

Serialization

- 2003 founded in Switzerland and China,
- 2014 founded in Germany as sales office to control European sales
- 2017 Buy in of Software competency (IIoT, Industry 4.0, Industry 2025, Industry Apps)

- Locations:



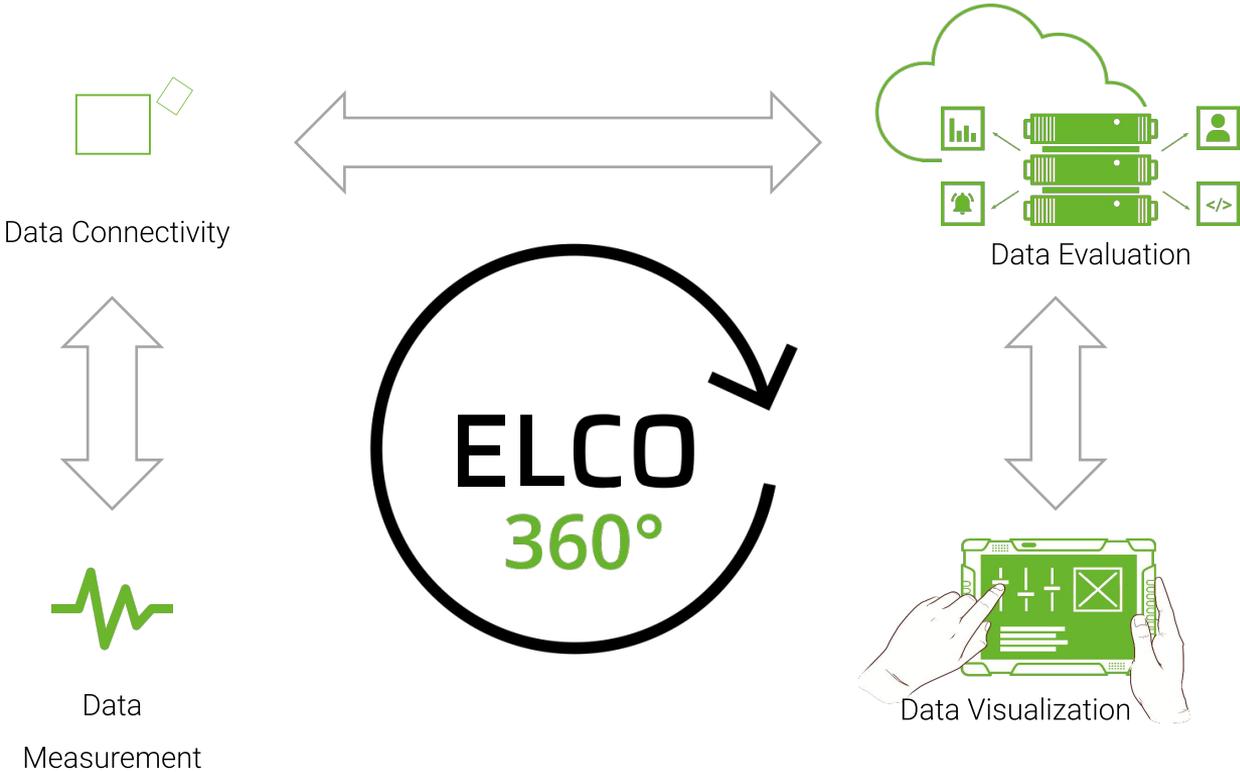
- Sales Europe
(Software, Hardware, Services)
- Software development
- 25 Employees and growing
(Goal: 50 Employees in 2025)



- Sales Asia
(Software, Hardware, Services)
- Hardware development and production
- 800 Employees and growing

From the Sensor to the Human and back again

The source of our success



Serialization

A word cloud of data formats and protocols arranged in a semi-circle. The words are in various colors including green, red, and yellow. The words include:

