

Introduction to HL7® FHIR®



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Aus Forschung wird Gesundheit

FHIR

- **F**ast
 - **H**ealthcare
 - **I**nteroperability
 - **R**esources
- 
- The logo for HL7 FHIR features a stylized flame icon composed of red and yellow segments, followed by the text "HL7® FHIR®".
- FHIR is a set of XML/JSON health data resources, plus a REST API for accessing them.

- Modular principle:
 - small semantic units - **Resources**
- Information network:
 - **References** between resources
- Web technologies
 - XML, JSON, HTTP, REST, OAuth

FHIR Interoperability Paradigms

- REST – lightweight, leverage web stack
- Documents – long-term persistence
- Messages – request/response paradigm
- Services – other SOA-based interfaces

PLUS:

- Storage
- Analysis

FHIR Versions and Maturity Levels

Major Milestones:

Dec 27, 2018 ↗	4.0.0	Release 4 (1 st Normative Content + Trial Use Developments)
Feb 21, 2017 ↗	3.0.0	Release 3 (STU - Standard for Trial Use)
Oct 24, 2015 ↗	1.0.0	DSTU2 (Second Draft Standard for Trial Use)
Sept 30, 2014 ↗	0.0.82	DSTU1 (First Draft Standard for Trial Use)

<http://hl7.org/fhir/history.html>

FHIR Versions and Maturity Levels

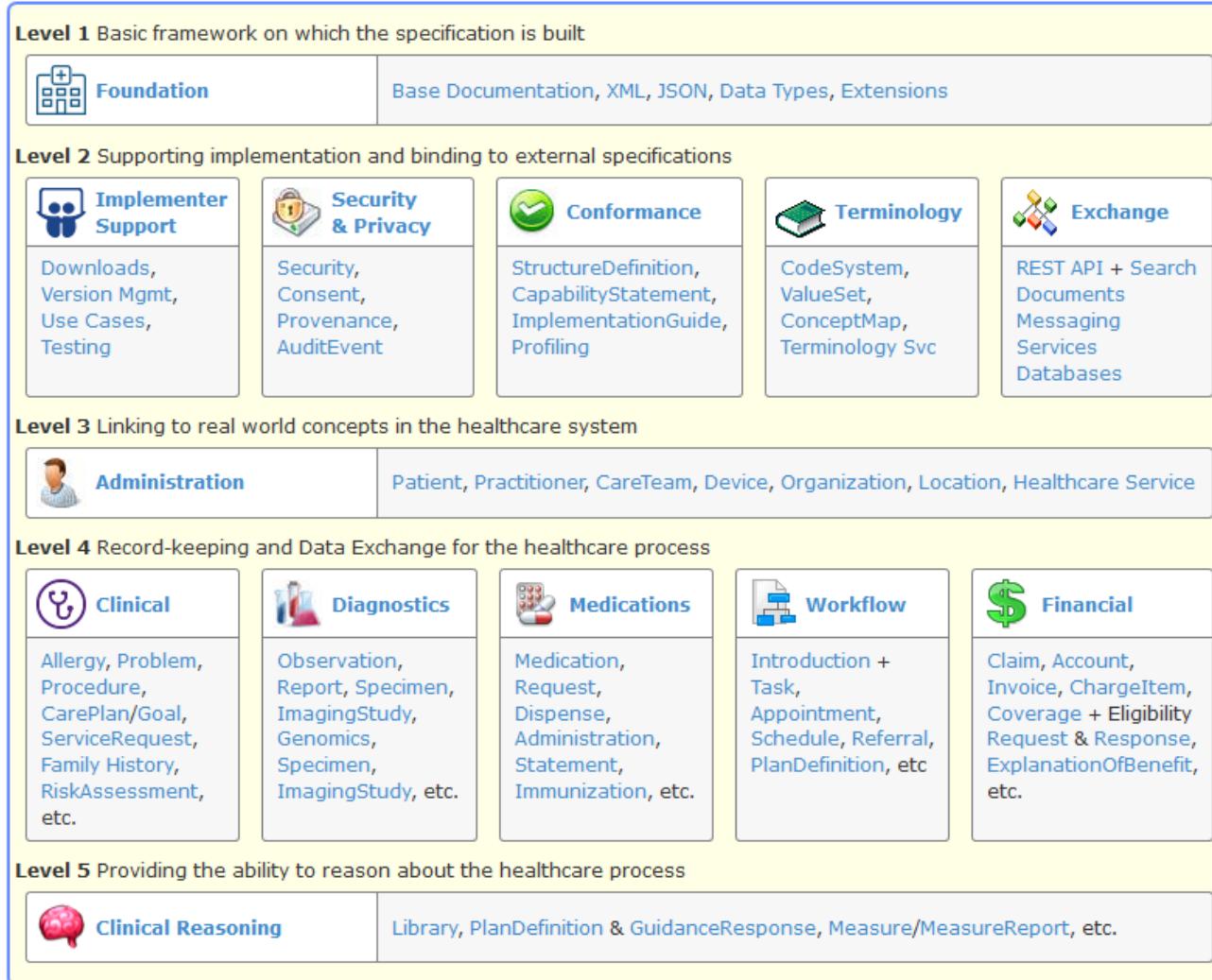
- Observation  
- ObservationDefinition 0 Normative Content
- OperationDefinition 0
- OperationOutcome 
- Organization 3
- OrganizationAffiliation 0

