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Introduction of EXI
（Efficient XML Interchange）

July, 11 2011

Fujitsu Ltd.

Background - ISO15118 -

EXI in Vehicle to Grid communication

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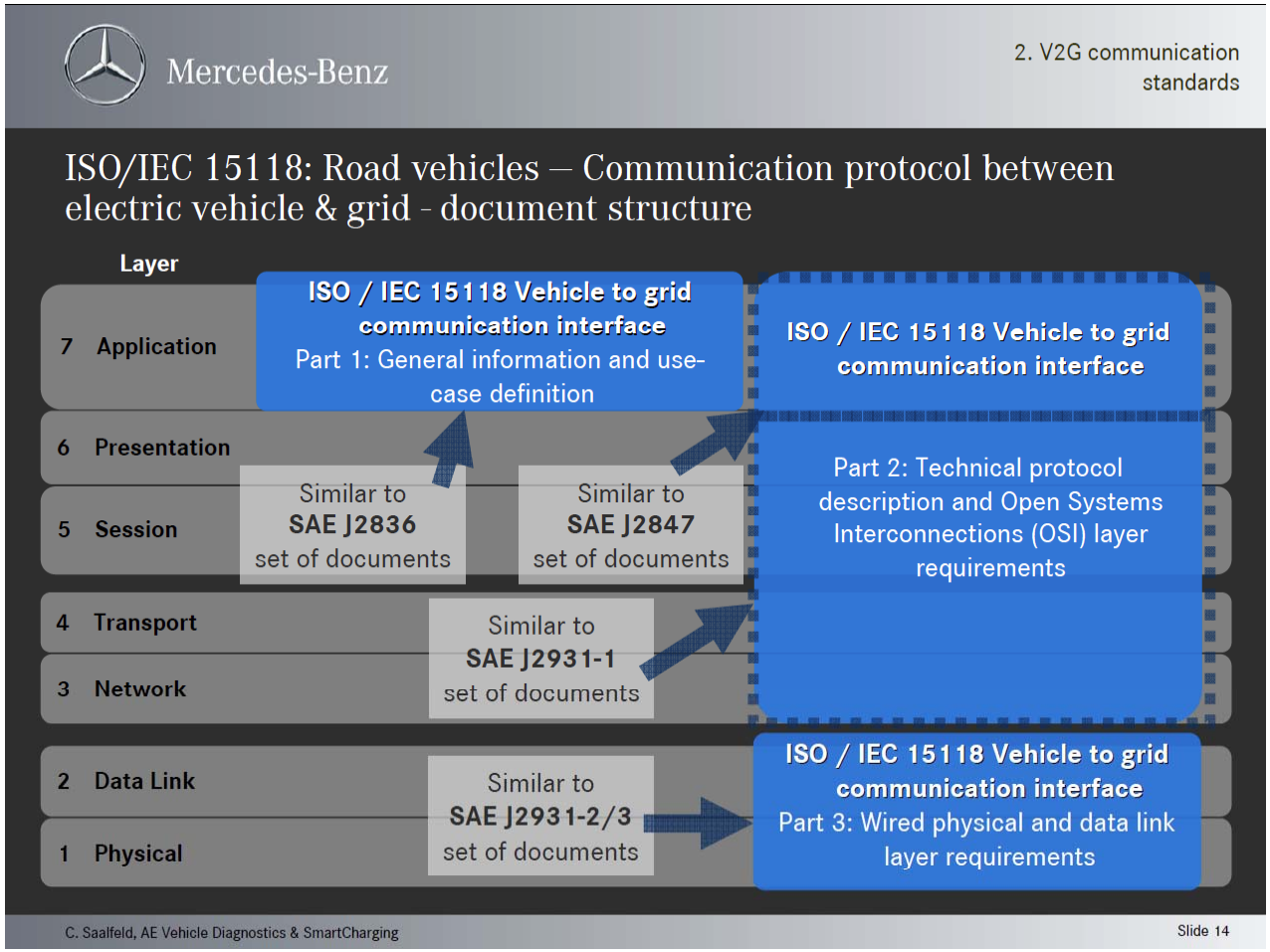
- ISO/IEC 15118 standard
  - Road Vehicles – Vehicle to grid communication interface