- XML-RPC
- Netstrings
- Simple-KMIP
- JSON
- Bond
- Fast-Infoset
- Apache-Binary-Encodings
- Property-list
- Candle-Markup
- FHIR2
- VelocityPack-(VPack)
- OpenDDL
- ASN.1-expressions
- Java-serialization
- edn
- Binn
- Protocol-Buffers-(protobuf)
- Thrift
- Efficient-XML-Interchange-(EXI)
- BSON
- OGDL
- Structured-Data-eXchange-Formats
- Data::Dumper-format-(Core-Perl-Module)
- eXternal-Data-Representation-(XDR)
- PHP
- Comma-separated-values-(CSV)
- MessagePack
- YAML
- Pickle
- Ion
- D-Bus-Message-Protocol
- Fast-Binary-Encoding
- Sereal
- Cap'n-Proto
- Apache-Parquet
- Named-Binary-Tag
- XML
- GVariant
- OPC-UA-Binary
- Argdata
- Smile
- Apache-Arrow
- Named-Binary-Tag
- Feather
- Colfer
- FlatBuffers
- transit
- ER7
- UBJSON
- Bencode
- CBOR
- CDR

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History

- Serialization exists since start of computer sciences
- 1980: First standard - Xerox Network Systems Courier RPC
- 1987: Sun published XDR
- 1990's: CORBA, COM, RMI distribute
- Late 1990's: Bigger memory and bandwidths allow human readable formats (XML)
- 2000: Java Script Object Notation (JSON) first standard 2013
- YAML in 2001
- ProtoBuf 2001-2008
- Flatbuffers 2014
- 2019: New Java Serialisation?
<http://cr.openjdk.java.net/~briangoetz/amber/serialization.html>

Serialisation methods

Custom serialization method

NATS



- Simple, secure and high performance open source messaging system

NATS documentation:

“Unlike traditional messaging systems that use a binary message format that require an API to consume,

the **text-based NATS protocol** makes it **easy to implement** clients in a **wide variety of programming and scripting languages.**”

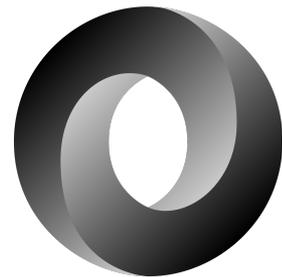
NATS



```
> SUB foo.* 90
< +OK

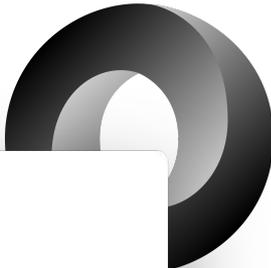
> PUB foo.bar 5
> hello
< +OK

< MSG foo.bar 90 5
< hello
```



JSON

Douglas Crockford: “It’s not too bad.”



```
{
  "id": 118,
  "name": "Serialisierung in Zeiten von JSON – ein alter Hut?",
  "date": {
    "start": "2019-07-04T19:00:00.001Z",
    "end": "2014-07-04T21:00:00.782Z",
    "duration": "2h"
  },
  "presenters": [
    "Michael Barth",
    "Johannes Tandler"
  ],
  "participants": [
    "Max Mustermann"
  ]
}
```

Xi - Editor



- Text editor (framework) by Raph Levien
- Initially developed for Fuchsia
- Micro service architecture

Raph Levien:

I considered binary formats, but the actual improvement in performance would be completely in the noise.

Using JSON considerably lowers friction for developing plug-ins, as it's available out of the box for most modern languages, and there are plenty of the libraries available for the other ones.

IoTHub Developer



- Usage in REST API and for unknown data structures
- Encoding/Decoding in most language available
- Handling differs from language to language
- Best usage in JS

Use case:

- Transfer a SQL result set between Golang and JavaScript
- Having test validating handling
- Some code ...



Java Serializable

“He [Mark Reinhold] estimates that at least a third —maybe even half— of Java vulnerabilities have involved serialization”

```
import java.io.BufferedWriter;
import java.io.ByteArrayOutputStream;
import java.io.IOException;
import java.io.ObjectOutputStream;
import java.io.Serializable;
import java.time.LocalDateTime;

public class Example implements Serializable {

    private static final long serialVersionUID = -5034291636966857972L;

    private int id;

    private String name;

    private String[] presenters;

    private String[] participants;

    private Date date;

    public class Date implements Serializable {
        private static final long serialVersionUID = -1136508262259840244L;

        private LocalDateTime start;
        private LocalDateTime end;

        private String duration;

        public LocalDateTime getStart() {
```