Maturity Levels

- Draft (0) → resource or artifact has been published on the current build.
- FMM 1 → artifact produces no warnings during the build process
- FMM 2 → artifact has been tested successfully at a connectathon
- FMM 3 → QA verified by the work group, passed ballot
- FMM 4 → artifact has been tested across its scope and implemented in multiple prototype projects
- FMM 5 → implemented in at least 5 independent production systems in more than one country
- Normative → the artifact is now considered stable

FHIR Specification: Resources and Datatypes

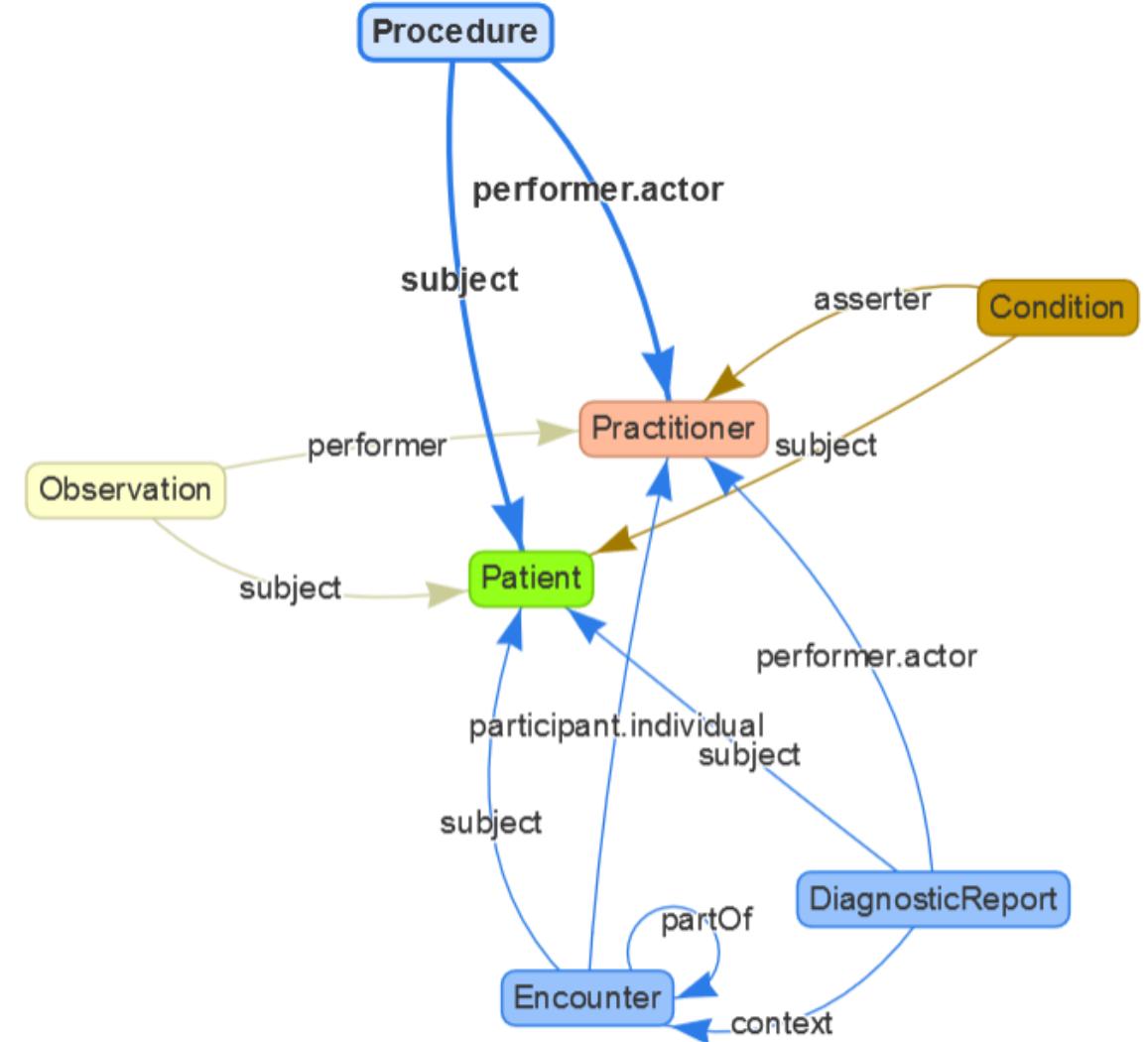
Specification



<http://hl7.org/fhir/>

Resources

- Discrete data blocks
- The content model
- The smallest units of communication
- The thing that is exchanged
 - Via REST (FHIR RESTful API)



Resource Definitions

11.5.2 Resource Content

Structure UML XML JSON Turtle R3 Diff All

Structure

Name	Flags	Card.	Type	Description & Constraints
Medication	TU		DomainResource	Definition of a Medication Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
identifier	Σ	0..*	Identifier	Business identifier for this medication
code	Σ	0..1	CodeableConcept	Codes that identify this medication SNOMED CT Medication Codes (Example)
status	?! Σ	0..1	code	active inactive entered-in-error Medication status codes (Required)
manufacturer	Σ	0..1	Reference(Organization)	Manufacturer of the item
form		0..1	CodeableConcept	powder tablets capsule + SNOMED CT Form Codes (Example)
amount	Σ	0..1	Ratio	Amount of drug in package
ingredient		0..*	BackboneElement	Active or inactive ingredient
item[x]		1..1		The actual ingredient or content
itemCodeableConcept			CodeableConcept	
itemReference			Reference(Substance Medication)	
isActive		0..1	boolean	Active ingredient indicator
strength		0..1	Ratio	Quantity of ingredient present
batch		0..1	BackboneElement	Details about packaged medications
lotNumber		0..1	string	Identifier assigned to batch
expirationDate		0..1	dateTime	When batch will expire

