Oliot
Open Language for Internet of Things

AUTO-ID LABS

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GS1 GLOBAL SMART PARKING SYSTEM:
ONE ARCHITECTURE TO UNIFY THEM ALL

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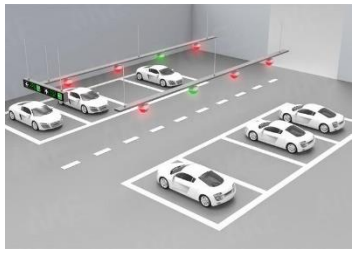
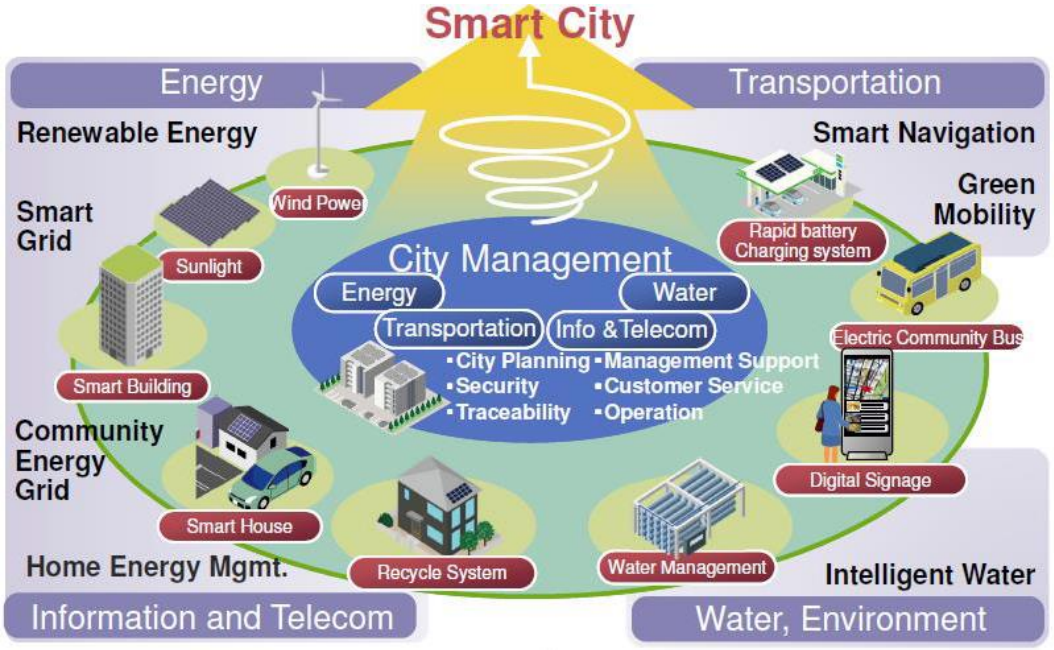
1. Introduction

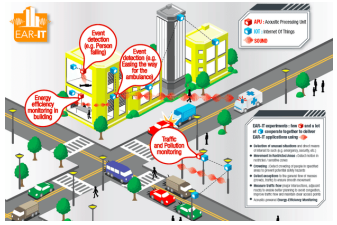
- **Smart parking in the big picture of future smart cities**
  - Population and size of our cities are predicted to steadily increase in the near future -> urban challenges for our future smart cities. E.g. 25-30% traffic is to find parking areas.
  - Many Smart City Services (e.g. conducted in Barcelona, San Diego, Open Cities project in Europe) -> lack of integrations, common and global data modelling.



Smart Parking

Smart Grid





Smart Traffic Light

Smart Home

1. Introduction

- **Motivations**
  - Having an open and unified smart parking service for users everywhere they go. (Similar to Internet services such as WWW.)
  - Open the discussion to realize a global and common base (regardless of countries and languages) for our future research and development of smart parking service.

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Open Language for Internet of Things
Stem From
GS1 EPCglobal

- **Assumptions**
  - Every parking lots is capable of monitoring its current status in real-time.
  - Parking lots information should be publicly available.