Stream magic

AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72



Stream version

AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72



Flag for new object



```
AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72
```



Flag for new class

AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72



Length of class name

AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72



class name



```
AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72
```



Serial version id

AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72



Some flags



```
AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72
```



No of fields in class



```
AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72
```



Type of first field



```

AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72

```



Length of field name

```
AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72
```



Name of field

```
AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72
```



Field content of title field

```
AC ED 00 05 73 72 00 07 45 78 61 6D 70 6C 65 BA 22 9A 6D D2 DE E3 0C 02 00 05 49
00 02 69 64 4C 00 04 64 61 74 65 74 00 0E 4C 45 78 61 6D 70 6C 65 24 44 61 74 65
3B 4C 00 04 6E 61 6D 65 74 00 12 4C 6A 61 76 61 2F 6C 61 6E 67 2F 53 74 72 69 6E
67 3B 5B 00 0C 70 61 72 74 69 63 69 70 61 6E 74 73 74 00 13 5B 4C 6A 61 76 61 2F
6C 61 6E 67 2F 53 74 72 69 6E 67 3B 5B 00 0A 70 72 65 73 65 6E 74 65 72 73 71 00
7E 00 03 78 70 00 00 00 76 73 72 00 0C 45 78 61 6D 70 6C 65 24 44 61 74 65 F0 3A
4F C1 C7 B4 AB 0C 02 00 04 4C 00 08 64 75 72 61 74 69 6F 6E 71 00 7E 00 02 4C 00
03 65 6E 64 74 00 19 4C 6A 61 76 61 2F 74 69 6D 65 2F 4C 6F 63 61 6C 44 61 74 65
54 69 6D 65 3B 4C 00 05 73 74 61 72 74 71 00 7E 00 06 4C 00 06 74 68 69 73 24 30
74 00 09 4C 45 78 61 6D 70 6C 65 3B 78 70 74 00 02 32 68 73 72 00 0D 6A 61 76 61
2E 74 69 6D 65 2E 53 65 72 95 5D 84 BA 1B 22 48 B2 0C 00 00 78 70 77 08 05 00 00
07 E3 07 04 EA 78 73 71 00 7E 00 0A 77 08 05 00 00 07 E3 07 04 EC 78 71 00 7E 00
04 74 00 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 75 72 00 13 5B 4C 6A 61 76 61 2E 6C 61 6E 67 2E 53 74 72 69 6E 67 3B AD D2
56 E7 E9 1D 7B 47 02 00 00 78 70 00 00 00 01 74 00 0E 4D 61 78 20 4D 75 73 74 65
72 6D 61 6E 6E 75 71 00 7E 00 0E 00 00 02 74 00 0D 4D 69 63 68 61 65 6C 20 42
61 72 74 68 74 00 10 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72
```





Protobuf

language-neutral, platform-neutral extensible mechanism for serializing structured data

```
syntax = "proto3";

package jug;
option go_package = "git.monkey-works.de/jug";

message Presentation {
    int32 id = 1;

    string name = 2;

    Date date = 3;

    repeated string presenters = 4;

    repeated string participants = 5;
}

message Date {
    string start = 1;

    string end = 2;

    string duration = 3;
}
```





08 76 12 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 1A 38 0A 18 32 30 31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30
30 31 5A 12 18 32 30 31 34 2D 30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 37 38
32 5A 1A 02 32 68 22 0D 4D 69 63 68 61 65 6C 20 42 61 72 74 68 22 10 4A 6F 68 61
6E 6E 65 73 20 54 61 6E 64 6C 65 72 2A 0E 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E
6E



Type and number of field

↓
08 76 12 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 1A 38 0A 18 32 30 31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30
30 31 5A 12 18 32 30 31 34 2D 30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 37 38
32 5A 1A 02 32 68 22 0D 4D 69 63 68 61 65 6C 20 42 61 72 74 68 22 10 4A 6F 68 61
6E 6E 65 73 20 54 61 6E 64 6C 65 72 2A 0E 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E
6E



Value of field 1 (118)

