METR
OVERVIEW

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6 July 2021   1

The Management of the Electronic distribution of surface Transport Rules (METR) standards are being developed to standardize how transport agencies can ensure that transport users have trustworthy information regarding "rules of the road". This presentation will provide an overview of this standard series and describe the types of rules covered by this effort.

Overview

- Problem statement

- Vision
  - Scope
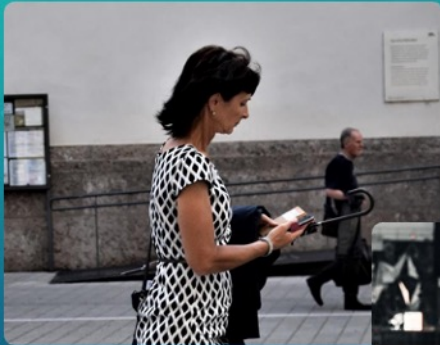 - Other considerations
  - Roles and Responsibilities

- Roadmap

The presentation starts by presenting the problem statement and then describes the vision of the METR system by discussing the scope, other considerations, and roles and responsibilities. The presentation concludes by reviewing the roadmap to complete the standard series.

PROBLEM STATEMENT

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The first task is to understand the problem leading to the development of METR.

We live in a transformative age for transportation. Increasingly, we are seeing pedestrians equipped (and often distracted by) smartphones, new modes of personal travel, such as e-scooters, an increase in the use of delivery services through the advancement of technologies that match drivers and travellers, and the introduction of automated vehicles whether they might be designed for personal travel, shared travel, or delivery of goods. Each of these changes in the transportation environment results in the need for new regulations, often all being applied within the same travel space.

Images:
Lady with smartphone - https://unsplash.com/photos/RyOKNPFF61A
Uber - https://unsplash.com/photos/Gk3apXDUZiI
Scooter - https://www.pexels.com/photo/black-and-orange-electric-scooter-3671151/

We are also seeing the introduction of ADS-equipped vehicles (i.e., vehicles with Automated Driving Systems). These vehicles need to be able to understand the current set of rules that they must operate under at all times and in many cases, conventional signage is not the best way to convey the rules to these vehicles. These vehicles include:
- Sidewalk delivery drones
- Localized shuttles
- ADS-equipped passenger cars
- ADS-equipped freight vehicles

Sidewalk Delivery - https://unsplash.com/photos/gteH4r8SSqM
Tesla Steering Wheel - https://unsplash.com/photos/Ddjl0Cicdr4
Shuttle - https://pixabay.com/photos/vehicle-autonomous-4759347/
Freight - https://img.directindustry.com/images_di/photo-g/16156-13566023.webp
Freight Zoomed out - https://img.directindustry.com/images_di/photo-mg/16156-13566021.webp

Challenges with Posted Information

Faded signs   Old signs   Dirty signs

Vandalized/obstructed signs

Snow covered markings

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In general, it is the responsibility of the driver to understand posted information; however, this is often easier said than achieved. Posted information can become obscured, dirty, faded, or covered with snow. Any of these anomalies can inhibit both human and automated systems from properly understanding the intent of the posted information.

Faded Sign - Pic by Ken Vaughn
No Parking - https://unsplash.com/photos/LGQFvBQkuNk
Motorcycle - https://unsplash.com/photos/t2Lsl9URbPY
Stop Stickers - https://unsplash.com/photos/BE-0j6f5SnU
Stop bullets - https://www.flickr.com/photos/mwichary/2831542077
Snowy Street - https://unsplash.com/photos/HX73apcFYts

