



Environmental data in UTMC systems

A UTMC Technical Guide
*Library reference **UTMC-TR011.001***

14 January 2015
Cover + 15 pages

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1 Introduction

1.1 About this document

- 1.1.1 UTMC is a UK-led initiative which provides and maintains a technical framework for traffic management and related systems. It is geared to producing open specifications geared to the needs of real world projects, delivered through an efficient and innovative supply market. UTMC specifications are endorsed by the UK Department for Transport and are published on the UTMC website at: <http://www.utmc.eu>.
- 1.1.2 To help users get the best out of the UTMC Technical Specification, we provide a set of guidance documents addressing some of the associated issues, ranging from non technical aspects such as procurement policy and operations, to technical aspects such as database design and communications network configuration.
- 1.1.3 During 2014 a new specification was developed for environmental and weather data in UTMC systems, building on the structure of the existing UTMC Technical Specification, with content drawn from the European project MESSAGE and the latest available version of the DATEX II specifications (where relevant).
- 1.1.4 The present document offers advice and guidance for UDG members on the use of this specification.

1.2 Scope of this document

- 1.2.1 The new UTMC specification for environmental and weather data is published as a new Annex to TS004. This is published as “UTMC Objects Registry: Updated Environment/Weather Data Model” with reference number UTMC-TS004.0063:2015.
- 1.2.2 This new specification refers to and extends, and in some cases amends, certain parts of UTMC-TS004.006:2010. The two documents therefore need to be read together. The contents of the new specification refer to:
 - a) Existing DOs which should be used directly, without modification.
 - b) Existing DOs or their attributes which should be used with no change to the technical specification, but with a new interpretation relevant to the environmental and weather context.
 - c) Existing DOs which are modified, including with changed or new attributes
 - d) New DOs.
- 1.2.3 An XML representation of the new specification is also available for inclusion into UTMC-TS004 Annex G, as XSDs. These are text files that are modifications of the existing Annex G.

1.3 Areas not currently addressed

- 1.3.1 There are a number of potential scenarios, systems or data which are not fully covered by the updated specification, including:
 - a) Black Carbon sensor data. Although the need to record the output from Black Carbon sensors has been identified, it is still unclear exactly what type of sensor may be adopted and what their data outputs would be. Currently, two “placeholder” data elements have

been included, without further qualification at this stage. The interpretation of these therefore needs to be supported by local operational agreements.

- b) Temperature and Relative Humidity data. There was some debate about considering the merger of some DOs, as some systems record both air quality and meteorological parameters (for example to enable temperature compensation). At present the DOs for the two areas remain separate.
- c) Parameters drawn from DATEX II. The DATEX II specifications include a number of meteorological elements. Among these, some engineering parameters and detailed observational parameters have been excluded from the UTMC specifications as being unlikely to be useful in the context of UTMC-based usage. These remain available for use, however, if a requirements emerges, and developers are as ever encouraged to look at DATEX II as a source of data elements. Section 3 provides a schedule of these.
- d) Winter maintenance and gritter tracking. This document does not specifically address the issues associated with tracking the location of gritters or their mode of operation; this may be a useful thing to do from a traffic management perspective and requires consideration. Note where information is available from a gritter (eg mobile temperature data), this can be represented using a mapping of the gritter location to a UTMC model of the network.
- e) Sources of data for inference of air quality. There are a range of data sources available through UTMC from which it is possible to estimate emissions. These include automatic traffic counters, Bluetooth monitors, ANPR cameras and bus location data. Each of these sources would need its own metamodel, and these have not yet been developed. However, the actual AQ estimates may be communicated using the UTMC specifications in the normal way.
- f) Tunnel/Bridge related information. There are specific requirements for environmental monitoring in and around specialised road structures such as bridges and tunnels. The contents of the new specification should cover these, but there may be further work required to align them fully with the new UTMC guidance on tunnels and bridges (UTMC-TR010).
- g) Connecting field equipment to a UTMC CDB. There are no current demands to provide additional interface functionality for connecting air quality or meteorological equipment directly to a UTMC CDB. The AQ MIB UM/002 might need to be extended if this were the case – although with increasing interest in using XML to communicate with field devices, the present specification may be sufficient.