- **GS1/Oliot**
  - EPCIS, ONS implementations are parts of Oliot project.
  - Oliot is freely available (Apache License 2.0) at http://gs1oliot.github.io/oliot/

2. Background

- **GS1 (Global Standard 1)**
  - Global Standardization Organization
  - Develop and maintain standards for supply and demand chains around the world.
  - **Identify**: Globally unique identification keys
  - **Capture**: Automatic data capture
  - **Share**: Exchange of business-critical information
  - Local member organizations in over 110 countries
  - Over a million member companies across the world
  - Global Common Language

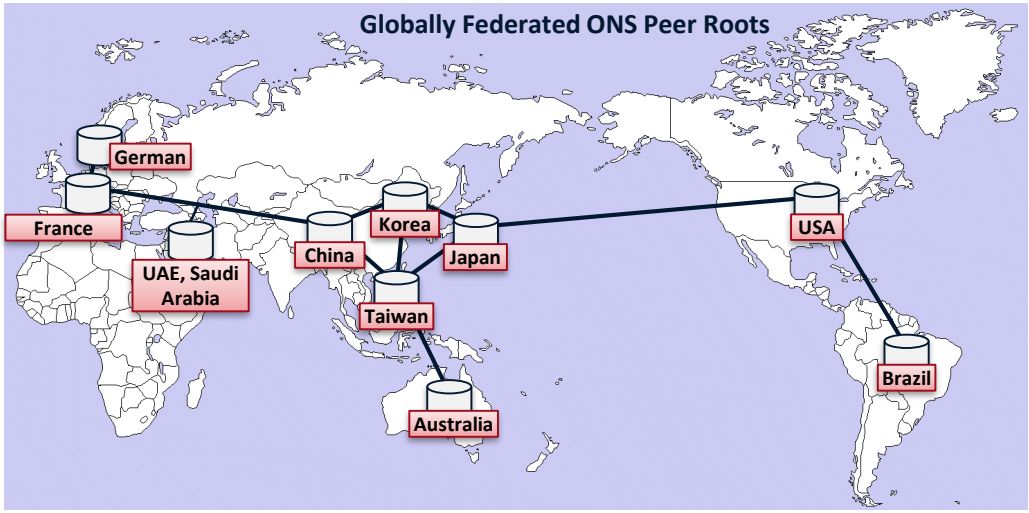
GS1 The global language of business

2. Background

- **EPCIS (EPC Information Service)**
  - Storage for storing master data and event data
  - Master data (EPCIS Header): is the core information about “who” and “what” of things.
  - Event data (EPCIS Body): WHAT object generates that event; WHEN, and WHERE, it was generated; and WHY it happens.