Challenges with Posted Information

Signage overload

Complex signs

Potential contradictions

Need to support areas with no signage

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Further, the amount of signing needed can become overwhelming for a human or machine to process. Signs can also present confusing or apparently contradictory information. Finally, some areas might not have posted signs or markings at all. If automated vehicles are to safely operate with humans, there need to be clear rules on how the automated vehicles will behave within each environment.
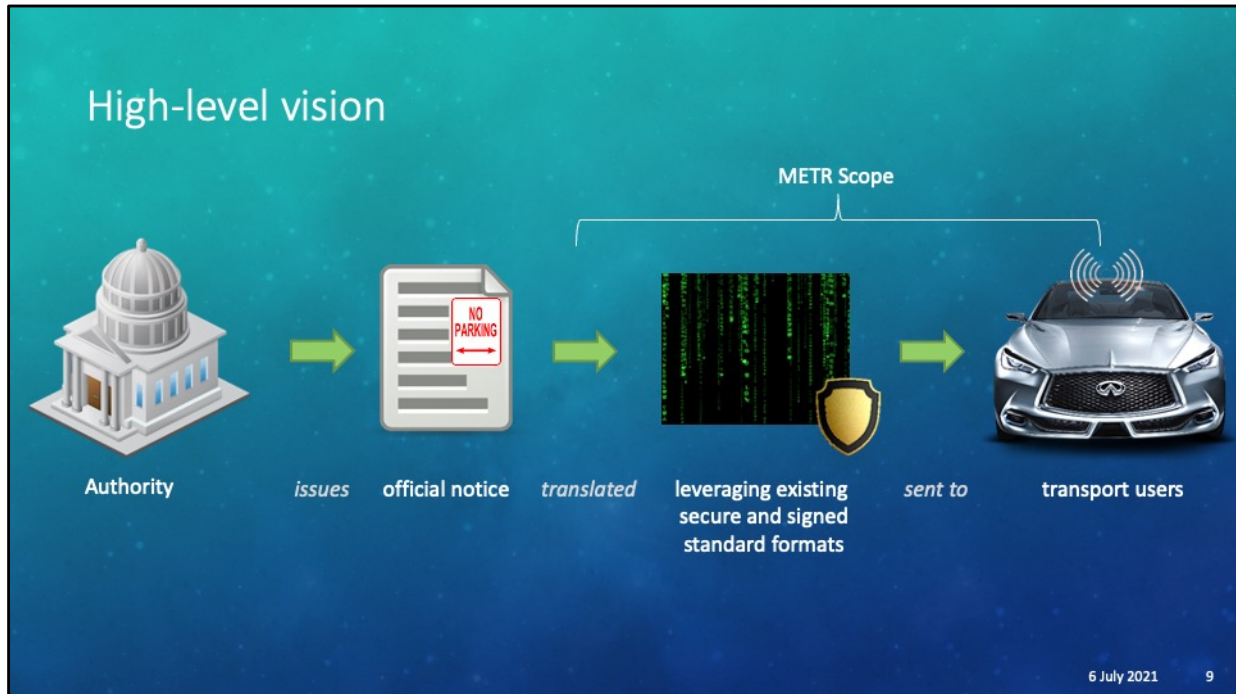
FDNY – Courtesy of J Booth
Complex - https://unsplash.com/photos/lZ6Dc0I225E
Potential Contradictions - https://unsplash.com/photos/80k1Wr9kEYY
Primitive Road - https://unsplash.com/photos/V12_AmFAINg

VISION

Now that we understand the problem, let's look at the vision of METR.

High-level vision

METR Scope

Authority — issues — official notice — translated — leveraging existing secure and signed standard formats — sent to — transport users

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METR starts with the premise that "authorities" issue official notices (i.e., regulations, warnings, and guidance) for the driving public. These notices are translated into an electronic form, signed, and sent to transport users.

Government Building - https://upload.wikimedia.org/wikipedia/commons/4/47/ICON_Govt_Building.png
Document - http://www.clipartpanda.com/clipart_images/clipart-office-document-60437139
No Parking – https://cdn.pixabay.com/photo/2012/04/13/14/18/no-parking-32578_960_720.png
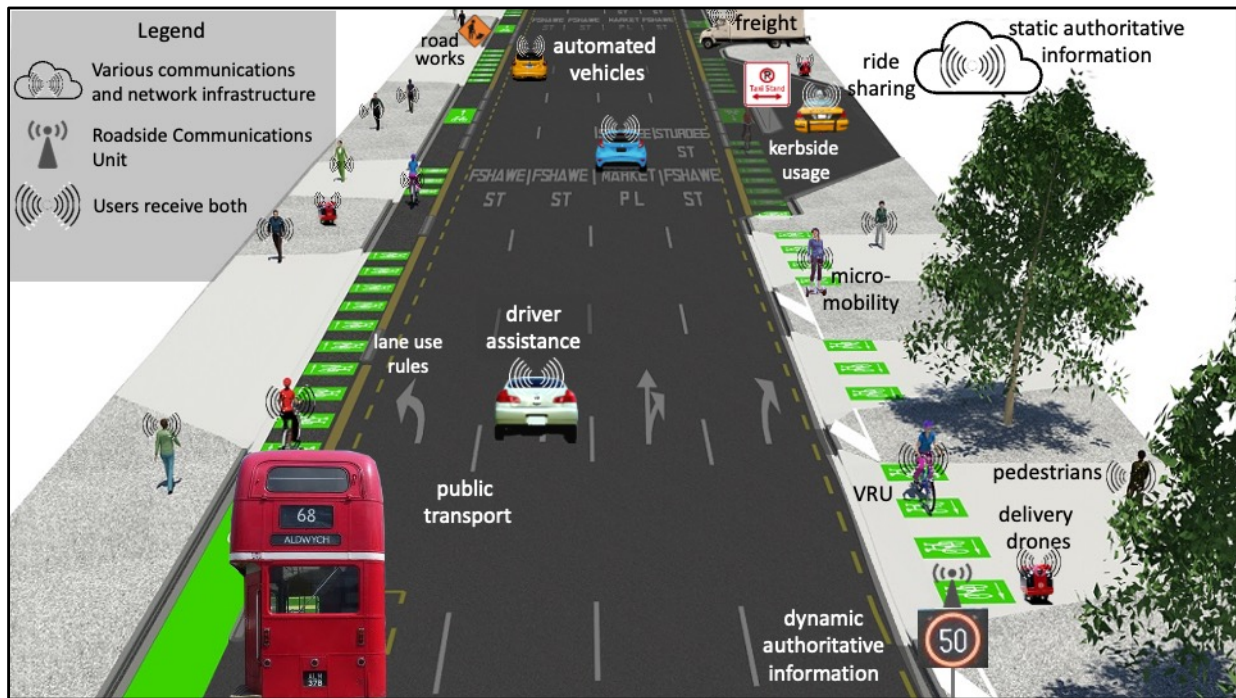Matrix - https://upload.wikimedia.org/wikipedia/commons/5/53/The.Matrix.glmatrix.1.png
Shield - http://www.clker.com/clipart-205046.html
Infinity - https://pngimg.com/image/39948
Radio Waves - https://cdn.pixabay.com/photo/2014/03/25/16/27/radio-297183_960_720.png