1.3.2 As always, the UDG is keen to learn of developments in the community that address new functionality, and encourages practitioners to submit any developments in the above (or other) areas.

2 Data Object Usage

2.1 Use cases

2.1.1 This section summarises the use new and revised DOs. Only DOs of direct relevance are considered, and where appropriate only their specific attributes.

2.1.2 Some systems, such as ANPR, may need to be associated with environmental or meteorological information. There are three options:

- The relevant env/met data is considered only as an engineering feature for device management, rather than as part of the UTMC data. In this case the data may be considered private to the system and need not be handled in a UTMC manner.
- The system reports valid env/met into the UTMC system. In this case the source system makes use of multiple DOs to send data into the centre.
- Separate systems provide env/met data into the UTMC centre, which can then be communicated to other functional systems to enable them to respond (eg by adjusting their configuration). In this case the systems are supplied with env/met data in UTMC format, allowing their design to be simplified.

2.1.3 In addition, there are existing DOs that may be relevant, but are defined in a suitably generic way to be used without changes – for example, DayTypeSupport. However some of the GlobalSupportObject enumerations describing road state and meteorological conditions do require extension and are included.

2.2 Updates to existing DOs

2.2.1 The table below lists key relevant DOs and/or their attributes, referenced by their Package and/or Class reference (see Annex D1 of the Data Objects Registry TS004:0061:2010), and states how they have been revised in TS004.0063:2015. The revision status is shown in column “S” as:

- U – DO should be used unchanged;
- d – deprecated attribute;
- e – extended/modified attribute;
- c – attribute use/definition is constrained;
- n – new attribute
- N – new DO.

2.2.2 Attributes marked as “deprecated” may be retained in the Specification for backwards compatibility, but new systems should avoid them.

Data Object (Package and/or Class reference)	Attribute(s) (Type(s))	S	Details
Incident:: Incident_Definition	Typeld (<i>Incident:: Incident_TypeID</i>)	U	An Incident should be used to describe a relevant issue of note to support management and reporting of environmental and meteorological events. Existing types are considered adequate to represent generic incidents relating to such events that may require general reporting or management by a UTMC system. It is expected that specific and detailed management of scenarios would use Strategy Supervisor functionality using relevant AirQuality and/or Meteorological DOs.
AirQuality (Package)		U	The AirQuality Package should be used to represent air quality monitoring locations, systems and/or sensors where they are of interest to a UTMC user. Note this may include virtual/derived sensors – see below for details. Where Package elements are not mentioned assume they are used in their current form.
AirQuality::AirQuality_Basic_Data	MeasurementUnits	d	It is proposed this is replaced by specific entries per sensor type using a Typeld to reference specific units (see below).
AirQuality::AirQuality_Basic_Data	BTXUnits, COUnits, etc (<i>AirQuality::AirQuality_Unit_TypeID</i>)	n	New attributes to match the possible set of measurements defined in Configuration and Dynamic (see below). Null values are acceptable where the measurement is not provided by the entity being represented by an instance of the DO. See the AirQuality_Unit_TypeID definition below. This provides a well-defined method for specifying measurements units.
AirQuality::Air_Quality_Basic_Data	MeasurementType (<i>AirQuality::AirQuality_Measurement_TypeID</i>)	n	Defines what type of real-world parameter is being measured. See the AirQuality_Measurement_TypeID definition below.
AirQuality::AirQuality_Basic_Data	TransportLink (<i>SystemCodeNumber</i>)	n	The TransportLink associated with this entity, specifically where the data associated with it represents the link's contribution to air quality, for example if a SCOOT link, the emissions associated with the (whole) link. May be null.