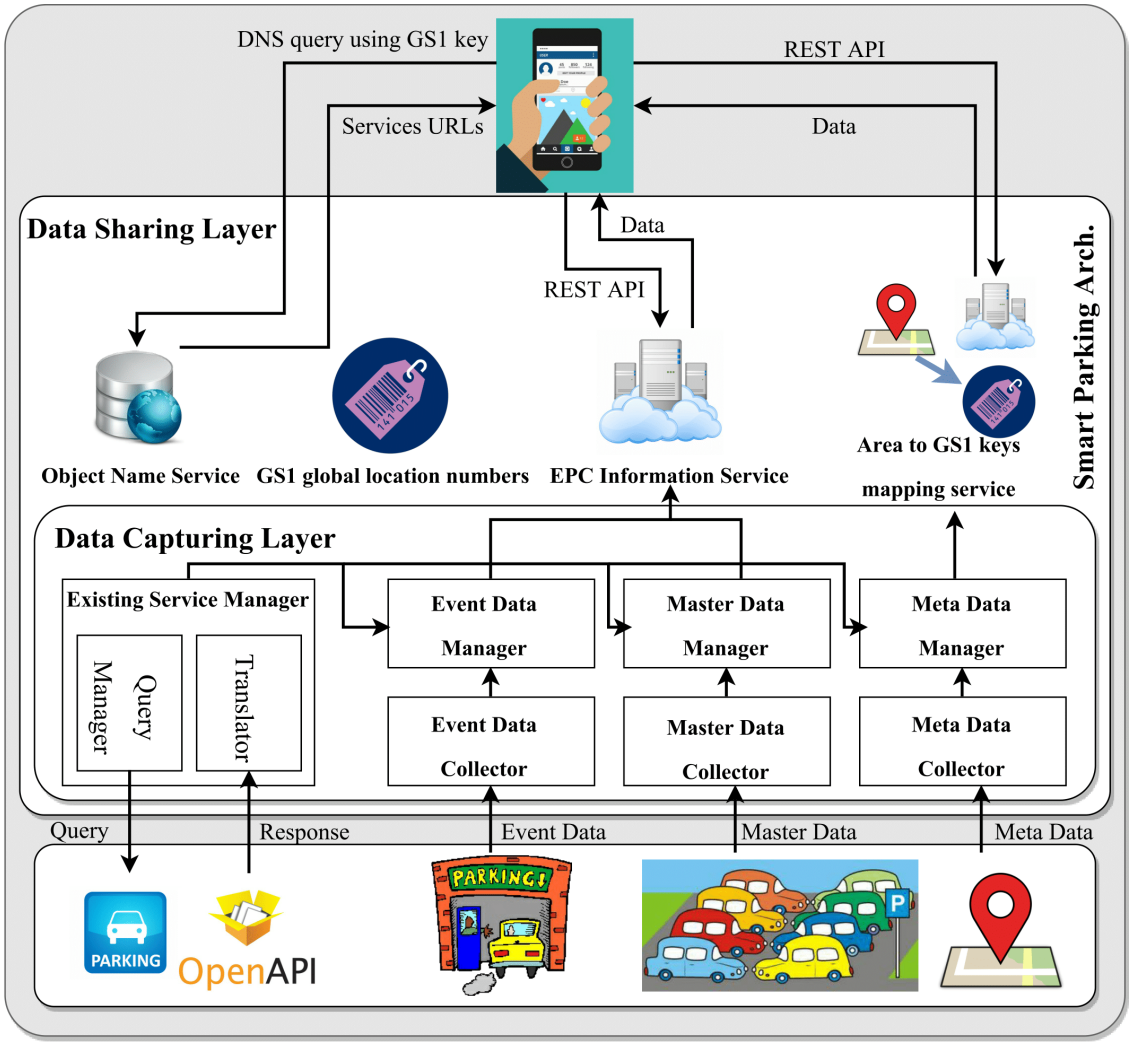
2. Background

- **ONS (Object Name Service)**
  - DNS-based service that helps finding the services for each identifier.
  - When receiving the GS1 key, it returns the service list for that key.



3. GS1 Global Smart Parking System Architecture

- **Identification**
  - GS1 Global Location Number (GLN).
- **Master data**
  - Parking lot's name, address, GLN, etc.
- **Event data**
  - Real-time status, i.e. current available parking spaces.
- **Meta data**
  - GPS coordinates, GLN => to do the mapping between user's area and parking lots' GLNs in that area.
- **Application flow:**
  - User's location -> parking lots' GLNs
  - GLN -> services and EPCIS URLs (ONS)
  - Query EPCIS URLs to get data.



3. GS1 Global Smart Parking System Architecture – Area-2-GLNs service

- **Area-2-GLNs service**
  - Designed as an EPCIS system, SimpleEventQuery is used to query GLNs from an area.

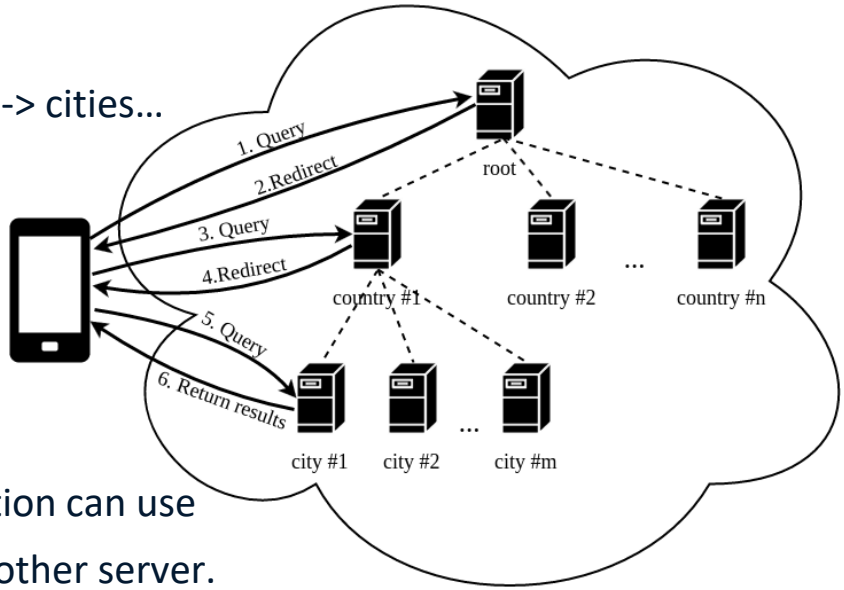
```
http://(SMART SEARCH SERVER)/epcis/Service/Poll/SimpleEventQuery?
LT_http://www.tta.or.kr/epcis/schema/parkingspace.xsd%23gps_latitude=(NE_latitude)&
GE_http://www.tta.or.kr/epcis/schema/parkingspace.xsd%23gps_latitude=(SW_latitude)&
LT_http://www.tta.or.kr/epcis/schema/parkingspace.xsd%23gps_longitude=(NE_longitude)&
GE_http://www.tta.or.kr/epcis/schema/parkingspace.xsd%23gps_longitude=(SW_longitude)&
```