Documentation for this format

Resources

2.17.3 Example Resource: Patient

This simple example shows the important parts of a resource: a local extension, the human readable HTML presentation, and the standard defined data content.

```
<Patient xmlns="http://hl7.org/fhir">
  <id value="glossy"/>
  <meta>
    <lastUpdated value="2014-11-13T11:41:00+11:00"/>
  </meta>
  <text>
    <status value="generated"/>
    <div xmlns="http://www.w3.org/1999/xhtml">
      <p>Henry Levin the 7th</p>
      <p>MRN: 123456. Male, 24-Sept 1932</p>
    </div>
  </text>
  <extension url="http://example.org/StructureDefinition/trials">
    <valueCode value="renal"/>
  </extension>
  <identifier>
    <use value="usual"/>
    <type>
      <coding>
        <system value="http://hl7.org/fhir/v2/0203"/>
        <code value="MR"/>
      </coding>
    </type>
    <system value="http://www.goodhealth.org/identifiers/mrn"/>
    <value value="123456"/>
  </identifier>
  <active value="true"/>
  <name>
    <family value="Levin"/>
    <given value="Henry"/>
    <suffix value="The 7th"/>
  </name>
  <gender value="male"/>
  <birthDate value="1932-09-24"/>
  <careProvider>
    <reference value="Organization/2"/>
    <display value="Good Health Clinic"/>
  </careProvider>
</Patient>
```

Resource Identity & Metadata

Human Readable Summary

Extension with URL to definition

Standard Data:
▪ MRN
▪ Name
▪ Gender
▪ Birth Date
▪ Provider

<http://hl7.org/fhir/summary.html>

Resources – Do not confuse

Resource definition / profile

9.2.3 Resource Content

Structure UML XML JSON Turtle R3 Diff All

Structure

Name	Flags	Card.	Type
Condition	I TU	1..1	DomainResource

Condition

- identifier
- clinicalStatus
- verificationStatus
- category
- severity
- code
- bodySite
- subject
- encounter

Resource instance

```
{  
  "resourceType": "Condition",  
  "code": {  
    "coding": [  
      {  
        "system": "http://snomed.info/sct",  
        "code": "73211009",  
        "display": "Diabetes mellitus"  
      }  
    ],  
    "subject": {  
      "reference": "Patient/example"  
    },  
    "recordedDate": "2020-10-06"  
  }  
}
```

Identifier - Example

id belongs to the metadata,
use this to access the
resource via its URL

identifier is a property of the
patient itself, can't be used
directly (but can be part of a
query)

```
{  
  "resourceType": "Patient",  
  "id": "b588bbac-1070-455d-b5cc-8de9204829f6",  
  "meta": {  
    "profile": [  
      "http://fhir.de/StructureDefinition/patient-de-basis/0.2"  
    ]  
  },  
  "identifier": [  
    {  
      "system": "http://fhir.de/NamingSystem/gkv/kvid-10",  
      "value": "G995030567"  
    }  
  ],  
  "name": [  
    {  
      "family": "Doe",  
      "given": [  
        "John"  
      ]  
    }  
  ]  
}
```

References

subject	Σ	1..1	Reference(Patient Group)
encounter	Σ	0..1	Reference(Encounter)
performed[x]	Σ	0..1	
performedDateTime			dateTime
performedPeriod			Period
performedString			string
performedAge			Age
performedRange			Range
recorder	Σ	0..1	Reference(Patient RelatedPerson Practitioner PractitionerRole)
asserter	Σ	0..1	Reference(Patient RelatedPerson Practitioner PractitionerRole)
performer	Σ	0..*	BackboneElement
function	Σ	0..1	CodeableConcept
actor	Σ	1..1	Reference(Practitioner PractitionerRole Organization Patient RelatedPerson Device)
onBehalfOf		0..1	Reference(Organization)

- absolute (resource on any server)

```
<subject>
  <reference value="https://fhir.de/Patient/1234"/>
</subject>
```

- relative (resource on the same server)

```
<performer>
  <actor>
    <reference value="Practitioner/1234"/>
    <display value="Dr. med Robert Koch"/>
  </actor>
</performer>
```