08 76 12 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 1A 38 0A 18 32 30 31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30
30 31 5A 12 18 32 30 31 34 2D 30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 37 38
32 5A 1A 02 32 68 22 0D 4D 69 63 68 61 65 6C 20 42 61 72 74 68 22 10 4A 6F 68 61
6E 6E 65 73 20 54 61 6E 64 6C 65 72 2A 0E 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E
6E



Type and number of field

08 76 12 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 1A 38 0A 18 32 30 31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30
30 31 5A 12 18 32 30 31 34 2D 30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 37 38
32 5A 1A 02 32 68 22 0D 4D 69 63 68 61 65 6C 20 42 61 72 74 68 22 10 4A 6F 68 61
6E 6E 65 73 20 54 61 6E 64 6C 65 72 2A 0E 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E
6E



Length of string

08 76 12 34 53 65 72 69 61 6C 69 73 69 65 72 75 6E 67 20 69 6E 20 5A 65 69 74 65
6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65 69 6E 20 61 6C 74 65 72 20 48 75
74 3F 1A 38 0A 18 32 30 31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30
30 31 5A 12 18 32 30 31 34 2D 30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 37 38
32 5A 1A 02 32 68 22 0D 4D 69 63 68 61 65 6C 20 42 61 72 74 68 22 10 4A 6F 68 61
6E 6E 65 73 20 54 61 6E 64 6C 65 72 2A 0E 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E
6E

Elco IoT Hub



Reasons for Protobuf:

- Industrial IoT Platform
 - Micro service architecture
 - Services written in Go, NodeJs, C#
 - Protobuf used for service to service communication and persistence
- Small messages
 - Fast (for our use case)
 - Language independent
 - Build in versioning
 - Big community

IoTHub Developer



- Usage in gRPC between agents and IoTHub
- Big amount of generated code
- In some cases hard work with IDEs (Goland vs. Rider)
- But usage is not complex

Use case:

- Agent - Gateway communication
- Gateway service with two functions
- Some code ...



Flatbuffers

language-neutral, platform-neutral extensible mechanism for serializing structured data

```
namespace jug;

table Presentation {
  id: int32;
  name: string;
  date: Date;
  presenters: [string];
  participants: [string];
}

table Date {
  start: string;
  end: string;
  duration: string;
}

root_type Presentation;
```





```
14 00 00 00 00 00 0E 00 18 00 14 00 0C 00 10 00 08 00 04 00 0E 00 00 00 B0 00 00 00 C8
00 00 00 0C 00 00 00 4C 00 00 00 76 00 00 00 34 00 00 00 53 65 72 69 61 6C 69 73 69 65
72 75 6E 67 20 69 6E 20 5A 65 69 74 65 6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65
69 6E 20 61 6C 74 65 72 20 48 75 74 3F 00 00 0A 00 10 00 08 00 0C 00 04 00 0A 00 00 00
0C 00 00 00 30 00 00 00 0C 00 00 00 02 00 00 00 32 68 00 00 18 00 00 00 32 30 31 39 2D
30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 18 00 00 00 32 30
31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 01 00 00
00 04 00 00 00 0E 00 00 00 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E 6E 00 00 02 00 00 00
20 00 00 00 04 00 00 00 10 00 00 00 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72 00
00 00 00 0D 00 00 00 4D 69 63 68 61 65 6C 20 42 61 72 74 68 00 00 00
```



Position of root table = 20

```
14 00 00 00 00 00 0E 00 18 00 14 00 0C 00 10 00 08 00 04 00 0E 00 00 00 B0 00 00 00 C8
00 00 00 0C 00 00 00 4C 00 00 00 76 00 00 00 34 00 00 00 53 65 72 69 61 6C 69 73 69 65
72 75 6E 67 20 69 6E 20 5A 65 69 74 65 6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65
69 6E 20 61 6C 74 65 72 20 48 75 74 3F 00 00 0A 00 10 00 08 00 0C 00 04 00 0A 00 00 00
0C 00 00 00 30 00 00 00 0C 00 00 00 02 00 00 00 32 68 00 00 18 00 00 00 32 30 31 39 2D
30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 18 00 00 00 32 30
31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 01 00 00
00 04 00 00 00 0E 00 00 00 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E 6E 00 00 02 00 00 00
20 00 00 00 04 00 00 00 10 00 00 00 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72 00
00 00 00 0D 00 00 00 4D 69 63 68 61 65 6C 20 42 61 72 74 68 00 00 00
```