Ref.: Daimler AG Vector-Kongress 2010

EXI in Vehicle to Grid communication

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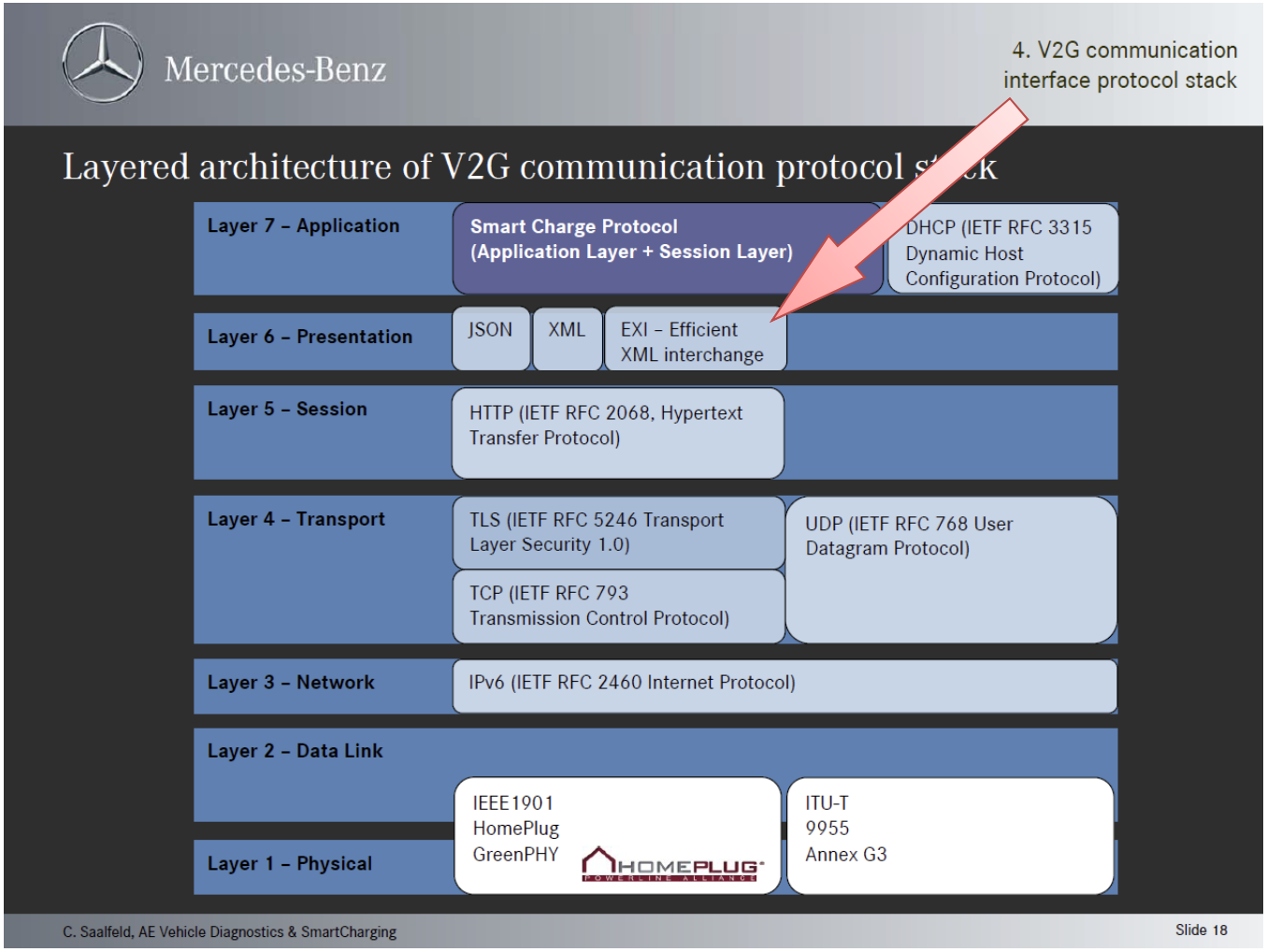
- ISO/IEC 15118
  - EXI is adopted for Layer 6: Presentation layer