FHIR & Terminology

External	Internal (FHIR)	External (FHIR)	HL7 v3	HL7 v2
URI	Source	Comment	OID (for non-FHIR systems)	
Externally Published code systems				
http://snomed.info/sct	SNOMED CT (IHTSDO)	See Using SNOMED CT with FHIR	2.16.840.1.113883.6.96	
http://www.nlm.nih.gov/research/umls/rxnorm	RxNorm (US NLM)	See Using RxNorm with FHIR	2.16.840.1.113883.6.88	
http://loinc.org	LOINC (LOINC.org)	See Using LOINC with FHIR	2.16.840.1.113883.6.1	
http://unitsofmeasure.org	UCUM: (UnitsOfMeasure.org) Case Sensitive Codes	See Using UCUM with FHIR	2.16.840.1.113883.6.8	



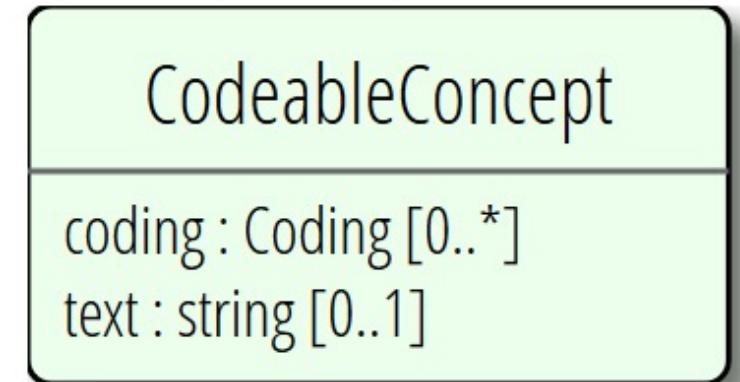
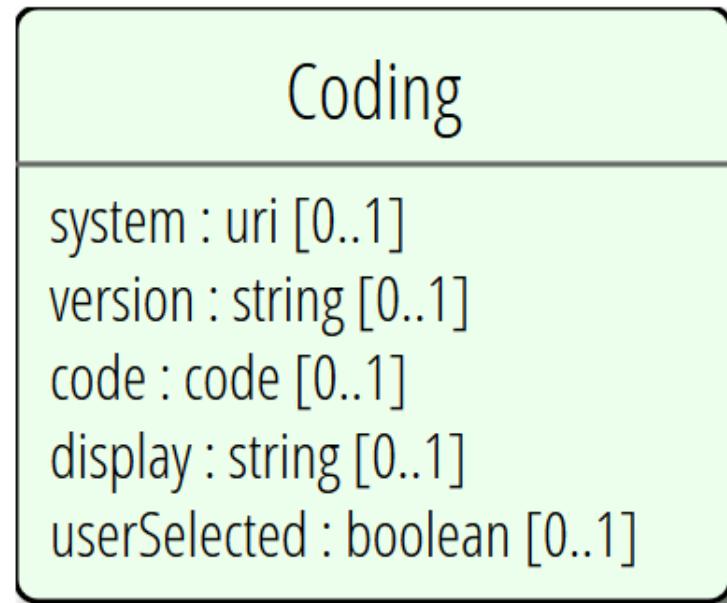
Terminology

CodeSystem, ValueSet, ConceptMap, Terminology Svc

<http://hl7.org/fhir/terminologies-systems.html>

Coded Data Types

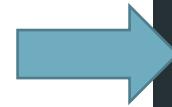
code



<http://hl7.org/fhir/datatypes.html>

Coded Data Types

- **code:** The instance represents the *code* only. The *system* is implicit - it is defined as part of the definition of the element, and not carried in the instance.



```
{  
  "resourceType": "Observation",  
  "status": "final",  
  "code": {  
    "coding": [  
      {  
        "system": "http://loinc.org",  
        "version": "2.66",  
        "code": "604-9",  
        "display": "Bacteria identified in Bronchial  
specimen by Aerobe culture"  
      }  
    ]  
  },  
  "valueCodeableConcept": {  
    "coding": [  
      {  
        "system": "http://snomed.info/sct",  
        "code": "9861002",  
        "display": "Streptococcus pneumoniae"  
      }  
    ]  
  }  
}
```