Rel. position of vtable = -14

```
14 00 00 00 00 00 0E 00 18 00 14 00 0C 00 10 00 08 00 04 00 0E 00 00 00 B0 00 00 00 C8
00 00 00 0C 00 00 00 4C 00 00 00 76 00 00 00 34 00 00 00 53 65 72 69 61 6C 69 73 69 65
72 75 6E 67 20 69 6E 20 5A 65 69 74 65 6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65
69 6E 20 61 6C 74 65 72 20 48 75 74 3F 00 00 0A 00 10 00 08 00 0C 00 04 00 0A 00 00 00
0C 00 00 00 30 00 00 00 0C 00 00 00 02 00 00 00 32 68 00 00 18 00 00 00 32 30 31 39 2D
30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 18 00 00 00 32 30
31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 01 00 00
00 04 00 00 00 0E 00 00 00 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E 6E 00 00 02 00 00 00
20 00 00 00 04 00 00 00 10 00 00 00 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72 00
00 00 00 0D 00 00 00 4D 69 63 68 61 65 6C 20 42 61 72 74 68 00 00 00
```



Size of vtable = 20

0E 00 18 00 14 00 0C 00 10 00 08 00 04 00 | 0E 00 00 00 B0 00 00 00 C8
00 00 00 0C 00 00 00 4C 00 00 00 76 00 00 00 34 00 00 00 53 65 72 69 61 6C 69 73 69 65
72 75 6E 67 20 69 6E 20 5A 65 69 74 65 6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65
69 6E 20 61 6C 74 65 72 20 48 75 74 3F 00 00 0A 00 10 00 08 00 0C 00 04 00 0A 00 00 00
0C 00 00 00 30 00 00 00 0C 00 00 00 02 00 00 00 32 68 00 00 18 00 00 00 32 30 31 39 2D
30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 18 00 00 00 32 30
31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 01 00 00
00 04 00 00 00 0E 00 00 00 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E 6E 00 00 02 00 00 00
20 00 00 00 04 00 00 00 10 00 00 00 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72 00
00 00 00 0D 00 00 00 4D 69 63 68 61 65 6C 20 42 61 72 74 68 00 00 00



Object size



```
14 00 00 00 00 00 0E 00 18 00 14 00 0C 00 10 00 08 00 04 00 |0E 00 00 00 B0 00 00 00 C8
00 00 00 0C 00 00 00 4C 00 00 00 76 00 00 00 34 00 00 00 53 65 72 69 61 6C 69 73 69 65
72 75 6E 67 20 69 6E 20 5A 65 69 74 65 6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65
69 6E 20 61 6C 74 65 72 20 48 75 74 3F 00 00 0A 00 10 00 08 00 0C 00 04 00 0A 00 00 00
0C 00 00 00 30 00 00 00 0C 00 00 00 02 00 00 00 32 68 00 00 18 00 00 00 32 30 31 39 2D
30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 18 00 00 00 32 30
31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 01 00 00
00 04 00 00 00 0E 00 00 00 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E 6E 00 00 02 00 00 00
20 00 00 00 04 00 00 00 10 00 00 00 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72 00
00 00 00 0D 00 00 00 4D 69 63 68 61 65 6C 20 42 61 72 74 68 00 00 00
```



Relative position of first field (id = 20)



```
14 00 00 00 00 00 0E 00 18 00 14 00 0C 00 10 00 08 00 04 00 | 0E 00 00 00 B0 00 00 00 C8
00 00 00 0C 00 00 00 4C 00 00 00 76 00 00 00 34 00 00 00 53 65 72 69 61 6C 69 73 69 65
72 75 6E 67 20 69 6E 20 5A 65 69 74 65 6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65
69 6E 20 61 6C 74 65 72 20 48 75 74 3F 00 00 0A 00 10 00 08 00 0C 00 04 00 0A 00 00 00
0C 00 00 00 30 00 00 00 0C 00 00 00 02 00 00 00 32 68 00 00 18 00 00 00 32 30 31 39 2D
30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 18 00 00 00 32 30
31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 01 00 00
00 04 00 00 00 0E 00 00 00 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E 6E 00 00 02 00 00 00
20 00 00 00 04 00 00 00 10 00 00 00 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72 00
00 00 00 0D 00 00 00 4D 69 63 68 61 65 6C 20 42 61 72 74 68 00 00 00
```



