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# Towards interoperable traffic data sources

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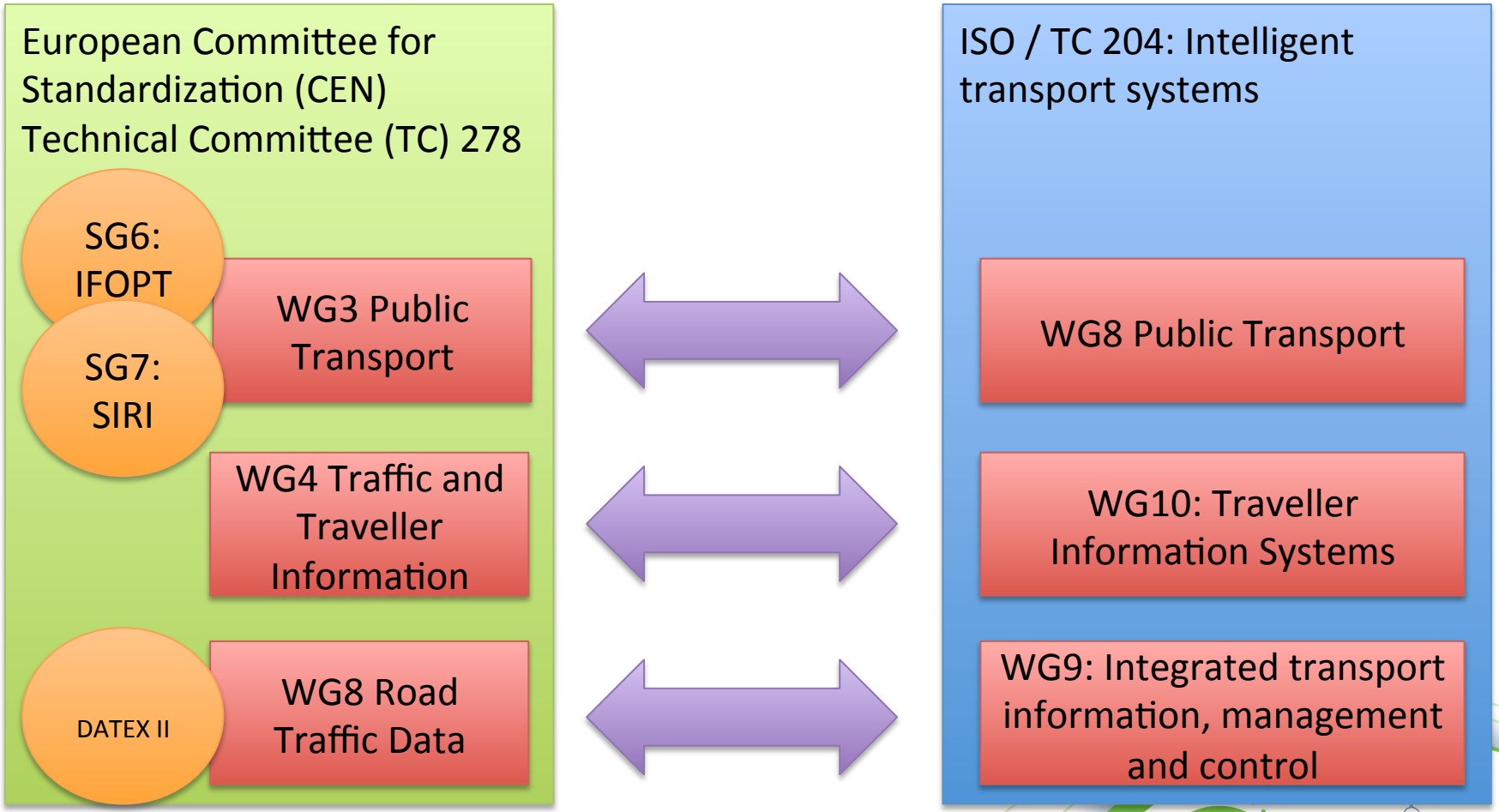
# Scope

- Survey of open data interfaces and datasets for land person traffic and transportation
  - Self-empowered pedestrians, bikers and drivers
  - Public transportation users
  - Excluded: Air travel, sea travel and goods transport
- Formats and Protocols
- Examples of use
- Identifiers
- Linked open data in traffic
- Summary & Conclusions