Ref.: Daimler AG Vector-Kongress 2010

EXI in Vehicle to Grid communication

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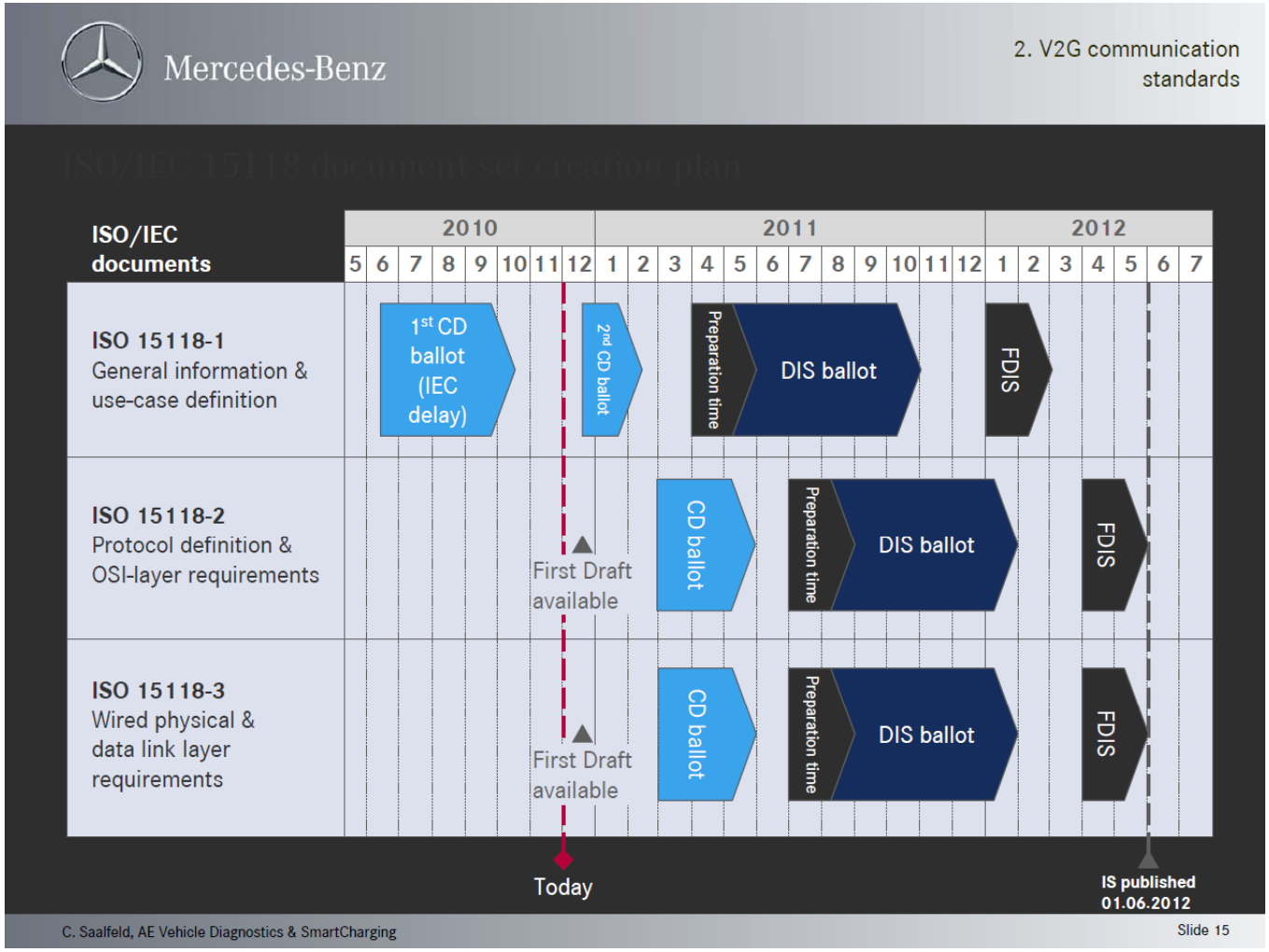
- ISO/IEC 15118
  - FDIS vote will be end of this year



Ref.: Daimler AG Vector-Kongress 2010

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What is EXI (Efficient XML Interchange)?

What is EXI?

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- Abbreviation of "**E**fficient **X**ML **I**nterchange"
- One of XML related technology. Developed for efficient XML Data exchange
- On of activity of W3C (World-Wide-Web Consortium)
  - EXI Working group is in charge for standard development
  - Became recommendation at March

What is XML ?