Value of field id = 118

```
14 00 00 00 00 00 0E 00 18 00 14 00 0C 00 10 00 08 00 04 00 0E 00 00 00 B0 00 00 00 C8
00 00 00 0C 00 00 00 4C 00 00 00 76 00 00 00 34 00 00 00 53 65 72 69 61 6C 69 73 69 65
72 75 6E 67 20 69 6E 20 5A 65 69 74 65 6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65
69 6E 20 61 6C 74 65 72 20 48 75 74 3F 00 00 0A 00 10 00 08 00 0C 00 04 00 0A 00 00 00
0C 00 00 00 30 00 00 00 0C 00 00 00 02 00 00 00 32 68 00 00 18 00 00 00 32 30 31 39 2D
30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 18 00 00 00 32 30
31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 01 00 00
00 04 00 00 00 0E 00 00 00 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E 6E 00 00 02 00 00 00
20 00 00 00 04 00 00 10 00 00 00 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72 00
00 00 00 0D 00 00 00 4D 69 63 68 61 65 6C 20 42 61 72 74 68 00 00 00
```



Relative position of second field (name = 12)

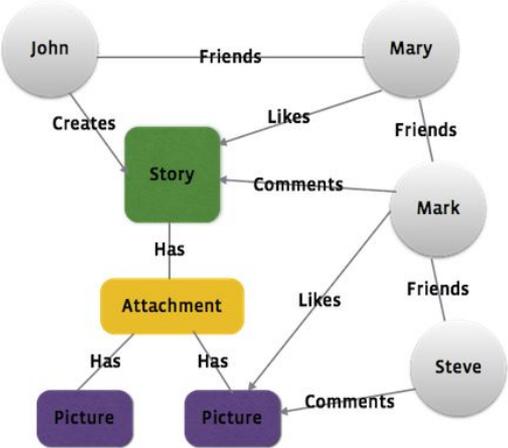


```
14 00 00 00 00 00 0E 00 18 00 14 00 0C 00 10 00 08 00 04 00 | 0E 00 00 00 B0 00 00 00 C8
00 00 00 0C 00 00 00 4C 00 00 00 76 00 00 00 34 00 00 00 53 65 72 69 61 6C 69 73 69 65
72 75 6E 67 20 69 6E 20 5A 65 69 74 65 6E 20 76 6F 6E 20 4A 53 4F 4E 20 E2 80 93 20 65
69 6E 20 61 6C 74 65 72 20 48 75 74 3F 00 00 0A 00 10 00 08 00 0C 00 04 00 0A 00 00 00
0C 00 00 00 30 00 00 00 0C 00 00 00 02 00 00 00 32 68 00 00 18 00 00 00 32 30 31 39 2D
30 37 2D 30 34 54 32 31 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 18 00 00 00 32 30
31 39 2D 30 37 2D 30 34 54 31 39 3A 30 30 3A 30 30 2E 30 30 31 5A 00 00 00 00 01 00 00
00 04 00 00 00 0E 00 00 00 4D 61 78 20 4D 75 73 74 65 72 6D 61 6E 6E 00 00 02 00 00 00
20 00 00 00 04 00 00 00 10 00 00 00 4A 6F 68 61 6E 6E 65 73 20 54 61 6E 64 6C 65 72 00
00 00 00 0D 00 00 00 4D 69 63 68 61 65 6C 20 42 61 72 74 68 00 00 00
```




Facebook - Android

- Segments of social graph stored on devices



Reasons for Flatbuffers:

- Story load time from disk cache is reduced from 35 ms to 4 ms per story
- Transient memory allocations are reduced by 75 percent
- Cold start time is improved by 10-15 percent
- We have reduced storage size by 15 percent

IoTHub Developer

- Usage as communication protocol between JavaScript (V8) and GoLang
- Similar handling in the different target languages
- Strings, vectors need some effort preparing serialization
- Deserialization on the other side is simple
- Access to single fields without dedicated deserialization step



Use case:

- SQL Select query
- `Sql.query(db, "SELECT * FROM person;")`
- Some code ...