Data Object (Package and/or Class reference)	Attribute(s) (Type(s))	S	Details
AirQuality::AirQuality_Basic_Data	TransportRoute (SystemCodeNumber)	n	The TransportRoute associated with this entity, specifically where the data associated with it represents the whole route's contribution to air quality, for example, the emissions associated with the route. May be null.
AirQuality::AirQuality_Unit_Typeld	Typeld	N	Identifies the unit of measurement: 1 = ppm 2 = ppb 3 = $\mu\text{g m}^{-3}$ 4 = LAeq dBA 5 = degrees Celsius 6 = percentage 99 = undefined / unknown
AirQuality::AirQuality_Measurement_Typeld	Typeld	N	Identifies the type of real-world measurement the entity is recording: 1 = emission 2 = concentration 99 = undefined / unknown Where emissions are the level of pollutants emitted into the environment, e.g. from a vehicle tailpipe and concentration is the dispersed value present at a location in the environment as subject to other factors (meteorology, etc). Both are relevant in a traffic management and UTMC context. For example emissions may be used to determine the output of a transport network, concentrations their potential impact at specific receptor locations.
AirQuality::AirQuality_Configuration	See below		Configuration will be extended to support thresholds for new pollutants and measured entities and also to support multiple threshold levels, in particular to align with DEFRA defined air quality index levels.
AirQuality::AirQuality_Configuration	ThresholdCO2 (real) ThresholdPM1 (real) ThresholdPM2p5 (real) ThresholdBC1 (real) ThresholdBC2 (real) ThresholdNoise (real) ThresholdTemp (real) ThresholdRH (real)	n	New attributes associated with an air quality measuring entity; these are in addition to the existing measurements – see AirQuality_Dynamic for details. Note if an entity has no related sensor type or threshold an attribute may be null.

Data Object (Package and/or Class reference)	Attribute(s) (Type(s))	S	Details
AirQuality::AirQuality_Configuration	ThresholdLevel (integer)	n	Where thresholds exist at various levels, the threshold level associated with these value(s). Although not mandated levels are assumed to be organised in a sensible manner e.g. ascending or descending through level values.
AirQuality::AirQuality_Configuration	ThresholdType (AirQuality::AirQuality_Threshold_TypeId)	n	The Threshold type. See the AirQuality_Threshold_TypeId definition below.
AirQuality::AirQuality_Threshold_TypeId	TypeId	N	Identifies the threshold type, and provides a mechanism to support hysteresis management across threshold transitions: 1 = Rising 2 = Falling 3 = RisingAndFalling Note threshold sets should be consistently defined, i.e. either a single set of RisingAndFalling thresholds should be provided, or pairs of Rising and Falling thresholds ones.
AirQuality::AirQuality_Dynamic	CO2 (real) PM2p5 (real) PM1 (real) BC1 (real) BC2 (real) Noise (real) Temp (real) RH (real)	e	Dynamic data will be extended to support new monitoring types of current relevance including: <ul style="list-style-type: none"> • CO₂, including CO_{2e} where it is an equivalence level which should be identified by the quality statement. • Finer particulates (PM_{2.5}, PM₁). • Black carbon (a placeholder for two different sensor types is proposed at this point in time, with no further explanation). • Noise. • Basic meteorology (temperature and relative humidity) is included as many AQ sensors record this data although this and it may provide a source of data otherwise absent.
AirQuality::AirQuality_Quality		U	No specific equipment only quality data is provided as it is implied by the equipment type and other parameters, and some equipment types can provide different quality levels which should be indicated by AirQuality_Dynamic_Quality