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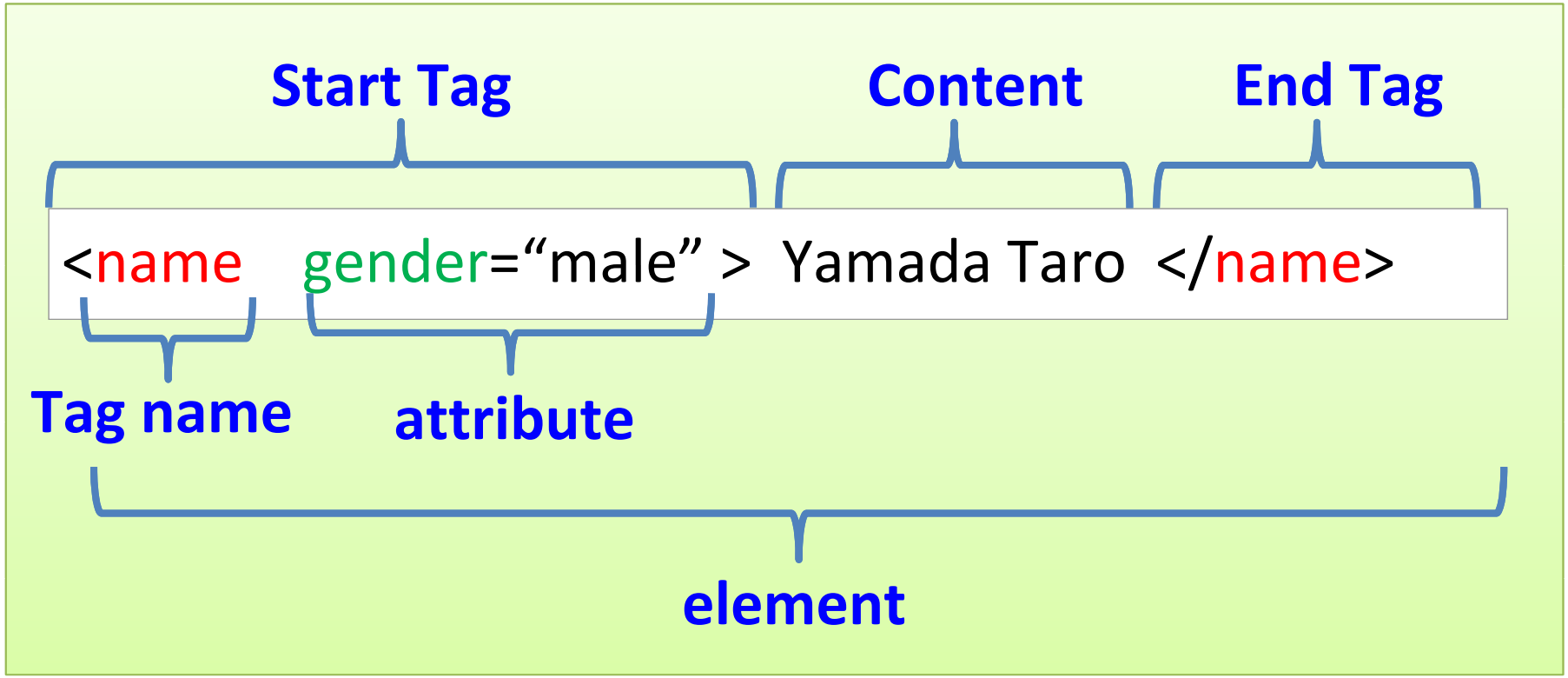
- XML : eXtensible Markup Language
- One of data format. Tagging for formatting the data
- HTML is well known tagging format