Benchmarks

Benchmarks

	FlatBuffers (binary)	Protocol Buffers LITE	Rapid JSON	FlatBuffers (JSON)	pugixml	Raw structs
Decode + Traverse + Dealloc (1 million times, seconds)	0.08	302	583	105	196	0.02
Decode / Traverse / Dealloc (breakdown)	0 / 0.08 / 0	220 / 0.15 / 81	294 / 0.9 / 287	70 / 0.08 / 35	41 / 3.9 / 150	0 / 0.02 / 0
Encode (1 million times, seconds)	3.2	185	650	169	273	0.15
Wire format size (normal / zlib, bytes)	344 / 220	228 / 174	1475 / 322	1029 / 298	1137 / 341	312 / 187
Memory needed to store decoded wire (bytes / blocks)	0 / 0	760 / 20	65689 / 4	328 / 1	34194 / 3	0 / 0
Transient memory allocated during decode (KB)	0	1	131	4	34	0
Generated source code size (KB)	4	61	0	4	0	0
Field access in handwritten traversal code	typed accessors	typed accessors	manual error checking	typed accessors	manual error checking	typed but no safety
Library source code (KB)	15	some subset of 3800	87	43	327	0

Flatbuffers > Protocol Buffers > JSON

Benchmarks

benchmark	iter	time/iter	bytes/op	allocs/op	tt.time	tt.bytes	time/alloc
BenchmarkEasyJsonMarshal	1000000	1656 ns/op	784 B/op	5 allocs/op	1.66 s	78400 KB	331.20 ns/alloc
BenchmarkEasyJsonUnmarshal	1000000	1623 ns/op	160 B/op	4 allocs/op	1.62 s	16000 KB	405.75 ns/alloc
BenchmarkFlatBuffersMarshal	5000000	360 ns/op	0 B/op	0 allocs/op	1.80 s	0 KB	0.00 ns/alloc
BenchmarkFlatBuffersUnmarshal	5000000	297 ns/op	112 B/op	3 allocs/op	1.49 s	56000 KB	99.00 ns/alloc
BenchmarkGogoprotobufMarshal	10000000	211 ns/op	64 B/op	1 allocs/op	2.11 s	64000 KB	211.00 ns/alloc
BenchmarkGogoprotobufUnmarshal	5000000	268 ns/op	96 B/op	3 allocs/op	1.34 s	48000 KB	89.33 ns/alloc

