Protocol Technology

ASN.1

Gusztáv Adamis
BME TMIT
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Data Specification

- High level data structure definition
  - Only structure
  - Can be complicated
- Abstract Data Types (~classes)
  - Data structure + operations
  - Axiomatic
    - ACT ONE in SDL
  - Pragmatic, constructive
    - C, C++, …

ASN.1

- Abstract Syntax Notation One
  - High level structures
  - Originally for Application layer protocols
  - Now mainl for mobile protocols
- Two parts
  - Data Specification
  - Encoding Rules
    - BER – Basic Encoding Rules
      - CER – Canonical Encoding Rules
      - DER – Distinguished Encodig Rules
      - variations of BER
    - PER – Packed Encoding Rules
      - compact encoding
      - for radio interface protocols

ASN.1 Syntax

- UPPERCASE and lowercase characters different
- Keywords – all capital
- Identifiers – start with letter, contains letters, numbers, and -;
  - two consequitive - not allowed
- Types – first letter: capital
- Other identifiers (e.g. record fields, enumerated literals) – first letter: lowercase
- -- comment till the end of line

ASN.1 Data Type Specification

- Universal Types
  - INTEGER
  - BOOLEAN
  - REAL
  - NULL
  - BIT STRING – ‘1010’B (length=4)
  - OCTET STRING – ‘AB12’O (length=2)
  - IA5String – ”Hello”
    - other string types: GraphicalString, NumericalString, PrintableString, etc.

Construction Rules

- SEQUENCE ~structure, record
- SET – similar, but fields can be transmitted in any order
- OPTIONAL – may be omitted
- DEFAULT
- CHOICE – union (only one of the fields)

```
PersonalData ::= SEQUENCE {
  age          INTEGER DEFAULT 10,
  married      BOOLEAN OPTIONAL }
```

Construction Rules ctd.

- SEQUENCE OF / SET OF
  - arrays
  - SEQUENCE OF INTEGER
  - SET OF PersonalData

- ENUMERATED

```
Colors ::= ENUMERATED { blue, green, red}
```

Sub-Types

- Telephone-Number ::= IA5String(FROM('1'|'2'|'3'|'4'|'5'|'6'|'7'|'8'|'9'|'0'|'*'|'#'))
- Small-Integer ::= INTEGER(0..9)
- Array64 ::= SEQUENCE SIZE (64..64) OF INTEGER
  - or
- Array64 ::= SEQUENCE SIZE (64) OF INTEGER
- ArrayMax64::= SEQUENCE SIZE (1..64) OF INTEGER
- Bit8 ::= BIT STRING SIZE(8)
- SmallPrimes ::= INTEGER(2|3|5|7)

ASN.1 – Encoding - Introduction

```
Coordinate ::= SET {
    x INTEGER,
    y INTEGER
    }
```

- in which order the fields transmitted?

```
Coordinate ::= SEQUENCE {
    x INTEGER OPTIONAL,
    y INTEGER OPTIONAL
    }
```

- if only one field transmitted: which?

ASN.1 Encoding – User defined TAG values

```
Coordinate ::= SET {
    x [0] INTEGER,
    y [1] INTEGER
    }
```

- to interpret: x is type 0, which is actually an INTEGER

```
Coordinate ::= SEQUENCE {
    x [0] INTEGER OPTIONAL,
    y [1] INTEGER OPTIONAL
    }
```

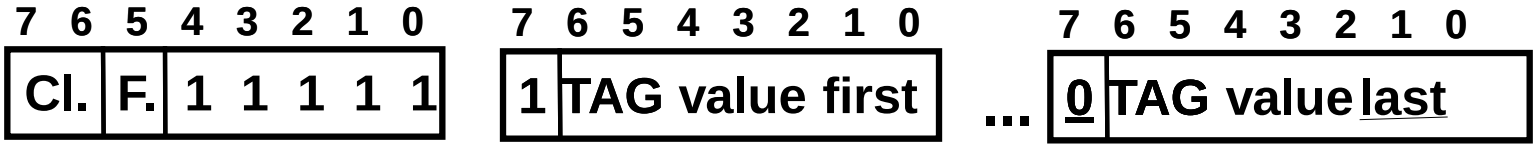
BER

- Each data is sent as a triplet:
- TAG + Length + Value
  - TAG ~ Type Code
  - Simple Types
    - Value is really the value
  - Structured Types
    - At Value new TAG+Length+Value triplet(s) stand recoursively
    - E.g.: Value of a SEQUENCE is the list of its fields

Encoding of a TAG

TAG short form:

TAG long form: :



Class:

- **00 = Universal**
- **01 = Application wide**
  (Standardised type)
- **10 = Context-specific**
  (SEQUENCE/SET/CHOICE field)
- **11 = Private**
  (Non standardised type)