# Formats and Protocols

# International Standards



# CEN / TC 278 Specifications

- Service Interface for Real-Time Information (SIRI)
  - Exchange of information about public transport services and vehicles in distributed systems
  - E.g. Vehicle Monitoring (VM), Stop (ST) and General Messaging (GM) Services
  - Messages exchanged either as XML documents with http-post or using SOAP
- Identification of Fixed Objects in Public Transport (IFOPT)
  - Main fixed objects related to public transport
  - E.g. Stop place model
- DATEX II
  - DATEX II aims to attract all actors in the dynamic traffic and travel information sector
  - E.g. traffic elements, operator actions, measured data and variable message signs

# Google GTFS and realtime

- General Transit Feed Specification (GTFS)
  - Set of specifications by Google for route, timetable and infrastructure information
  - A “feed” consists of a set of CSV text files collected into a zip-compressed package, made available in the net
  - Each file addresses a certain aspect of the information, e.g. stops, routes, trips and stop times
  - Extremely popular; over 700 transit agencies listed*) in Nov 2013, list was incomplete
- GTFS realtime
  - Extension of GTFS supporting realtime updates to fleet positions
  - Based on Google-proprietary “protocol buffer” format
  - Trip updates, service alerts, vehicle positions

*) http://www.gtfs-data-exchange.com/agencies#filter official

# Open Street Map

- Open Street Map (OSM) currently consists of over 2 billion nodes kept up-to-date by 1.4 million active contributors
- Has recommendations for tagging of both fixed public transportation infrastructure and public transportation routes
  - Offers a comprehensive set of tags for public transport stops (23 vs. e.g. 12 parameters in GTFS)
- Flipside of flexibility: Applications need to be prepared for inconsistencies and changing recommendations and practices
- OSM wiki lists 11 applications using OSM public transport data

# Examples of Open Traffic Data

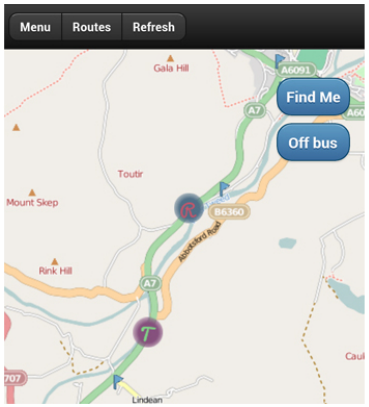
# Road Conditions and Traffic

- Digitraffic by the Finnish Transport Agency
  - Dynamic real-time fluency and travel time
  - Current road weather station data
  - WS-I based WSDL specification of SOAP-messaging
- Incident and roadwork information
  - RSS
  - FTP downloads of XML-files in national and DATEX II formats
- No other freely available traffic data discovered, but e.g. Google and TomTom make their data available through web services and mobile applications

# Public Transportation Info

- Early SIRI implementations available in Tampere (VM, ST, GM) and New York (VM, SM)
- UK stop information is NaPTAN (earlier version of IFOPT)
- HAFAS
  - The timetable information system of German traffic, transport and logistics software company HaCon
  - Users in 25 countries, e.g. Deutsche Bahn in Germany and SNCF in France
  - Supports multiple interfaces including SIRI but API documentation hard to find
- Finnish API:s mostly local solutions
  - Nation-wide connection search and bus stop timetable API using HTTP get requests, responses in XML
  - Helsinki regional transport offers API:s for journey planning, live fleet tracking, service disruptions and stop-specific next departures
  - National railway provides information in RSS feeds

# Crowd-Sourcing Vehicle Positions



Screen capture from GetThere Application in the referenced paper

- So far mostly used by car navigation companies to obtain traffic fluency data
- Research experiments made in areas, where no positioning data from buses is available
- Corsar, D., Edwards, P., Baillie, C., Markovic, M., Papangelis, K., Nelson, J.: Short Paper : Citizen Sensing within a Real-Time Passenger Information System. In: SSN 2013
  - Public transportation passengers using a mobile application to semi-automatically report the position of the buses to fellow passengers.

# Identifiers

- No dominant international scheme has emerged
  - IFOPT and DATEX II recommending to pre-fix identifiers with IANA top level domain (ISO 3166-1) country codes
  - IFOPT recognizes the needs for both unique system-level identifiers and human-usable short identifiers
  - NaPTAN identifies stops with a 12-character “AtchoCode” and 7- or 8-digit “NaPtanCode”
  - International union of railroads (UIC) has uses a 7-digit station identifier beginning with a 2-digit country code
- Finnish Digitraffic uses local schemes based on Finnish road numbering and addresses
- GTFS defines no identifiers, but includes fields also for URI:s of things