XML : hierarchical structure

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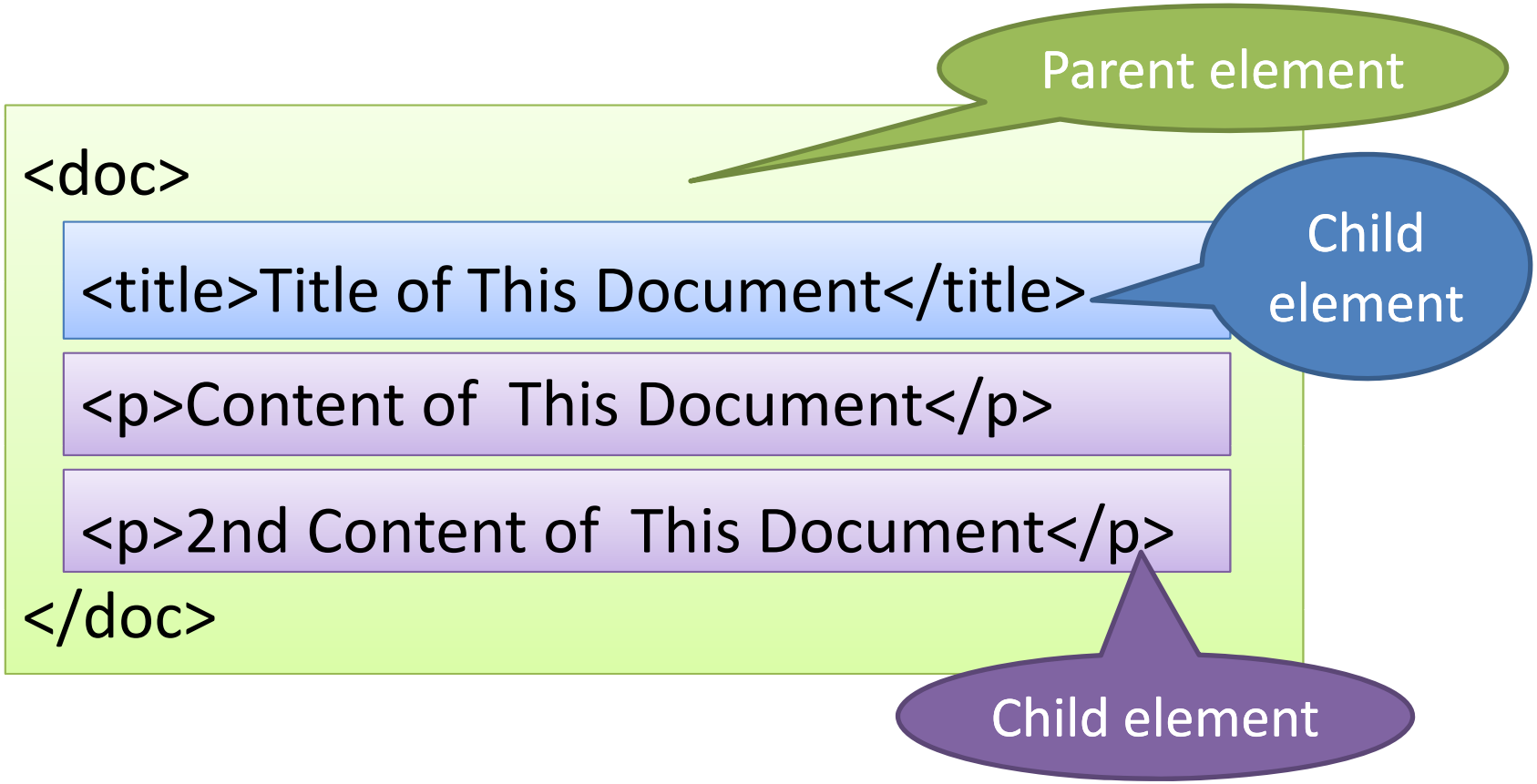
- Tag is used for giving the meaning of the data
- Surrounding data by tag for grouping the data



Sample of structured XML data

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Records

発注書	発注番号	0123456	発行日	01/01/26

商品コード	商品名	数量	単価
FMVMF660R3	MF6 600R	2	248,000
GP52BL1K2	GP ES210	1	620,000

Availability

Easy to describe the meaning of record

XML

```
<伝票>
  <発注番号> 0123456 </発注番号>
  <発行日> 010126 </発行日>
  <明細>
    <商品コード> FMVMF660R3 </商品コード>
    <商品名> MF6 600R </商品名>
    <数量> 2 </数量>
    <単価> 248000 </単価>
  </明細>
  <明細>
  <商品コード> GP52BL1K2 </商品コード>
    :
</伝票>
```

Record to XML mapping

XMLで表現された伝票

Advantage of XML(1) : easy to understand

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- Tagging is flexible mechanism for data formatting
  - Ex. CSV format : "1000",“Tanaka",“Jiro",“R&D div.“
- How can we recognize “1000”? Is it number of items or employee number ?
  - Ex. XML format :
    <EmployeeNumber>1000</EmployeeNumber>
- XML format is easy to understand by human. Also machine can identify which part of data is employee number

