active lane assist
- > Audi pre sense front
- > Obstacle avoidance assist
- > Camera-based traffic sign recognition
- > Predictive efficiency assistant
- > Traffic jam assist

City assistance package

- > Audi side assist
- > Exit warning
- > Audi pre sense rear
- > Park assist plus
- > Rear cross-traffic assist
- > Reversing camera

Additional options

- > Trailer assist
- > Main beam assist
- > MMI navigation plus with MMI touch
- > Night vision assistant

Parking assistance package

- > Surroundings camera
- > Park assist



Autonomous?

The Building Blocks of Autonomy

Prepared by VISION SYSTEMS INTELLIGENCE

Level of Integration



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WHAT'S MORE FORWARD THINKING?..

DRIVERLESS
CARS

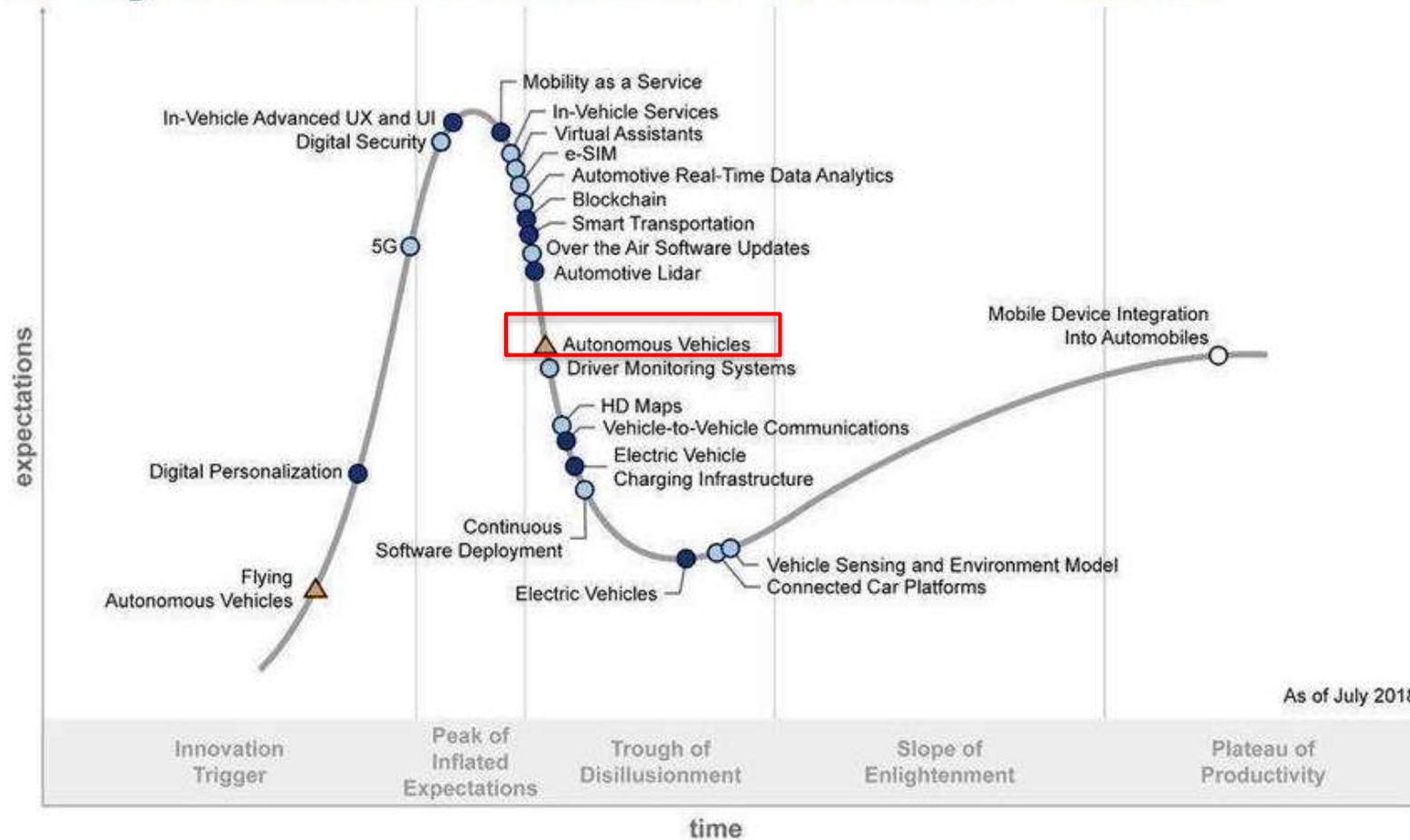


CAR-LESS
DRIVERS



WAT
HINDLSON
and
Newman

Hype Cycle for Connected Vehicles - 2018



As of July 2018

Plateau will be reached:

- less than 2 years
- 2 to 5 years
- 5 to 10 years
- ▲ more than 10 years
- ⊗ obsolete before plateau

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XF

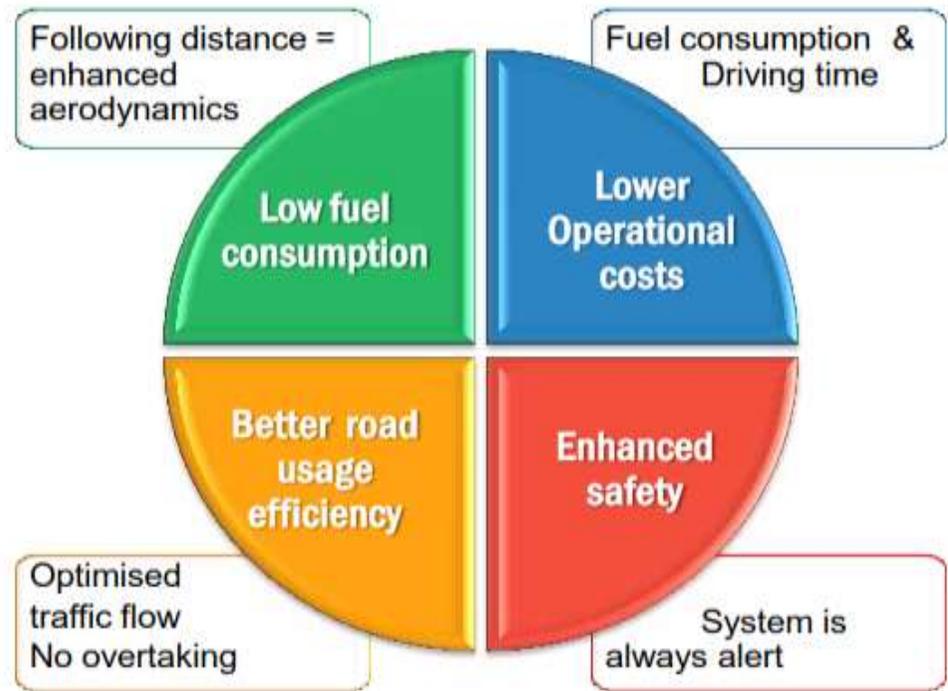
XF

XF

HEAVY GOODS VEHICLES
PLATOONING TRIALS

DAF

DAF



INPUTS	ACTUATORS
Radar	Driveline
Camera	Braking system
Wifi-P	Steering system

THE COMING FLOOD OF DATA IN AUTONOMOUS VEHICLES

RADAR
~10-100 KB
PER SECOND

SONAR
~10-100 KB
PER SECOND

GPS
~50KB
PER SECOND

CAMERAS
~20-40 MB
PER SECOND

LIDAR
~10-70 MB
PER SECOND



AUTONOMOUS VEHICLES
4,000 GB
PER DAY... EACH DAY



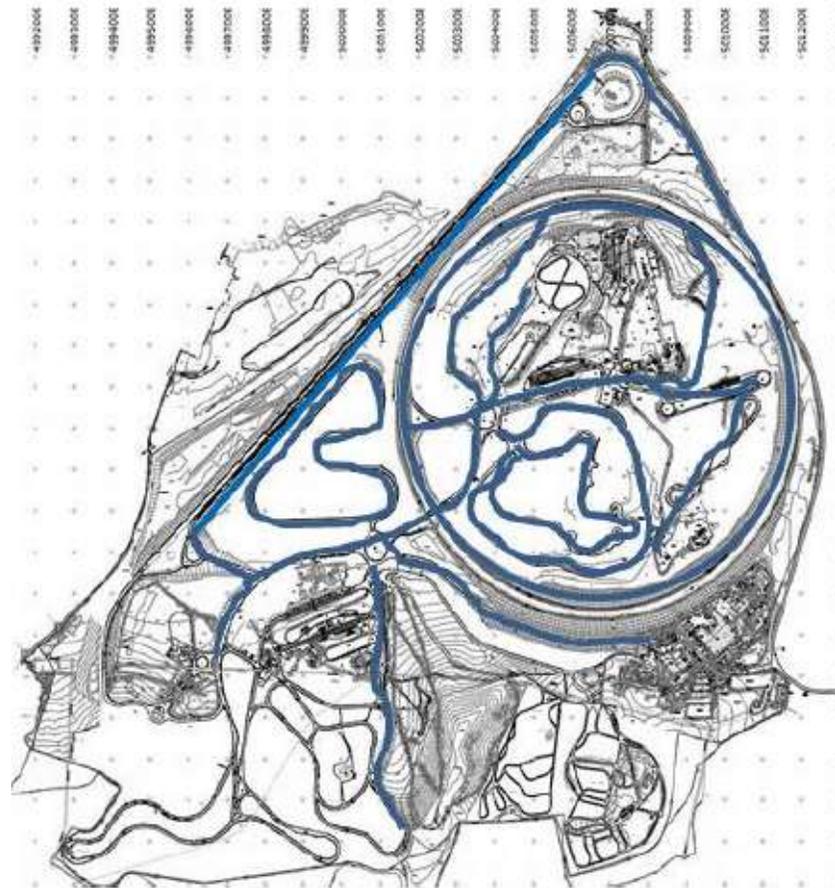


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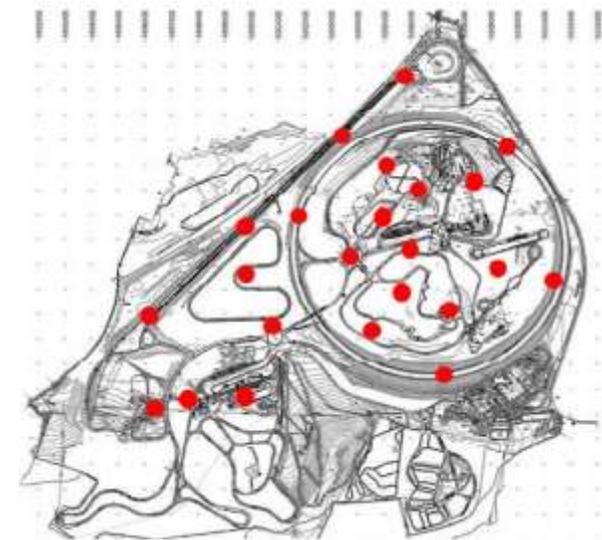
Connectivity (Fibre and Power)

Addition of high speed fibre and wireless communications (802.11p):

- Key Partner: AWTG
- Creating a base infrastructure to provide Power and Fibre connectivity to all locations across the track facility
- 3G/4G coverage assurance across the entire track site.
- Tuneable mobile network for testing 5G and CCAV



Fibre network (14kms)



Wifi network (23 points)

Cisco Grant Project: Orkney Islands

The project is named 5G Rural First and will be based mainly on the Orkney Islands and in rural Shropshire and Somerset. This project will look at **smart farming, autonomous farm vehicles and remote veterinary inspections.**

Sensor City Grant: Liverpool

This project is based at Liverpool and includes public sector health suppliers, the NHS, university researchers etc. The focus here will be in **patient care and monitoring, loneliness in older adults and communication between hospitals and the community.**

Worcestershire 5G Consortium: Malvern Hills Science Park

This project sees O2 and BT involved along with companies such as Huawei looking at ways to increase industrial productivity robotics, cyber security, big data analytics and Augmented Reality over 5G. This testbed will be located at Malvern Hills Science Park.

5G Testbeds



Quickline Communications Grant: Rural across 7 counties

This project is named the 5G Rural Integrated Testbed (5GRIT) and will be used to trial and test **smart agriculture, 5G-ready AR apps** for tourists and connecting poorly-served communities across the following counties: Cumbria, Northumberland, North Yorkshire, Lincolnshire, Inverness-shire, Perthshire and Monmouthshire.

Airspan Communications Ltd Grant: Bedford

This project looks at the development and validation of connected and autonomous vehicles at the vehicle proving ground at Millbrook. The main focus for this project covers **complicated cell-tower handoffs, and autonomous vehicles network bandwidth issues and how 5G connectivity solutions could be transferable to both road and rail transportation.**

West of England Combined Authority Grant: Bristol and Bath

This project is named 5G Smart Tourism and will have attractions in Bath roman baths and Bristol's Millennium Square. The project will focus on delivering **enhanced visual experiences for tourists via Augmented Reality (AR) and Virtual Reality (VR) technology.**