Map creation, monitoring and maintenance for automated driving
Summary of Literature Review

Scope
The literature review focuses on the question: “What prior map models are being implemented or considered as part of the government’s role to prepare for automated driving?”

Map types
Modern maps for driving can be categorised as digital maps, enhanced digital maps and high definition maps.

- Digital maps are digital street maps used in conjunction with GPS navigation software commonly found in newer vehicles.
- Enhanced digital maps include additional data that is beneficial to both Advanced Driver Assistance Systems (ADAS) and automated vehicles. These additions include road speed limits, road curvature, approximate location of traffic signs (and type of sign) and lane logic.
- A High Definition (HD) map contains a rich, 3D representation of the world with high positional accuracy. HD maps include all of the features of enhanced digital maps, but with much greater accuracy and contains detailed information necessary for automated driving.
  - A HD map will typically include lane positions and widths, positions and descriptions of road signs, logic data such as the direction of travel of a lane, and environmental data for the purpose of localisation.
  - Creating a HD map is a complex task; it is not just a matter of simply recording sensor data, but also involves adding semantics (meaning) to the data. For example, a traffic sign observed with a camera needs to be identified and marked on the HD map.
  - A HD map is not a static element: it is a live system that requires regular updating as the environment changes.
  - A key challenge with existing HD maps is the problem of keeping maps up to date when the environment changes. Re-mapping the road network is both expensive and time consuming.
International efforts

- Several governments are spearheading trials, infrastructure and policies to support automated vehicles and HD maps.
- The United States of America (US) has approximately 163 companies involved in automated vehicles headquartered in the U.S. Government responses vary by State jurisdiction, although most of the response is currently limited to policy decisions concerning automated vehicle trials. Some federal efforts are focusing on cybersecurity and 5G for automated vehicles.

In the European Union (EU), the government response is proactive and unified. A variety of government led initiatives include:

- C-Roads – an organisation focusing on developing technical specifications and performing trials for connected and automated vehicles in the EU.
- TN-ITS – an organisation developing a new data designed to transmit information on changes in static road attributes (such as road signs and speed limits).
- NordicWay - a Cooperative-Intelligent Transport Systems pilot to investigate the inter-communication between vehicles, infrastructure and network operators, with the objective of communicating safety hazards and other information from roads in Nordic countries.
- SHOW – the largest automated vehicle trial in the EU, with 69 partners from 13 countries in the EU.

Data formats

- In a connected and automated infrastructure system, there are multiple actors involved: the HD map provider cloud, the infrastructure manager (Government) cloud, roadside ITS (Intelligent Transport System) stations and the vehicles themselves. Data is transmitted between each of these actors, with different data formats used in each instance.
- Between Government cloud and vehicles, typically DENM (Decentralized Environmental Notification Message) is used, as defined by ETSI EN 302 637-3.
- Between HD map providers and vehicles, TPEG (Transport Protocol Expert Group) is commonly used. SENSORIS is also used, which can upload raw sensor data from the vehicle back to the map provider cloud.
- In the EU, Datex II and TN-ITS are the two standards used to communicate data between Government managed systems and both roadside stations and HD map provider clouds.
- Datex II is designed for real-time (event based) data transmission, focusing on traffic incident and road work data transmission.
- Conversely, TN-ITS is designed to transmit static road attributes, particularly data used to produce HD maps, such as speed limits, lane logic and road signs.

Recommendations

- Significant discussions will be required to decide on the best way forward for both our state and our country.
- The EU is the ideal model to follow, as they have a combination of local automotive vehicle manufacturing industry and a proactive Government response to connected and automated vehicles.
- Australia could either:
  A. Directly re-implement the ITS technologies in development in the EU,
  B. Develop our own systems inspired by “what works” in the EU, or finally,
  C. Develop our own HD maps independently.