Ref : @IT article

Advantage of XML(2) : easy to enhance

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- If the data item is changed such as address field is added…
  - CSV: "1000","Tanaka","Jiro",**"Minato-ku Toranomon 1-1-1"**,"R&D div."
- In the case of CSV format, all systems are affected by the change since the system recognize the data item by order of item. Then many system must be modified
- In case of XML format, it is easy to insert new field since the data is identified by its tag

```
<Employee>
 <EmployeeNumber>1000</EmployeeNumber>
 <EmployeeName>
  <FamilyName>田中</FamilyName>
  <GivenName>次郎</GivenName>
 </EmployeeName>
 <Address>Minato-ku Toranomon 1-1-1</Address>
 <Department>総務</Department>
</Employee>
```

Ref: @IT article

Issues of XML

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File size

- XML is very flexible format but increases file size. XML file size is lager than proprietary data format twice to severalfold

Zip for data compression

- Zip is easy way for reduce the data size, but
- Inefficient for smaller file
- Compressing process requires match CPU cycles and memory(it is hard to small-footprint hardware)
- Decompressing process increases total processing time(decompressing time + XML processing time)

Aim of EXI

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Design goal of EXI

- Smaller or similar size than hand assembled format
- Independence from original file size. EXI should valid for smaller file
- Processing performance is better or similar than XML + ZIP decompression and XML Parse
- 100% compatible with original XML

W3C EXI Working group

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- **Member : 10 companies and organizations**
  - AgileDelta, Canon, Siemens, Navy Collage, MITRE, University of Helsinki, Stanford University, China Electronics Standardization Institute, FUJITSU
- **Chair: MITRE and FUJITSU**
- **Editor: AgileDelta and FUJITSU**

Compactness of EXI

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	FPML	JTLM
XML	3815 bytes	937005 bytes
XML+GZIP	1292 bytes	113904 bytes
EXI	345 bytes	7885 bytes
XML+GZIP / EXI	3.7	14.4

- FPML: Financial Product Markup Language (financial area)
- JTML: Joint Theater Logistics Management (military affair)

Processing performance

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- XML+GZIP is NOT efficient for high speed network
- EXI is efficient for any bandwidth

	11 mbps	54 mbps	High speed LAN (loopback)
EXI	6660 TPS	15448 TPS	84711 TPS
XML	1060 TPS	3722 TPS	5055 TPS
XML+GZIP	1680 TPS	3559 TPS	3963 TPS
EXI/XML+GZIP	4.0	4.2	16.8

How to compress (1) String table

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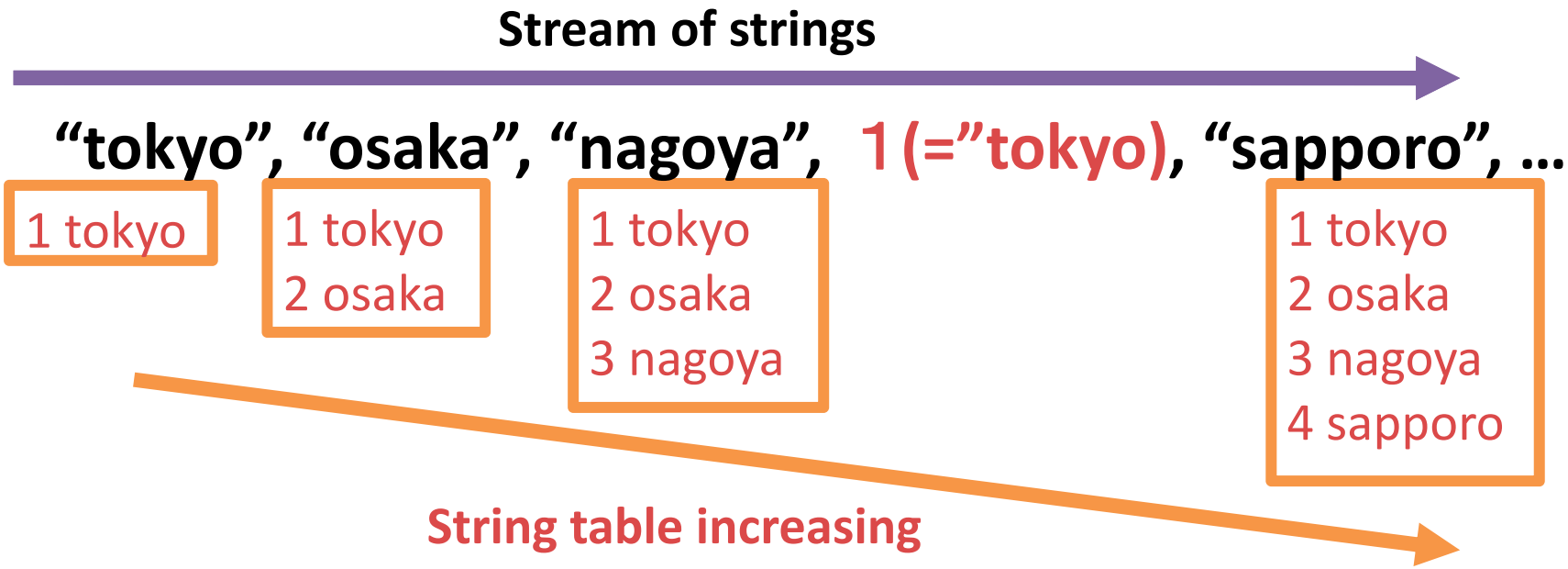
- Assign ID for strings