This picture provides an overview of the major types of information covered by METR. It includes:

- Both dynamic and static authoritative information (i.e., regulations, warnings, and guidance), including speed limits
- Rules for sidewalk delivery drones
- Rules for the use of pedestrian facilities
- Rules for vulnerable road users, including those on pedicycles
- Rules for other micromobility devices, such as segways and e-scooters
- Rules on how vehicles are allowed to interact with the kerbside
- Rules on the operation of ride sharing services
- Rules for freight operations
- Rules for the operation of vehicles within work zones
- Rules for automated vehicles
- Rules for driver assistance systems
- Rules for what vehicles are allowed to use specific lanes
- Rules for the use of public transport

Streetscape - https://at.govt.nz/media/1973835/nelson-street-phase-2-street-design.jpg

Cloud - PPT Clipart

RCU - https://cdn.pixabay.com/photo/2012/04/15/19/13/tower-34981_960_720.png

Radio Waves - https://cdn.pixabay.com/photo/2014/03/25/16/27/radio-297183_960_720.png

Bus - https://s0.geograph.org.uk/geophotos/01/88/57/1885754_b95c7673.jpg

Road Work Sign - https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf

Truck - https://pngimg.com/uploads/truck/truck_PNG16273.png

Taxi - https://upload.wikimedia.org/wikipedia/commons/4/45/Yellow_Taxi_Ford_Crown_Victoria_(rear).jpg

Taxi Stand - https://commons.wikimedia.org/wiki/Category:Diagrams_of_taxi_stand_road_signs#/media/File:New_Zealand_road_sign_R6-72.1LR.svg

Segway - https://i2.wp.com/clipset.20minutos.es/wp-content/uploads/2016/06/Segway-miniPRO-mujer-640x480.jpg?resize=640%2C480

Sidewalk Drone - https://grendz.com/wp-content/uploads/2017/07/zmp-15015021768n4kg.jpg

Speed Limit - https://s0.geograph.org.uk/geophotos/03/70/93/3709375_9e239686.jpg

Green Car - https://upload.wikimedia.org/wikipedia/commons/4/43/2001-2003_NISSAN_SKYLINE_V35_rear.jpg

Blue Car - https://static.vecteezy.com/system/resources/previews/000/112/951/original/ford-fiesta-front-rear-view-vector.jpg

Orange Car - https://upload.wikimedia.org/wikipedia/commons/8/8e/Rear_View_-_2013_Ford_Focus_ST_(10062637774).jpg

METR Applicability

- **Once received, the receiver can respond appropriately:**
  - ADS-equipped vehicles can directly control the vehicle to comply
    - Includes road vehicles and delivery drones
  - Driver assisted vehicles can warn or provide guidance to the driver as deemed appropriate
  - A smartphone app can similarly automate or assist in compliance, for example:
    - Disabling some applications based on local restrictions
    - Providing warnings and advice to users as appropriate

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Once the rules have been received, each respective user system can respond appropriately according to internal algorithms. For example:
- ADS-equipped vehicles can directly control the vehicle to comply with the received rules. Different types of ADS-equipped vehicles might respond slightly differently and each vehicle will need to be able to discern which rules apply to it (e.g., a sidewalk delivery drone is likely to have a different speed limit rule than a ADS-equipped passenger car)
- Driver-assisted vehicles can warn or otherwise provide guidance to the driver as appropriate (e.g., an audible or tactile alert)
- A smartphone application can similarly provide alerts to automate or assist in compliance in some cases. For example, the smartphone might restrict access to some applications while in motion or might provide warnings and advice to users when crossing a street.

Now that we have an idea of the vision, let's take a closer look at the full scope of METR.

The current draft scope is shown on this slide. We will investigate the meaning of each underlined phrase on the following slides.

ITS user systems include any system that might receive rules from the METR network. These include (but are certainly not limited to):
- The full variety of ADS-equipped vehicles
- Shipping and delivery vehicles
- Personal smart phones
- Both built-in and after market devices for passenger cars