Data Object (Package and/or Class reference)	Attribute(s) (Type(s))	S	Details
AirQuality::AirQuality_Dynamic_Quality			This will be extended by the addition of attributes that identify the providence of the data associated with a particular (set of) dynamic instance(s). Note basic providence should be determined from the sensor type (AirQuality_Definition::TypeId) and all fields are optional.
AirQuality::AirQuality_Dynamic_Quality	DataStatus_TypeId	n	Indicates if data is suspect in some manner or not: 0 = Normal / Not Suspect 1 = Incomplete (derived from data with missing values) 2 = Inconsistent (compiled from data that is not guaranteed to be consistent – e.g. two different data types where the instances don't exactly time align) 3 = Suspect (other reason) 99 = Unknown
AirQuality::AirQuality_Dynamic_Quality	Checked_TypeId	n	Indicates how much validation has been performed on the data: 0 = raw from (virtual or real) sensor 1 = validated (reliable data from a sensor, e.g. cross checked via co-location) 2 = ratified (AURN data fully validated)
AirQuality::AirQuality_Dynamic_Quality	Smoothed (<i>string</i>)	n	Some text providing information on how processed the data is.
AirQuality::AirQuality_Dynamic_Quality	Accuracy (<i>string</i>)	n	Some text providing information on the level of accuracy of the data provided, e.g. "+2-3%", "+-5ppm" etc.
AirQuality::AirQuality_Dynamic_Quality	Derivation (<i>string</i>)	n	Some text indicating how the value is derived, e.g. is it an estimation of CO2 or a CO2e level made up of various elements
AirQuality::AirQuality_TypeId	TypeId	e	Extended to identify an additional type: 5 = AQ Virtual/Derived Monitor This type of monitor provides data values derived from other sources (e.g. traffic data from SCOOT) by the application of second order processing (models, algorithms, etc.)

Data Object (Package and/or Class reference)	Attribute(s) (Type(s))	S	Details
Meteorological (Package)		U	<p>The Meteorological Package should be used to represent meteorology stations, systems and/or sensors where they are of interest to a UTMC user. Where Package elements are not mentioned assume they are used in their current form.</p> <p>The majority of changes proposed for DOs in this package are to align with recent updates to the DATEX II standard.</p>
Meteorological:: Meteorological_Dynamic			There are a number of additional parameters available that provide useful indicators of road and/or atmospheric state.
Meteorological:: Meteorological_Dynamic	DepthTemperature (Celsius)	n	Temperature measured typically 30cm below the road surface. Reported in degrees C.
Meteorological:: Meteorological_Dynamic	Dewpoint (Celsius)	n	<p>The temperature to which a given parcel of air must be cooled to, for water vapour to condense into water. Dew will form on a surface if the temperature of that surface is below the dew point of the air next to the surface.</p> <p>Reported in degrees C.</p>
Meteorological:: Meteorological_Dynamic	FreezingPoint (Celsius)	n	<p>An indication of the temperature at which water and moisture on the road surface will freeze. This is based on the concentration of de-icing chemical present, which varies due to the amount of chemical applied and the amount of water on the road surface. The higher the concentration, the lower freezing temperature.</p> <p>Reported in degrees C. Range 0.0 to -21.1C</p>
Meteorological:: Meteorological_Dynamic	GroundTemperature (Celsius)	n	Temperature measured 6cm below the road surface. Reported in degrees C.
Meteorological:: Meteorological_Dynamic	Solar Radiation (<i>real</i>)	N	<p>The incident power of sunlight.</p> <p>Reported in W/m² Range 0.4 to 1.1 μm (400-1100 W/m²)</p>