Coded Data Types

- **Coding:** A data type that has a *code* and a *system* element that identifies where the definition of the code comes from.
- **CodeableConcept:** A type that represents a concept by plain text and/or one or more *coding* elements.

```
{  
  "resourceType": "Observation",  
  "status": "final",  
  "code": {  
    "coding": [  
      {  
        "system": "http://loinc.org",  
        "code": "13955-0",  
        "display": "HCV Ab IA Q1"  
      }  
    ],  
    "text": "HCV-Antikörper (ELISA, Roche Elecsys)"  
  },  
  "valueCodeableConcept": {  
    "coding": [  
      {  
        "system": "http://snomed.info/sct",  
        "code": "406105002",  
        "display": "HCV ELISA test negative"  
      }  
    ],  
    "text": "Kein Nachweis von HCV-Ak"  
  }  
}
```

Coded Data Types

- **Keep in mind:**
Coding inside
CodeableConcept is
0..*, so can be
repeating

```
<code>
  <coding>
    <system value="http://fhir.de/CodeSystem/dimdi/icd-10-gm"/>
    <code value="J15.2+ B95.6!"/>
    <display value="Pneumonie durch Staphylokokken"/>
  </coding>
  <coding>
    <system value="http://snomed.info/sct"/>
    <code value="22754005"/>
    <display value="Staphylococcal pneumonia (disorder)"/>
  </coding>
</code>
```

Structure					
Name	Flags	Card.	Type	Description & Constraints	?
CodeableConcept	Σ [N]	1..1	Element	Concept - reference to a terminology or just text Elements defined in Ancestors: id, extension	
coding	Σ	0..*	Coding	Code defined by a terminology system	
text	Σ	0..1	string	Plain text representation of the concept	

CodeSystem vs. ValueSet



Example: SNOMED CT



Definition
of terms

Introduction to HL7 FHIR

Takes concepts from

Takes concepts from

Takes concepts from

Can take
concepts from
multiple code
systems

No need to
write them all
down!

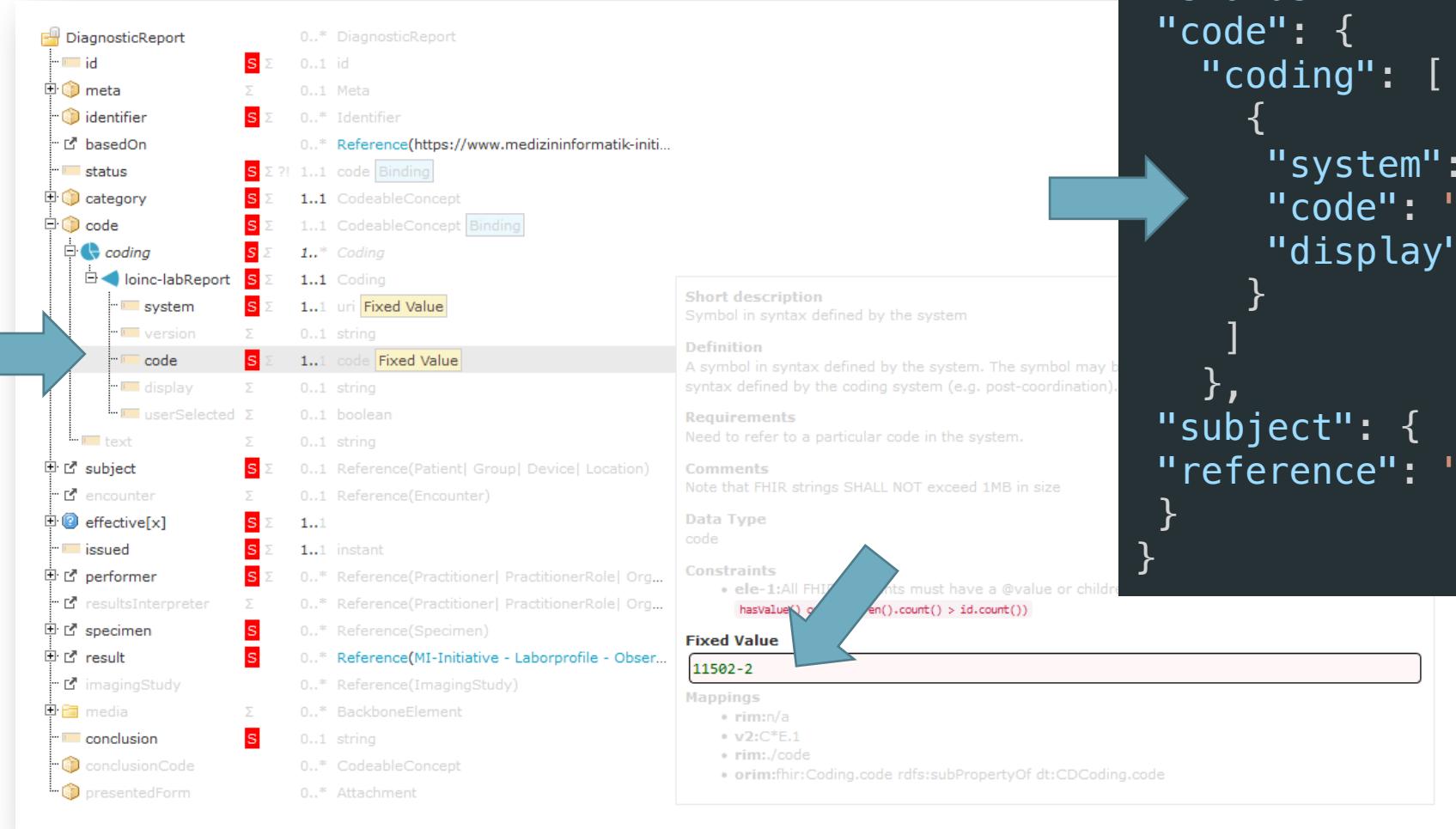
"All concepts under bacteria"