Sidewalk Delivery - https://unsplash.com/photos/gteH4r8SSqM
Tesla Steering Wheel - https://unsplash.com/photos/Ddjl0Cicdr4
Shuttle - https://pixabay.com/photos/vehicle-autonomous-4759347/
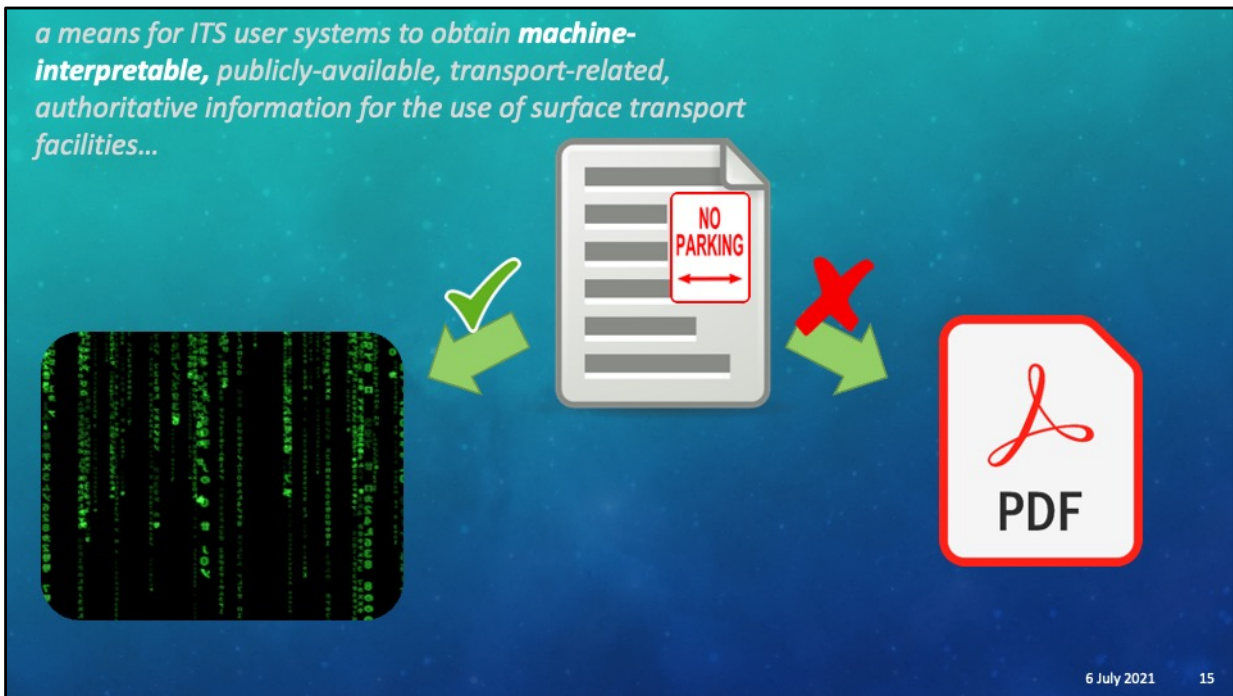Truck - https://www.allwhitebackground.com/truck-white-background.html
Scooter Phone - https://www.flickr.com/photos/touring_club/50042395383
Driver - https://images.pexels.com/photos/787476/pexels-photo-787476.jpeg?cs=srgb&dl=woman-in-yellow-shirt-driving-a-silver-car-787476.jpg&fm=jpg
Hana Hwy - https://www.flickr.com/photos/daveynin/7258857234

a means for ITS user systems to obtain **machine-interpretable**, publicly-available, transport-related, authoritative information for the use of surface transport facilities...

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The ITS user systems need to obtain authoritative information in a "machine interpretable" format. In other words, ITS user systems need to be able to obtain the rule information in a standard format that can be easily parsed, not just an image of a paper document.

Matrix - https://upload.wikimedia.org/wikipedia/commons/5/53/The.Matrix.glmatrix.1.png
Document - http://www.clipartpanda.com/clipart_images/clipart-office-document-60437139
No Parking – https://cdn.pixabay.com/photo/2012/04/13/14/18/no-parking-32578_960_720.png
Check - https://cdn.pixabay.com/photo/2016/03/31/14/37/check-mark-1292787_1280.png
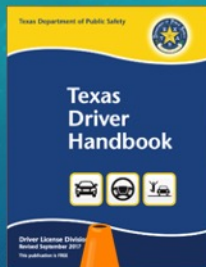X - https://upload.wikimedia.org/wikipedia/en/thumb/b/ba/Red_x.svg/1024px-Red_x.svg.png
PDF - https://commons.wikimedia.org/wiki/File:PDF_file_icon.svg

METR focuses on publicly-available information; it does not consider other information as might be related to military bases and other restricted areas, although there is nothing that explicitly prevents extending it to use within these environments.

Speed - https://commons.wikimedia.org/wiki/File:Night_speed_limit.jpg
Checkmark - https://pixabay.com/vectors/check-mark-tick-mark-check-correct-1292787/
Texas Driver Handbook - http://dps.texas.gov/internetforms/forms/dl-7.pdf
No Bike - https://pixabay.com/photos/road-marking-no-cycling-sign-usa-4991686/
Cone - https://pixabay.com/vectors/traffic-cone-safety-cone-road-cone-31883/
Restricted Area - https://commons.wikimedia.org/wiki/File:Restricted_Area_Sign.jpg
Bio Hazard - https://www.flickr.com/photos/dionhinchcliffe/3264474269
No - https://pixabay.com/vectors/cross-delete-remove-cancel-abort-296507/
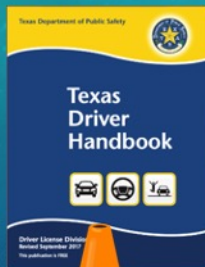
Likewise, METR focuses on transport-related rules rather than on personal behaviour and other rules that might be posted for travellers but unrelated to the actual movement of people or goods (e.g., no smoking on public bus). However, once again, METR does not explicitly prevent extending it to use within these environments.