Data Object (Package and/or Class reference)	Attribute(s) (Type(s))	S	Details
Meteorological:: Meteorological_Dynamic	Level of Grip (<i>real</i>)	n	A slipperiness index based on the amount of water, ice or snow on a road surface, scaled against the friction value of a typical road surface and car tyre. Reported as a range 0 to 1 0 to 0.39 = very poor grip* 0.40 to 0.59 = poor grip* 0.60 to 0.82 = good grip* * These descriptions are intended only as indicators, as the real friction values depend on many variables, such as vehicle type and speed, tyre type, road surface structure, etc.
Meteorological:: Meteorological_Dynamic	Ice Layer (<i>integer</i>)	n	Water equivalent thickness level of ice on the road surface. Reported in mm.
Meteorological:: Meteorological_Dynamic	Snow Layer (<i>integer</i>)	n	Water equivalent thickness level of snow on the road surface. Reported in mm.
Meteorological:: Meteorological_Dynamic	Water layer (<i>integer</i>)	n	Water thickness level on the road surface. Reported in mm.
GlobalSupportObject:: RoadCondition_TypeId	TypeId	e	Defined types (existing values kept for compatibility): 1 Dry 2 Wet 3 Deep Water 4 Frost 5 Ice 6 Black Ice 7 Snow New types (providing DATEX II alignment): 13 Slushy 15 Moist 17 Wet and Chemical 21 Moist and Chemical 99 Invalid (sensor error)
CommonSubSystemSupport (Package)		U	The data defined by this Package can be used as appropriate to identify monitoring and/or data collecting sub-systems (e.g. in fault reporting). Note this will probably require extension of the SubsystemTypeId type as appropriate to include new suppliers; these will need to be defined as required by specific implementations.

Data Object (Package and/or Class reference)	Attribute(s) (Type(s))	S	Details
CommonSupport (Package)		U	The definitions in this Package can be used to exchange command/control requests between UTMC and monitoring and/or data collection and analysis systems, using the appropriate specialisation, (e.g. AirQuality_Commands), where there is a separate system collecting data from on-street sensors. Details will need to be defined as required by specific implementations.
FaultSupport (Package)		U	The definitions in this Package can be used to exchange fault information between UTMC and monitoring and/or data collecting systems, using the appropriate specialisation (e.g. AirQuality_Faults).
TransportLink (Package)		U	TransportLinks can be sources of data for virtual environmental sensors (e.g. SCOOT link).
TransportRoute (Package)		U	TransportRoutes can be sources of (summed) data for virtual environmental sensors.
Profile (Package)		U / N	Specific subclasses of the abstract Profile classes should be defined in line with the other specialisations in the package, to profile the parameters defined in both AirQuality_Dynamic and Meteorological_Dynamic
Prediction (Package)		U / N	Specific subclasses of the abstract Prediction classes should be defined in line with the other specialisations in the package, to provide the parameters defined in both AirQuality_Dynamic and Meteorological_Dynamic

3 Unused DATEX II Meteorological Parameters

3.1 Engineering Parameters

3.1.1 The following engineering parameters are defined in DATEX II. Their most likely use would be in reporting fault status through the Meteorological_Faults DO.

Parameter	Definition & Guidance
Alarm Status	Calculated description warnings based on surface temperature and moisture (liquid or frozen)
Amount of Chemical	Estimation of chemical on road surface (g/m2)
Black Ice Frequency	Dielectric measurement used in calculation of the road Surface State / Condition (Hz)
Cloud State	Basic description estimation of cloud and rain status based on behaviour of other measurements
Conductivity	Technical measurement to help determine the amount of deicing chemical on the road surface translated into the Freezing Temperature
Surface Signal	Technical measurement to help determine the amount of deicing chemical on the road surface translated into the Freezing Temperature
Battery Voltage	Technical measurement for weather stations with batteries
DSC Hardware Status	Technical equipment status
General Status	Technical equipment status
Rain On/Off	Basic rain yes / no measurement. Detail provided by Precipitation State or Present Weather
Relay State	Technical output from any installed relay devices
Visibility Sensor Status	Technical equipment status
Wind Speed Max Direction	A technical parameter, whose meaning is the subject of some discussion, and has not been included for reasons of clarity and because there is no perceived use in a UTMC context. (Note was included as a proposed attribute of Meteorological:: Meteorological_Dynamic but removed following review and discussion with the HA).