Format:

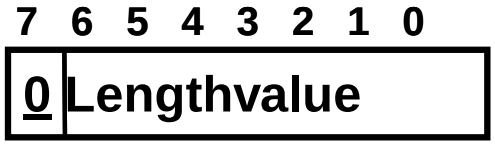
- **0 = Primitive**
- **1 = Structured**

TAG values for Universal Types:

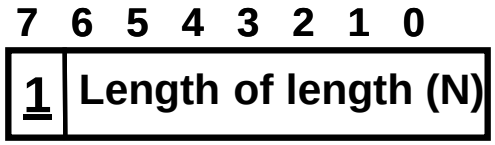
- **1 = BOOLEAN**
- **2 = INTEGER**
- **3 = BIT STRING**
- **4 = OCTET STRING**
- **5 = NULL**
- **10 = ENUMERATED**
- **16 = SEQUENCE / SEQUENCE OF**
- **17 = SET / SET OF**
- **22 = IA5String**

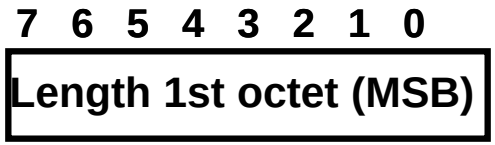
Encoding of Length

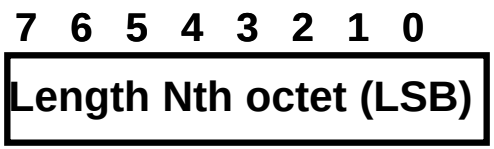
- Length short form (Length <= 127):



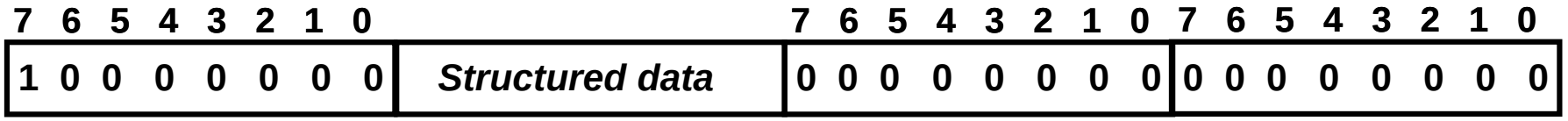
- Length long form (Length > 127)





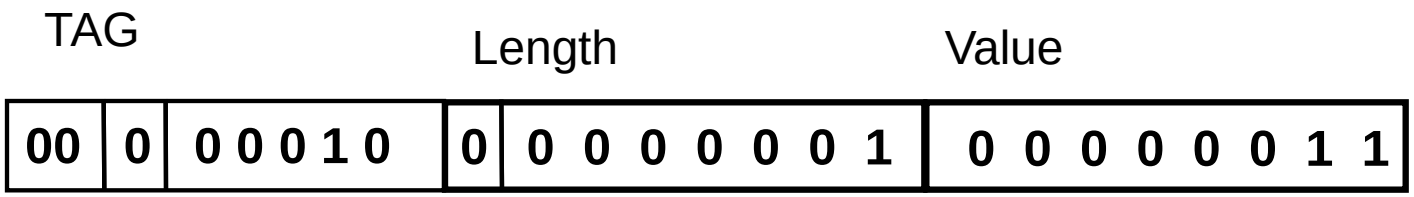


- Length indefinite form:



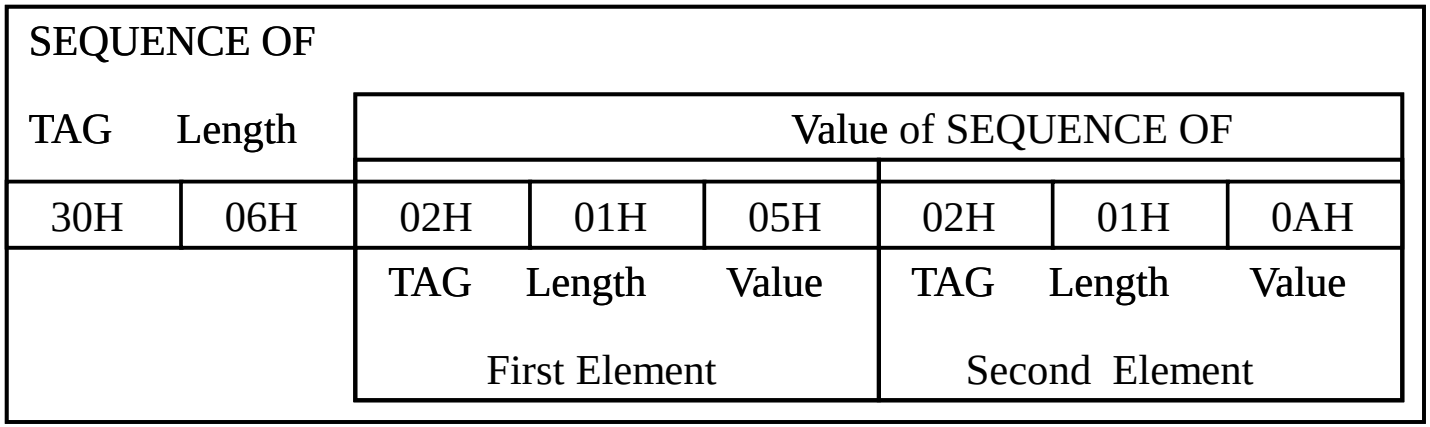
BER Example – INTEGER

- Transmit an INTEGER with value of 3



BER Example – Array

- Array of 2 INTEGERS: 5 and 10
  - SEQUENCE OF INTEGER



Encoding of User Defined TAG values

- x [0] INTEGER
  - Meaning: x is a type 0, that is an INTEGER
- Encoding:
  - [0] – Format: 1, since the value contains the type code of the actual type (INTEGER in this example)
  - TAG Value: the value in [ ] (0 in this example)
  - TAG [0] + Length of the whole data value + TAG of the actual data type (INTEGER) + Length of the actual data + Value of the actual data

BER Example – SEQUENCE

```
Coordinate ::= [APPLICATION 3] SEQUENCE{
x [0] INTEGER OPTIONAL, -- 4
y [1] INTEGER OPTIONAL  -- 5
}
```

TAG	Length			
[APPLICATION 3]				
01 1 00011=63H	0CH			
TAG	Length			
[SEQUENCE]				
00 1 10000=30H	0AH			
TAG	Length			
[Context Sensitive 0]				
10 1 00000=A0H	03H			
	TAG	Length	Value	
	[INTEGER]			
	00 0 00010=02H	01H	04H	
TAG	Length			
[Context Sensitive 1]				
10 1 00001=A1H	03H			
	TAG	Length	Value	
	[INTEGER]			
	00 0 00010=02H	01H	05H	

IMPLICIT encoding

- x [0] **IMPLICIT** INTEGER

- For user TAGged fields, the actual type is not transmitted
- More compact code, but to decode the data structure shall be known by the decoder
- Encoding:
  - [0] – Format: format of the actual type, since the type code of the actual type (INTEGER in this example) NOT transmitted (Format: 0 in this example)
  - TAG [0] + Length of the actual data + Value of the actual data

BER Example – Implicit SEQUENCE

```
Coordinate ::= [APPLICATION 3] IMPLICIT SEQUENCE{
x [0] IMPLICIT INTEGER OPTIONAL, -- 4
y [1] IMPLICIT INTEGER OPTIONAL  -- 5
}
```

TAG	Length	
[APPLICATION 3]		
01 1 00011=63H	06H	
TAG	Length	Value
[Context Sensitive 0]		
10 0 00000=80H	01H	04H
TAG	Length	Value
[Context Sensitive 1]		
10 0 00001=81H	01H	05H

BER Example – Indefinite Length

- Only for Structured types
- Same example as the previous

TAG	Length
[APPLICATION 3]	(indefinite)
01 1 00011=63H	80H

TAG	Length	Value
[Context Sensitive 0]		
10 0 00000=80H	01H	04H
TAG	Length	Value
[Context Sensitive 1]		
10 0 00001=81H	01H	05H

TAG	"Length "
[End of Content]	
00 0 00000=00H	00H

BER Complex Example

```
Coordinate ::= [APPLICATION 3] IMPLICIT SEQUENCE{ --
Indefinite length encoding
x [0] IMPLICIT INTEGER OPTIONAL, -- 4 + Indef. length
y [1] IMPLICIT INTEGER OPTIONAL  -- 5
}
```

TAG	Length			
[APPLICATION 3]	(indefinite)			
01 1 00011=63H	80H			
TAG	Length			
[Context Sensitive 0]	(indefinite)			
10 1 00000=A0H	80H			
	TAG	Length	Value	
	[INTEGER]			
	00 0 00010=02H	01H	04H	
TAG	"Length"			
[End of Content - First Field]				
00 0 00000=00H	00H			
TAG	Length			
[Context Sensitive 1]				
10 1 00001=A1H	03H			
	TAG	Length	Value	
	[INTEGER]			
	00 0 00010=02H	01H	05H	
TAG	"Length"			
[End of Content - SEQUENCE]				
00 0 00000=00H	00H			