Speed - https://commons.wikimedia.org/wiki/File:Night_speed_limit.jpg
Checkmark - https://pixabay.com/vectors/check-mark-tick-mark-check-correct-1292787/
Texas Driver Handbook - http://dps.texas.gov/internetforms/forms/dl-7.pdf
No Bike - https://pixabay.com/photos/road-marking-no-cycling-sign-usa-4991686/
Cone - https://pixabay.com/vectors/traffic-cone-safety-cone-road-cone-31883/
No - https://pixabay.com/vectors/cross-delete-remove-cancel-abort-296507/
No Food - https://commons.wikimedia.org/wiki/File:No_food_or_drink_and_no_smoking_signs_in_222M1_(20170410191700).jpg

*a means for ITS user systems to obtain machine-interpretable, publicly-available, transport-related, **authoritative information** for the use of surface transport facilities...*

authoritative information is defined as:
trustworthy official notice(s) from a jurisdictional entity

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The meaning of authoritative information is a bit more complex. It is defined as shown on this slide with the underlined terms shown on the following slides.

trustworthy official notice(s) from a jurisdictional entity

Trustworthiness

Information Security — Safety — Reliability — Usability

Confidentiality — Integrity — Privacy — Availability — Transparency

Accountability — Quality

Accuracy — Resilience

Authenticity — Timeliness

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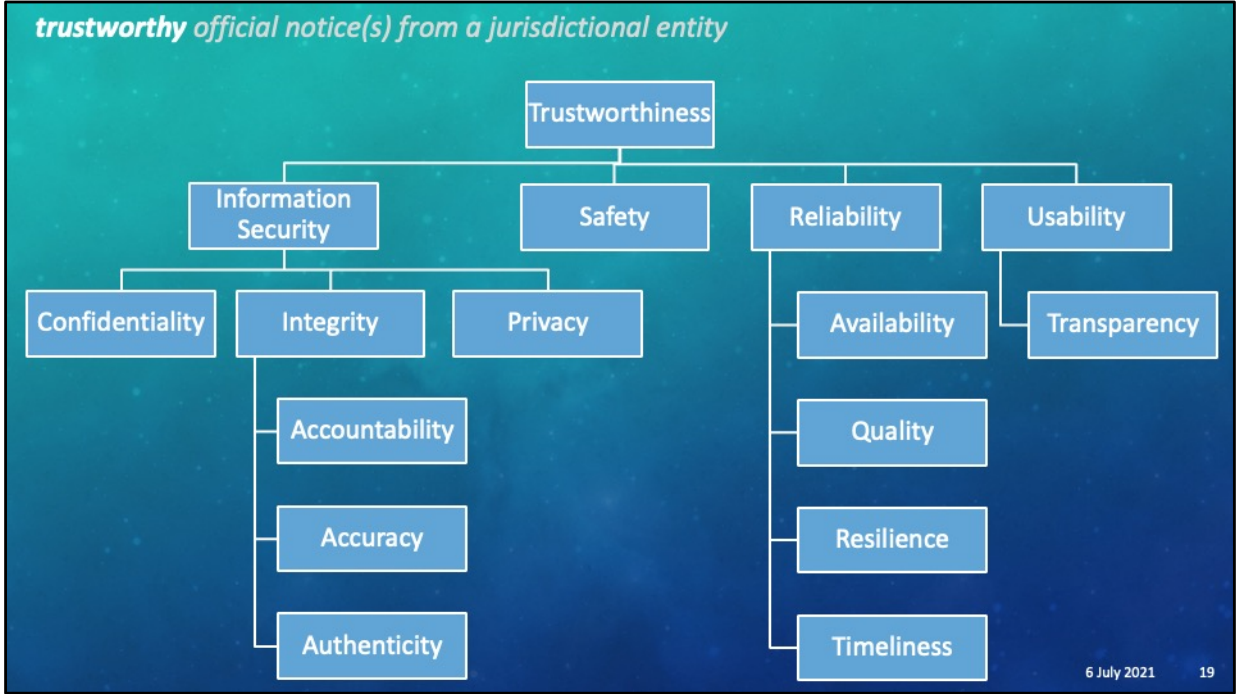
The term "trustworthy" encompasses a set of attributes that are often separately analysed. These are shown on this graph
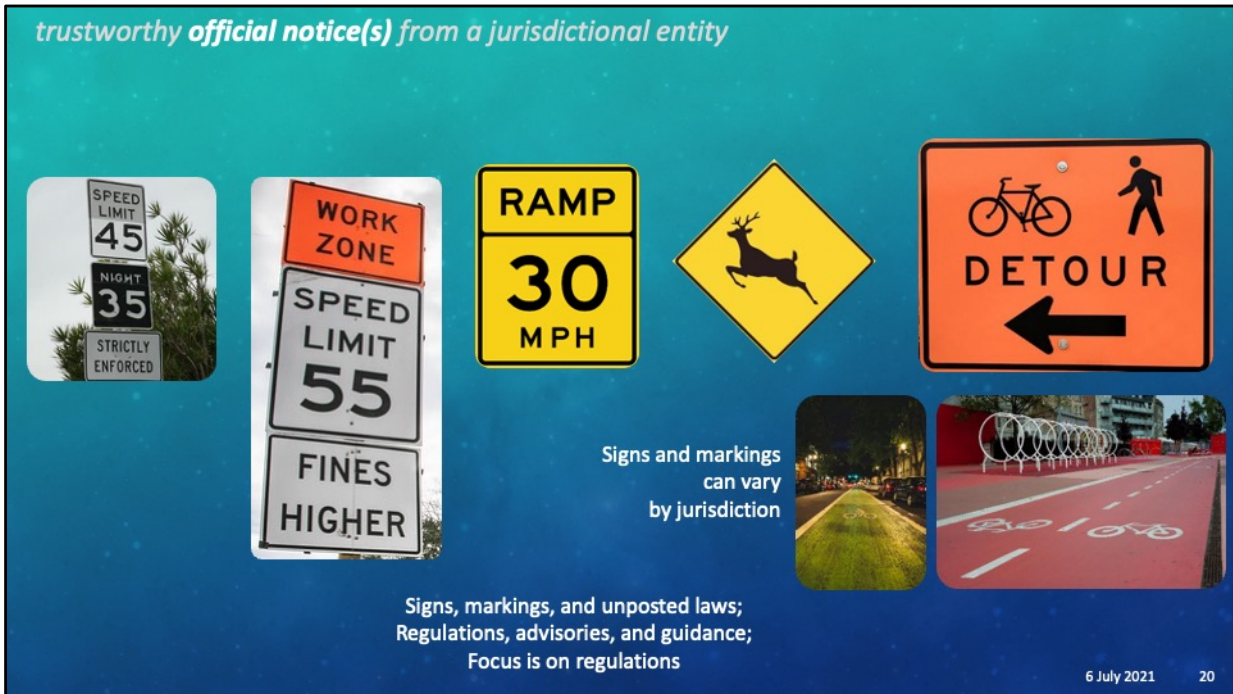
Official notices is the term currently being used in our discussions to cover:
- Regulations
- Warnings, and
- Guidance