3.2 Present Weather Enumeration

3.2.1 The following parameters are the WMO defined values to describe present weather conditioned. Their definitions overlap with both the Visibility_TypeID and Precipitation_TypeID enumerations. There is no recommendation to change either of these enumerations to incorporate the following.

WMO Value	Status
0	Nothing obstructing horizontal visibility
1	Clouds generally dissolving or becoming less developed (during past hour) (not yet used)
2	State of sky generally unchanged (not yet used)
3	Clouds forming or developing (during past hour) (not yet used)
4	Haze, smoke or dust in suspension in the air, visibility >= 1 km

WMO Value	Status
5	Haze, smoke or dust in suspension in the air, visibility < 1 km
10	Mist
11	Diamond dust (not yet used)
12	Distant lightning (not yet used)
18	Squalls (not yet used)
20	Fog was observed during the preceding hour but not at the time of observation
21	Precipitation was observed during the preceding hour but not at the time of observation
22	Drizzle (not freezing) or snow grains was observed during the preceding hour but not at the time of observation
23	Rain (not freezing) was observed during the preceding hour but not at the time of observation
24	Snow was observed during the preceding hour but not at the time of observation
25	Freezing rain or freezing drizzle was observed during the preceding hour but not at the time of observation
26	Thunderstorm with/without precipitation was observed during the preceding hour but not at the time of observation (not yet used)
27	Blowing or drifting snow or sand (not yet used)
28	Blowing or drifting snow or sand, visibility \geq 1.0 km (not yet used)
29	Blowing or drifting snow or sand, visibility < 1.0 km (not yet used)
30	Fog
31	Fog or ice fog, in patches
32	Fog or ice fog, has become thinner during the past hour
33	Fog or ice fog, no appreciable change during the past hour
34	Fog or ice fog, has begun or become thicker during the past hour
35	Fog, depositing rime (not yet used)
40	Precipitation
41	Precipitation, slight or moderate
42	Precipitation, heavy
43	Liquid precipitation, slight or moderate
44	Liquid precipitation, heavy
45	Solid precipitation, slight or moderate
46	Solid precipitation, heavy
47	Freezing precipitation, slight or moderate
48	Freezing precipitation, freezing, heavy
50	Drizzle
51	Drizzle, not freezing, slight
52	Drizzle, not freezing, moderate

WMO Value	Status
53	Drizzle, not freezing, heavy
54	Drizzle, freezing, light
55	Drizzle, freezing, moderate
56	Drizzle, freezing, heavy
57	Drizzle and rain mixed, slight
58	Drizzle and rain mixed, moderate or heavy
60	Rain
61	Rain, light
62	Rain, moderate
63	Rain, heavy
64	Rain, freezing, light
65	Rain, freezing, moderate
66	Rain, freezing, heavy
67	Rain (or drizzle) and snow, light
68	Rain (or drizzle) and snow, moderate or heavy
70	Snow
71	Snow, light
72	Snow, moderate
73	Snow, heavy
74	Ice pellets, light
75	Ice pellets, moderate
76	Ice pellets, heavy
77	Snow grains (from WMO 4677)
78	Ice crystals (from WMO 4677)
80	Showers or intermittent precipitation
81	Rain showers, light
82	Rain showers, moderate
83	Rain showers, heavy
84	Rain showers, violent (>32 mm/h)
85	Snow showers, light
86	Snow showers, moderate
87	Snow showers, heavy
89	Showers of hail, with or without rain or rain and snow mixed, not associated with thunder (from WMO 4677)
90	Thunderstorm (TS) (not yet used)
91	Thunderstorm, slight or moderate, no precipitation (not yet used)

WMO Value	Status
92	Thunderstorm, slight or moderate, rain/snow showers (not yet used)
93	Thunderstorm, slight or moderate, hail (not yet used)
94	Thunderstorm, heavy, no precipitation (not yet used)
95	Thunderstorm, heavy, rain or snow showers (not yet used)
96	Thunderstorm, heavy, hail (not yet used)
99	Tornado (not yet used)