How to compress (2)　prediction by Schema

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- Use XML Schema as template of structure
- Omit the information which defined in XML Schema

Template(defined by XML Schema)

<A>String</A><B>String</B><C>String</C>

List of strings(“tokyo”, “osaka”, “nagoya”) is enough for the structure

<A>tokyo</A><B>osaka</B><C>nagoya</C>

How to compress (3) XML specific compression

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- Similar values are stored in same value list
- Compressing value list for high performance and better compression
- Values in same tag are stored in same value list
- As result;
  - High processing performance
    - Read: Nine times faster than XML+ZIP on average
    - Write: Six times faster than XML+ZIP on average
  - More compact than XML+ZIP for any original file size

Available resources

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- **EXI Processor**
  - OpenEXI (Open source project in Apache license)
  - EXIficient (Freeware in GPL license)
  - AgileDelta Efficient XML (Product)
- **Performance data (Reference documents)**
  - EXI Evaluation (W3C Note)
    http://www.w3.org/TR/exi-evaluation/

Plan of EXI

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- Implementation of processor
- 2011: Open source implementation by Java
  - Recognition and diffuse of EXI
- 2012: Implementation in C++
  - Embedding purpose
  - High performance
- 2013: Implementation in C
  - For smaller device such as sensor
  - For small footprint Web browser