These notices can be conveyed to travellers by signage, pavement markings, and vehicle codes.

There has been a suggestion that the "official notice" term should be changed to "rules", with the same meaning

Speed - https://commons.wikimedia.org/wiki/File:Night_speed_limit.jpg
Work Speed - https://www.flickr.com/photos/vadot/49493260283/
Ramp - https://pixabay.com/vectors/ramp-road-speed-traffic-30-mph-30-161172/
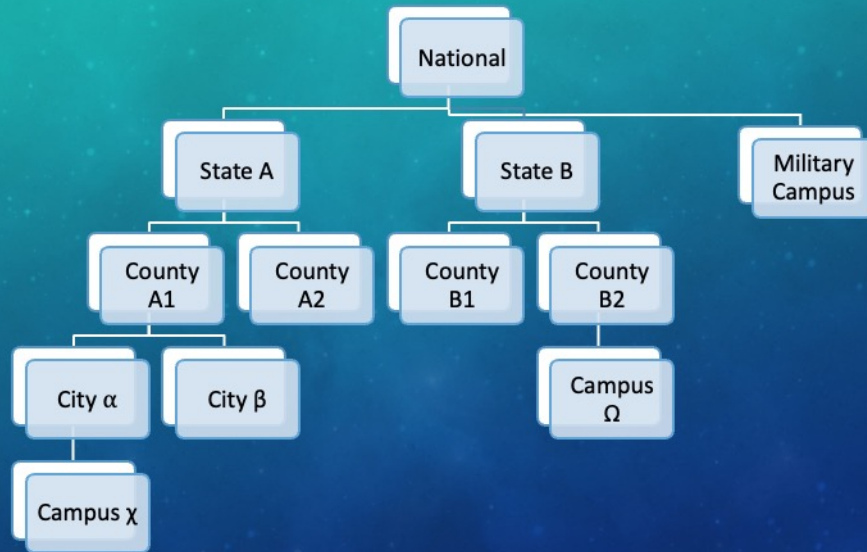Deer - https://www.vectorportal.com/StockVectors/Symbols-and-Signs/WILD-ANIMALS-SIGN/20006.aspx
Detour - https://c1.staticflickr.com/1/52/177246951_a289e12660_z.jpg?zz=1
Green Bike Lane - https://images.pexels.com/photos/3256031/pexels-photo-3256031.jpeg?auto=compress&cs=tinysrgb&dpr=2&h=650&w=940

Red Bike Lane - https://upload.wikimedia.org/wikipedia/commons/e/e7/Red_bikeway_in_Copenhagen%2C_Denmark.jpg

trustworthy official notice(s) from a *jurisdictional entity*

National

State A — State B — Military Campus

County A1 — County A2 — County B1 — County B2

City α — City β — Campus Ω

Campus χ

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METR covers official notices from any authorized jurisdictional entity. This includes rules that may be established by different layers of government for the same geographic location. For example, a vehicle might simultaneously be subject to regulations issued by national authority, a state authority, a county authority, a city authority, and a local campus (e.g., shopping centre)

a means for ITS user systems to obtain machine-interpretable, publicly-available, transport-related, authoritative information for the **use of** surface transport facilities...

Signs, markings, and vehicle code information

Texas Driver Handbook
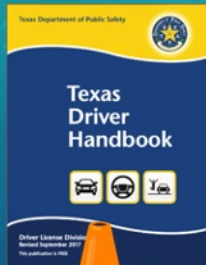
METR includes devices specified in in the MUTCD (and vehicle code), but it does not address guidelines for size, installation, etc.

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METR is also limited to the rules related to the use of transport facilities – i.e., METR does not attempt to convey rules for the deployment or siting of traffic control devices (i.e., rules intended for engineers) it is focused instead on the rules for transport users.