- **Global scale**
  - Hierarchical architecture: root -> countries -> cities…
  - Employ Google's reverse geocoding:

  (36.367056, 127.363965 -> Daehak-ro, Yuseong-gu, Daejeon, South Korea)

  ⇒Query root -> redirect S.Korea server -> redirect Daejeon server.

  - When user moves to new location, application can use cached URLs to trace upwards until found another server.



3. GS1 Global Smart Parking System Architecture - ONS

- **ONS**
  - Provides a link between a GLN and its services.
  - Leverages existing DNS infrastructure and standard.
  - Example of ONS NAPTR (A Name Authority Pointer) record

Order	Pref	Flags	Service	RegExp	Replacement
0	0	"U"	"www.parking-space-finder.org/freespace"	"!^.*$!http://143.248.53.173:10024!"	.

  - Service field: contain an URL indicating a provided service of a parking lot.
  - RegExp field: the corresponding EPCIS URL for a service in Service field.

- **ONS use cases:**
  - **Parking lot owners**: register their services and corresponding EPCIS URLs to ONS system.
  - **User's application:** convert a parking lot's GLN -> FQDN (Fully qualified domain name) -> query NAPTR records from ONS -> get the list of services and their EPCIS URLs.

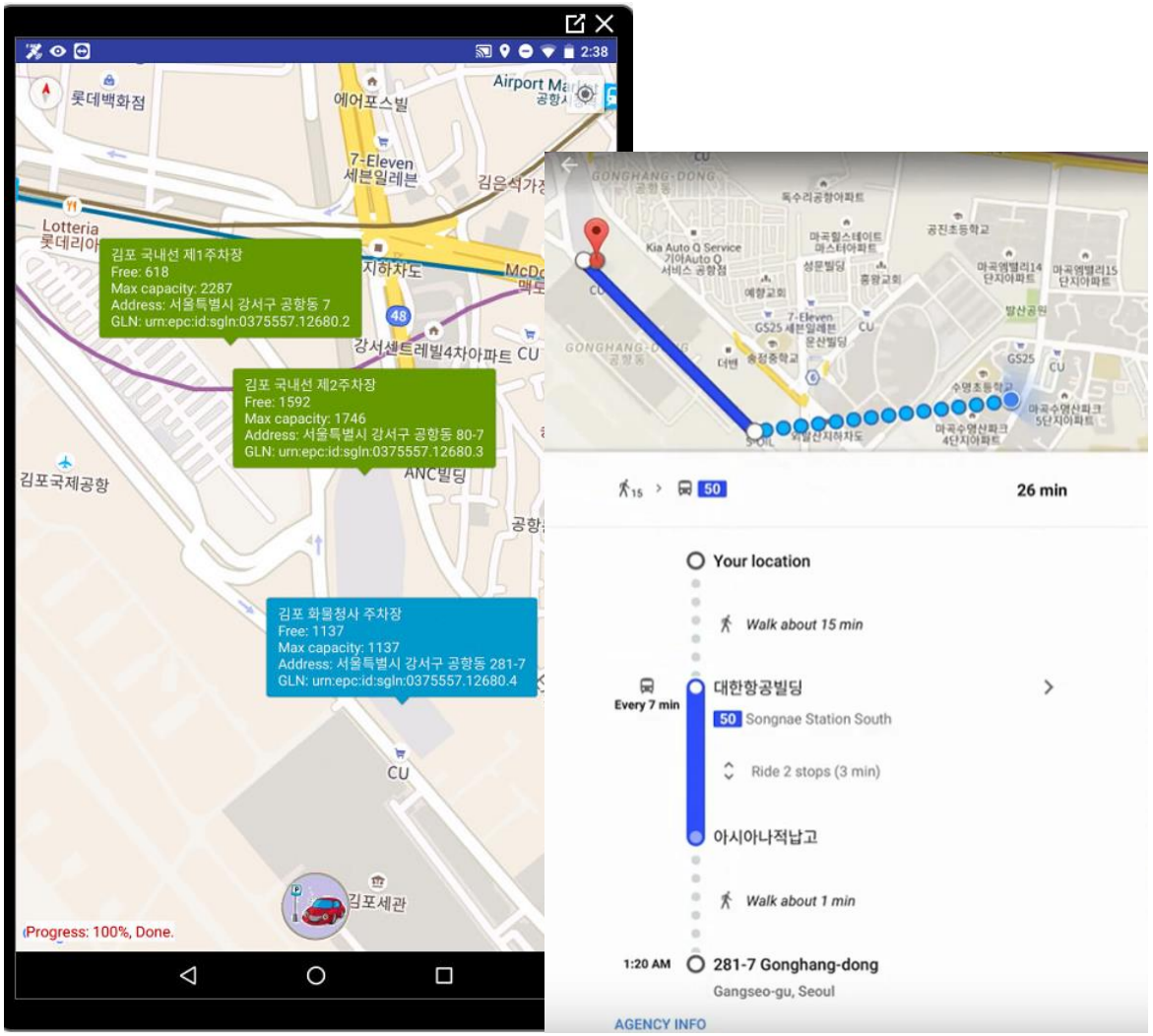
3. GS1 Global Smart Parking System Architecture - EPCIS

- **EPCIS use cases**
  - **Governments (or organizations):** get GLNs from GS1 and install Area-2-GLNs, EPCIS and ONS systems in their desired areas.
  - **Parking lot owners:** setup their sensors, and send Master, Event and Meta data to EPCIS, and Are-2-GLNs systems, respectively.
  - **User's application:** query EPCIS system to get XML files holding necessary data.
- **XSD schemas:**
  - An example for XSD schema of Master data is shown on the right side.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns="http://www.unece.org/cefact/namespaces/StandardBusinessDocumentHeader"
    attributeFormDefault="unqualified" elementFormDefault="qualified"