EXI for V2G

Use case : OpenV2G

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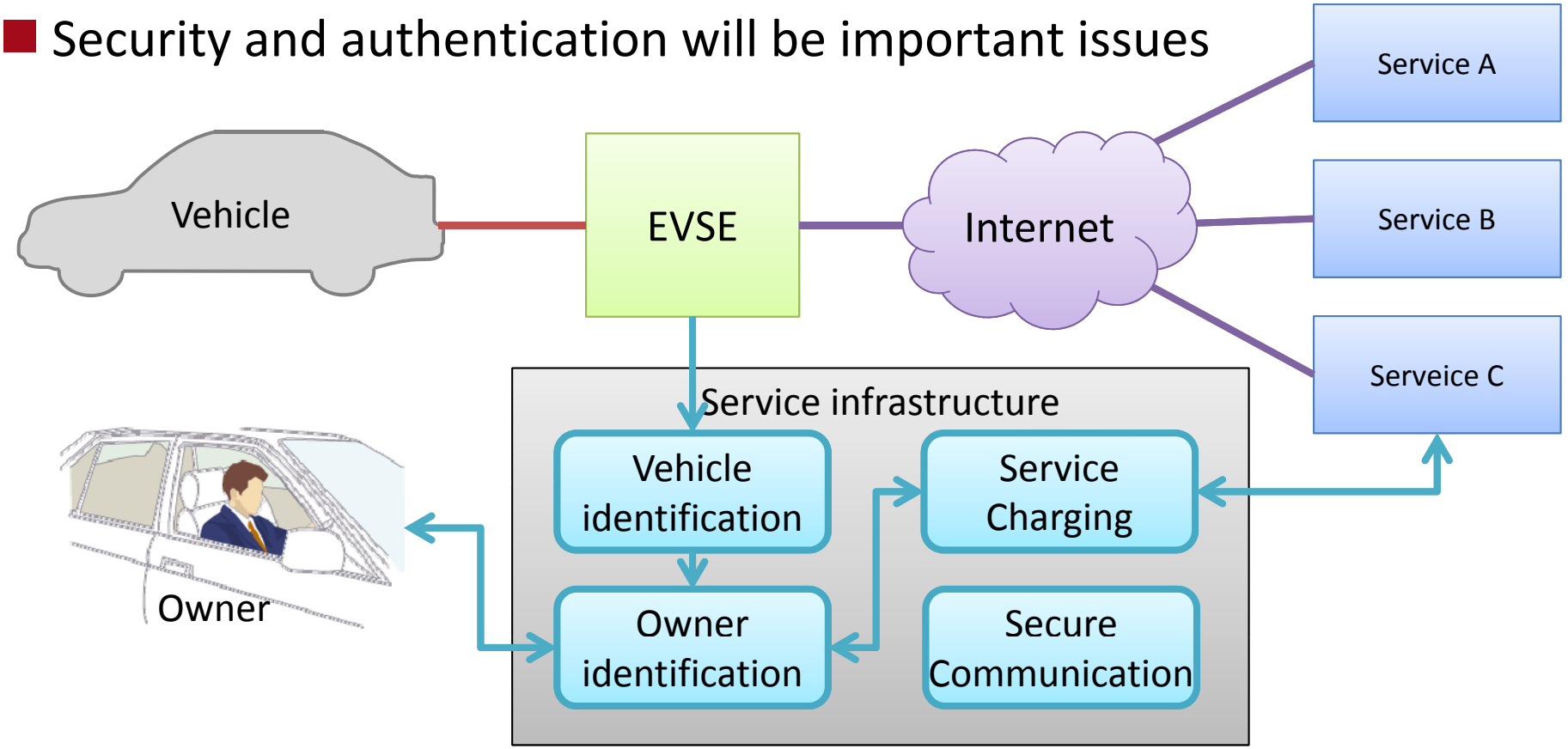
- OpenV2G

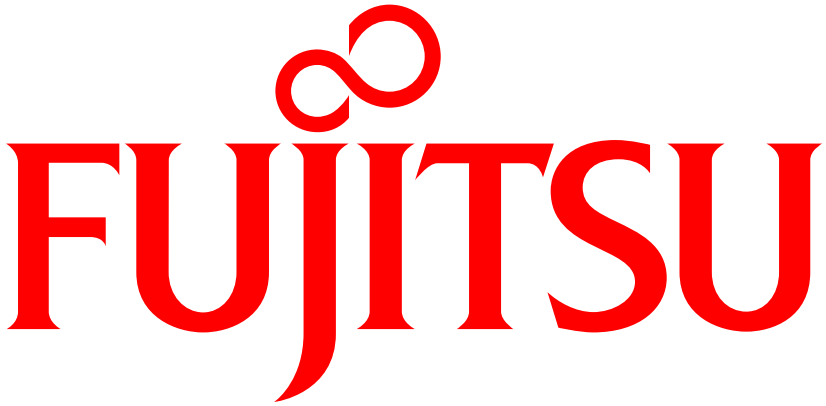
  - Open source activity leaded by Siemens
    - Siemens is member of W3C EXI WG
    - Siemens is enthusiastic about signature for EXI
  - The objective to start this project is primarily to support the ISO and IEC standardisation process
  - Specifications
    - ISO TC22/SC 3, W3C EXI, EXIficient, Smart Energy Profile 2.0
  - Latest version is 0.7 Release
  - focusing on the applicability of the openV2G library to the embedded domain in terms of processing speed and code footprint
    - the EXI codec alone is at 26 kB (compiled with gcc),
    - the complete V2G service implementation for a PEV application results in 46 kB, and
    - the complete V2G servie implementation for an EVSE application results in 42 kB.

http://openv2g.sourceforge.net/

Connection to Open network

- ISO15118 is using specifications which are common in internet
  - IPv6, HTTP, XML, EXI, etc.
- Then it is easy to connect EV Internet via EVSE EV. EV may use the services on Internet
- Security and authentication will be important issues





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