Speed - https://commons.wikimedia.org/wiki/File:Night_speed_limit.jpg
Checkmark - https://pixabay.com/vectors/check-mark-tick-mark-check-correct-1292787/
Texas Driver Handbook - http://dps.texas.gov/internetforms/forms/dl-7.pdf
No Bike - https://pixabay.com/photos/road-marking-no-cycling-sign-usa-4991686/
Cone - https://pixabay.com/vectors/traffic-cone-safety-cone-road-cone-31883/
No - https://pixabay.com/vectors/cross-delete-remove-cancel-abort-296507/
MUTCD - https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/mutcd2009r1r2edition.pdf
Sign install - https://www.kingsporttn.gov/city-services/public-works/traffic/trafficsignsandmarkings/
Sign map - https://www.clrp.cornell.edu/q-a/118-stop.html

METR includes rules for the use of all surface transport facilities, including all of those shown on this slide.

Freeway - https://upload.wikimedia.org/wikipedia/commons/e/e6/Eastern_Freeway_Belford_St.jpg

Bus - https://upload.wikimedia.org/wikipedia/commons/thumb/6/60/Sydney_Buses_(mo_1687)_Custom_Coaches_'CB60'_bodied_Volvo_B12BLEA_at_Railway_Square.jpg/1200px-Sydney_Buses_(mo_1687)_Custom_Coaches_'CB60'_bodied_Volvo_B12BLEA_at_Railway_Square.jpg

Sidewalk delivery - https://www.flickr.com/photos/perspective/37905654532

Coop Delivery - https://commons.wikimedia.org/wiki/File:Co-op_delivery_robots_(50750126396).jpg

Skate - https://www.geagea.xyz/products.aspx?cname=dc+bike+lanes&cid=5&xi=5&xc=23&

pr=74.99

Ferry - https://pixabay.com/photos/ferry-seattle-washington-olympic-4562432/

Train - https://upload.wikimedia.org/wikipedia/commons/thumb/7/76/Amtrak_-_GE_P42DC_-_Heritage_Phase_III_Livery.JPG/1280px-Amtrak_-_GE_P42DC_-_Heritage_Phase_III_Livery.JPG

Taxi - https://www.flickr.com/photos/vogelium/89596604/

Freight - https://pixabay.com/photos/container-port-loading-stacked-2934279/

OTHER CONSIDERATIONS

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Now let's consider some of the other issues involved with METR

The METR standards need to accommodate the real-world constraints related to how rules are proposed, approved, and rescinded. The concept of operations will need to explore how the rules migrate through these stages and the implications that the changes have on real-time operations of vehicles.

Availability of METR might affect ODD

METR COVERAGE ENDS

Self Drive Ending

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As we develop the concept of operations, we will also be considering issues related to what happens when METR coverage ends or changes in the level of scope. In particular, this might affect planned routes for ADS-equipped vehicles and/or alerts that they must issue to drivers to take over as they near ODD boundaries.

Tesla Steering Wheel - https://unsplash.com/photos/Ddjl0Cicdr4

Deployment Led by Invested Stakeholders

ADS-equipped vehicle manufacturers

Automated parking companies

Sidewalk drone manufacturers

Smart Cities

Transportation service providers

ADS-equipped freight companies

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Another aspect that will be considered in the operational concept is how the METR information will be deployed. In particular, the deployment of this technology will only be achieved if interested stakeholders perceive a benefit in making it happen. Stakeholders that stand to receive significant benefits from this technology include those that appear on this slide

Veh Manufacturers - https://en.wikipedia.org/wiki/Adient
Feight - https://commons.wikimedia.org/wiki/File:Automated_guided_vehicle_container_mover_at_Port_of_Rotterdam.JPG
Auto Park - https://upload.wikimedia.org/wikipedia/commons/thumb/a/a8/Lexus-LS600hL_self_parking.jpg/250px-Lexus-LS600hL_self_parking.jpg
Coop Delivery - https://commons.wikimedia.org/wiki/File:Co-op_delivery_robots_(50750126396).jpg
Smart City - https://unsplash.com/photos/Khqmo4T-rs0

ROLES AND RESPONSIBILITIES

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Now that we understand the scope and other considerations, let's take a look at the roles and responsibilities

Roles and Responsibilities

| Role	Responsibilities
Regulator	Creates, manages, and posts official notices through traditional means
Translator	Converts official notices for a defined scope into the METR format with electronic signature
Collector	Collects official notices from all relevant translators for a defined scope; may package notices for efficient exchange; provides the notices to disseminators
Disseminator	Collects official notices from one or more collectors; may (re)package notices for efficiency; distributes notices to (many) end users
User	Follow the information contained in the official notice

Official notices for a jurisdiction might include:
- Regulations
  - Regulations contained in the vehicle code (e.g., whether e-scooters are allowed in cycle lanes)
  - Regulations established by traffic engineers (e.g., stop signs)
  - Regulations activated as needed (e.g., evacuation orders, road closures)
- Advisories
- Guidance