    targetNamespace="http://www.unece.org/cefact/namespaces/StandardBusinessDocumentHeader">
    <xs:simpleType name="parkingspace_name">
        <xs:annotation>
            <xs:documentation>
                parking lot's name
            </xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:string"></xs:restriction>
    </xs:simpleType>
    <xs:simpleType name="parkingspace_address">
        <xs:annotation>
            <xs:documentation>
                parking lot's address
            </xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:string"></xs:restriction>
    </xs:simpleType>
    <xs:simpleType name="parkingspace_max_cap">
        <xs:annotation>
            <xs:documentation>
                parking lot's maximum capacity
            </xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:string"></xs:restriction>
    </xs:simpleType>
    <xs:simpleType name="gpc">
        <xs:annotation>
            <xs:documentation>
                GS1 GLN code
            </xs:documentation>
        </xs:annotation>
        <xs:restriction base="xs:string"></xs:restriction>
    </xs:simpleType>
```

4. Prototype implementation

- **Android application**
  - Implemented on Nexus 7 (Android 6.0)
  - Support 9 Korean airports and Busan city w/ total 35 parking lots.
  - Parking lots' real-time data are provided by Korean gov.
  - These data are captured and converted to Master, Event and Meta data to be used in our system.



5. Conclusion

- **Contributions**
  - Open the discussion to realize a global and common base for smart parking services.
  - A global architecture for smart parking system based on GS1 standards has been proposed. It enables a new and open business model for parking lot owners and users everywhere in the world to smoothly integrate their information and services around common standards.
  - A prototype has been implemented to show its feasibility.

- **Acknowledment**

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GS1 Oliot Architecture