# Example Identifiers in Finnish Public Transport API:s

| Name | Source | Scope | Description |
|---|---|---|---|
| StationId | matka.fi, HSL | National (kalkati.net) | 7-digit numeric code |
| CountryId | matka.fi, HSL | Global, IANA | "fi" for Finland. |
| CityId | matka.fi, HSL | National | Optional, defines city or county. |
| GlobalId | matka.fi, HSL | National | "Digistop"-id. National database collecting information on bus stops. |
| JORE stop code | HSL (Live) | Capital area | A 7-digit stop code listed in the Helsinki region register of public transportation. |
| Metropolitan area number | HSL | Capital area | An older 4-, 5- or 6-digit stop identifier with a four-digit stop number and 0-2 character city prefix. |
| JORE route | HSL | Capital area | Public transportation routes: Seven characters. |
| Route | HSL Live | Capital area | Four- or five-digit identifiers with examples given as "1052V.1" and "1064" |
| Vehicle id | HSL Live | Capital area | Vehicle identification as e.g. " CEENG1074300245" |
| Departure id | HSL Next Departures | Capital area | An 8-digit number. |

# Linked Open Traffic Data

| Stars:*) | Definition: | Status: |
|---|---|---|
| ★ | Available on the web with an open licence | Not always fully openly available, most providers require a separate license agreement. All surveyed licenses except Digiroad were free-of-charge. |
| ★★ | Available as machine-readable structured data | Everything is machine-readable. Some RSS-feeds provide only unstructured text. |
| ★★★ | as above plus non-proprietary format (e.g. CSV instead of excel) | The “protocol buffers” in GTFS-realtime are a proprietary format. Specifications are available, but processing is easier using tools from Google. Otherwise non-proprietary formats, mostly based on XML. Some using commonly agreed XML schemas. |
| ★★★★ | as above plus use open standards from W3C (RDF and SPARQL) to identify things so that they can be referenced | Nobody is providing data in RDF. GTFS supports URIs for agencies, routes and stops, but original purpose is to use them for web pages. |
| ★★★★★ | as above plus link the data to other people’s data to provide context | Some interfaces are referencing XML namespace definitions, but clear cross-compatibility of concepts by e.g. pointing to globally available ontologies was not detected between any two systems. None of the data directly links to any other data. OWL-ontologies on Open Street Map are available. |

***) http://www.w3.org/DesignIssues/LinkedData.html**

# Traffic Linked Open Data Experiments

- Trial service in Madrid[1)]
  - Local bus transport authority EMT follows a similar scheme as the providers in Finland: XML documents using a locally defined schema
  - The trial follows linked open data principles
    - URI:s given to both buses and bus stops
    - RDF used as the data format both for static and streaming data
  - *EMT Live Services* are converted into a SPARQL stream and static data is provided by a SPARQL endpoint
  - A tablet application has been created for data consumption demonstration.
- Smart city service in Dublin[2)]
  - Main target of the service city traffic monitoring and administration
  - Built on linked data principles using RDF and SPARQL, extended with proprietary streaming operators
  - Traffic-related information includes bus, bikes, air quality, ambient noise, pedestrian counts, traffic cameras and weather

**1) Calbimonte, J.p., Fernandez-carrera, A., Corcho, O.: Demo paper : Tablet-based visualization of transportation data in Madrid using SPARQLStream. In: SSN Workshop 2013**

**2) Tallevi-diotallevi, S., Kotoulas, S., Foschini, L., Lecue, F.: Real-time Urban Monitoring in Dublin using Semantic and Stream Technologies. In: ISWC 2013.**

# Traffic Data Ontologies

- Three ontologies to provide vocabularies for OSM were discovered
- OSMOnto
  - Appears to be a one-time effort created for a research paper
  - Available as a downloadable OWL-file, but not as a browsable description
- OSM Semantic Network (OSN)
  - Looks up-to-date with OSM recommendations on public transport infrastructure
  - Browser-friendly access also available
- LinkedGeoData
  - By the Leipzig University to make OpenStreetMap data available as an RDF knowledge base according to the Linked Data principles
  - Using popular ontologies such as rdfs, foaf and skos in addition to an own linkedgeodata.org ontology
  - No references to OSN within linkedgeodata were discovered.

# Conclusions

- Almost all current interface-formats are based on XML
  - JSON, RSS, proprietary CSV also appear
- Main protocol http, in older systems ftp
- New European standards DATEX II, SIRI and IFOPT created by CEN/TC 278 are not widely available in open interfaces yet
- OSM enjoys huge support and also contains public transport infrastructure information, but suffers from internal fragmentation
- For public transportation GTFS by Google is simple and has over 700 traffic operators listed
- Finnish open interfaces provide data on roads, traffic and public transport, but are practically all based on different specifications
- Traffic identifier situation is still very fragmented
  - Agreement to use ISO 3166-1 country prefixes
- Linked open data principles absent from current solutions