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This slide shows the initial draft list of roles that have been identified for the operation of METR and the responsibilities for each.
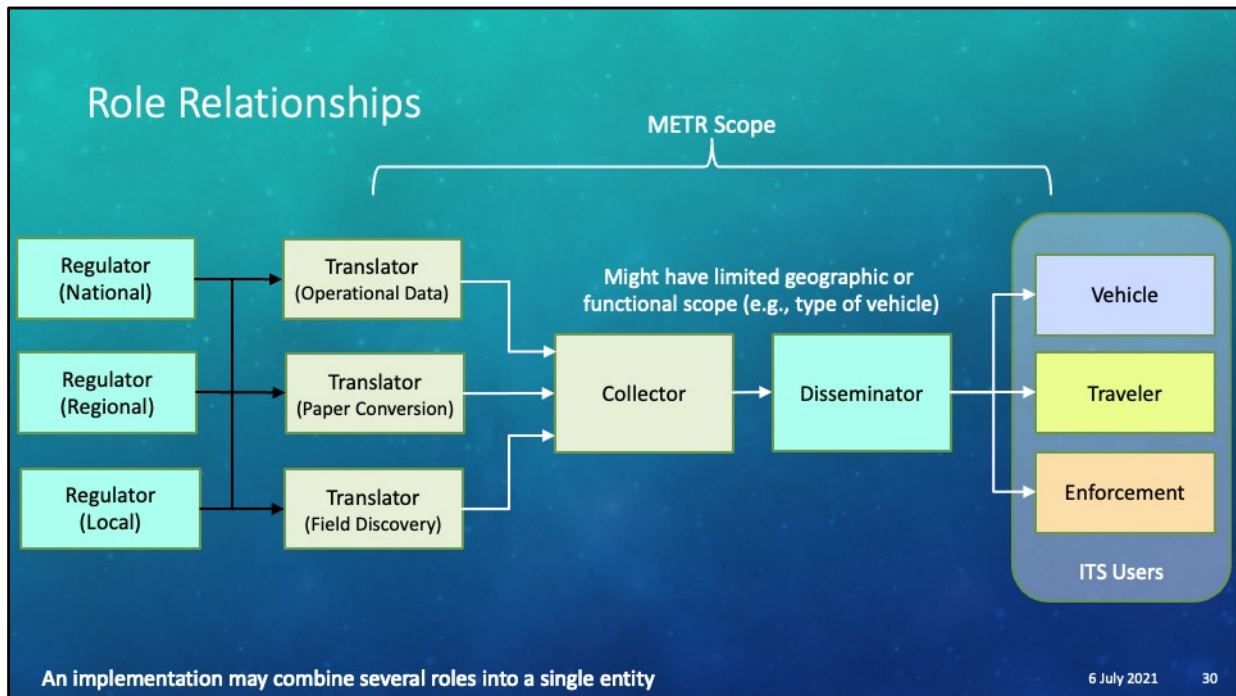
This slide shows the relationships among the different identified roles. In particular, it highlights that there might be many-to-many relationships among the various roles. For example, as discussed previously, there are likely to be various levels of regulators (e.g., national, regional, and local) all issuing rules for the same geographic area. Likewise, there might be different types of translators that divide their operation on an orthogonal plane; for example, one translator might focus on translating paper documents into electronic information while another focuses on converting real-time commands from a traffic management central system (e.g., that changes the speed limit on a variable speed limit sign) into an electronic format for METR. A third translator might accept data from specialized vehicles that capture signs in the field and translates them into the appropriate electronic format.

All of these translators might need to feed a variety of collectors and disseminators, which might have their own defined scopes (e.g., geographic regions or types of vehicles supported). Finally, each user system will need to be able to identify which rules are of interest to them and what operational decisions need to be made.

ROADMAP

Now that we know what METR is to define, we will now look at how we plan to create this standards series
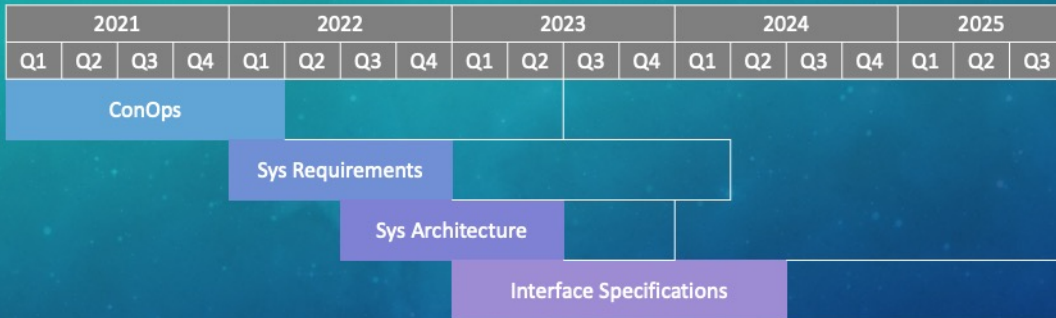
The current effort is to develop the operational concept (ConOps). Future efforts will develop the system requirements, system architecture, and interface specifications.

METR

- Purpose is to support all transport users, especially ADAS and ADS-equipped vehicles
- Current effort is focused on the operational concept
  - Identify stakeholder needs
  - Build consensus on approach
- Future efforts will extend to design, which will leverage existing standards and specifications, to the extent applicable

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In summary, METR is intended to support all users of the surface transport system, but is especially focused on ensuring the needs are met for driving assistance and automated driving systems. While the current effort is focused on the operational concept, which will identify the stakeholder needs and build consensus, subsequent efforts will extend the effort to produce system requirements and eventually interface specifications that are expected to heavily leverage existing standards, to the extent applicable.