Protocol Buffers > FlatBuffers >> JSON

Benchmarks

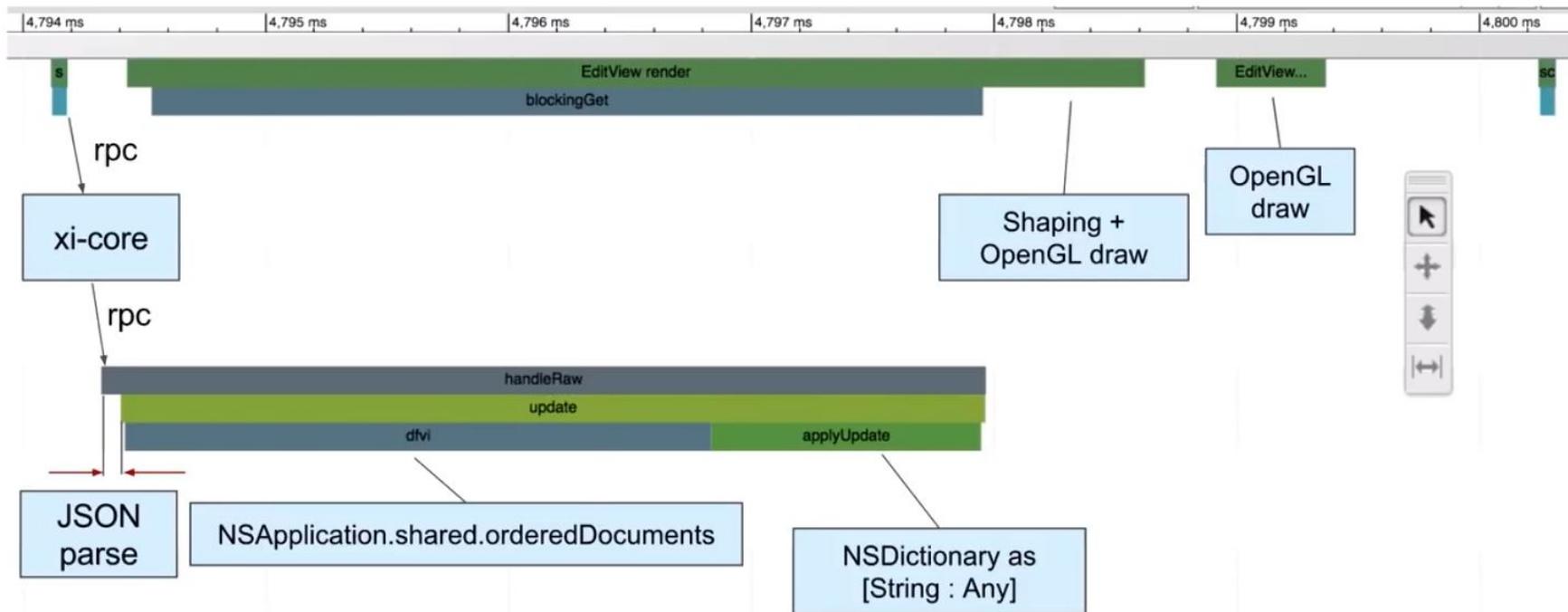
benchmark	iter	time/iter
-----	----	-----
BenchmarkMarshalByGogoProtoBuf-4	10000000	109 ns/op
BenchmarkUnmarshalByGogoProtoBuf-4	5000000	398 ns/op
BenchmarkMarshalByFlatBuffers-4	5000000	346 ns/op
BenchmarkUnmarshalByFlatBuffers_withFields-4	10000000	147 ns/op
BenchmarkMarshalByEasyjson-4	5000000	313 ns/op
BenchmarkUnmarshalByEasyjson-4	3000000	474 ns/op

Protocol Buffers = FlatBuffers > JSON

XI - Editor



Frame trace breakdown (scroll at 165Hz)

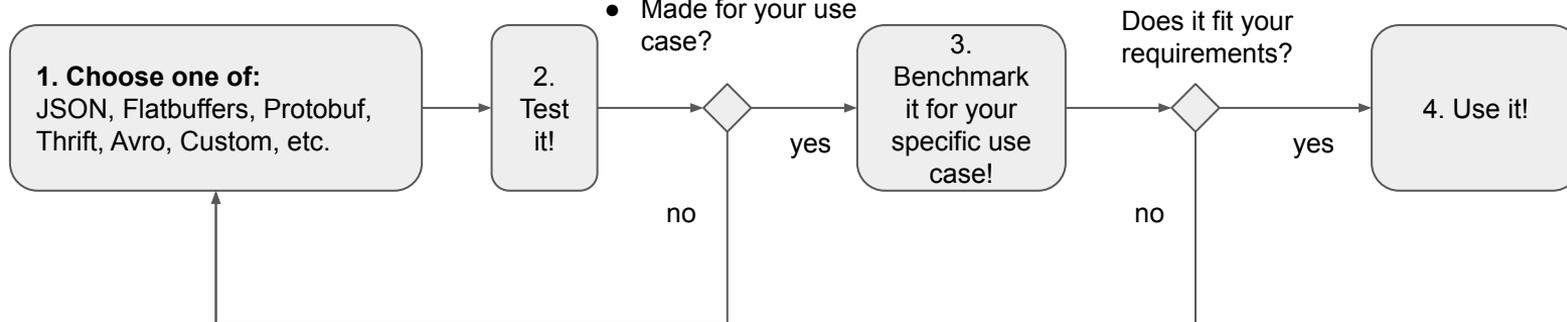


Conclusion

Conclusion

Is it:

- Available for your programming language?
- Nice to use?
- Good to integrate into CI?
- Maintained?
- Made for your use case?



Thanks for listening!

Sources

- https://en.wikipedia.org/wiki/Comparison_of_data-serialization_formats
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