"All concepts from SNOMED CT"

"Bacteria"

Acinetobacter baumannii
Enterobacter cloacae
Escherichia coli
Klebsiella pneumoniae
Staphylococcus aureus
Streptococcus pyogenes

FHIR & Terminology



```
{  
  "resourceType": "DiagnosticReport",  
  "status": "final",  
  "code": {  
    "coding": [  
      {  
        "system": "http://loinc.org",  
        "code": "11502-2",  
        "display": "Laboratory report"  
      }  
    ],  
    "subject": {  
      "reference": "Patient/111"  
    }  
  }  
}
```

FHIR & Terminology

The diagram illustrates the FHIR Medication resource structure and its relationship to a terminology code system.

FHIR Structure:

- Medication** resource structure:
 - id**: System.String
 - meta**: Meta
 - identifier**: Identifier
 - code**: CodeableConcept
 - status**: code Binding
 - manufacturer**: Reference(Organization)
 - form**: CodeableConcept Binding
 - amount**: Ratio
 - ingredient**: BackboneElement
 - batch**: BackboneElement

A large blue arrow points from the FHIR structure towards the terminology table.

Terminology Table:

Code	Display
10101000	Oral drops, solution
10102000	Oral drops, suspension
10103000	Oral drops, emulsion
10104000	Oral liquid
10105000	Oral solution

• The following codes from system: <http://standardterms.edqm.eu>

A blue arrow points from the terminology table towards the FHIR resource details.

FHIR Resource Details:

Medication resource structure with specific details for the form element:

- Element Id:** Medication.form
- Short description:** powder | tablets | capsule +
- Definition:** Describes the form of the item
- Comments:** When Medication is referenced this is the dispensed form. When
- Data Type:** CodeableConcept
- Binding:** DoseFormUvIps (preferred)
- Constraints:**
 - ele-1:All FHIR elements must have either exactly one extension or exactly one child element that is not a reference to another element. This element must not contain both an extension and a child element.

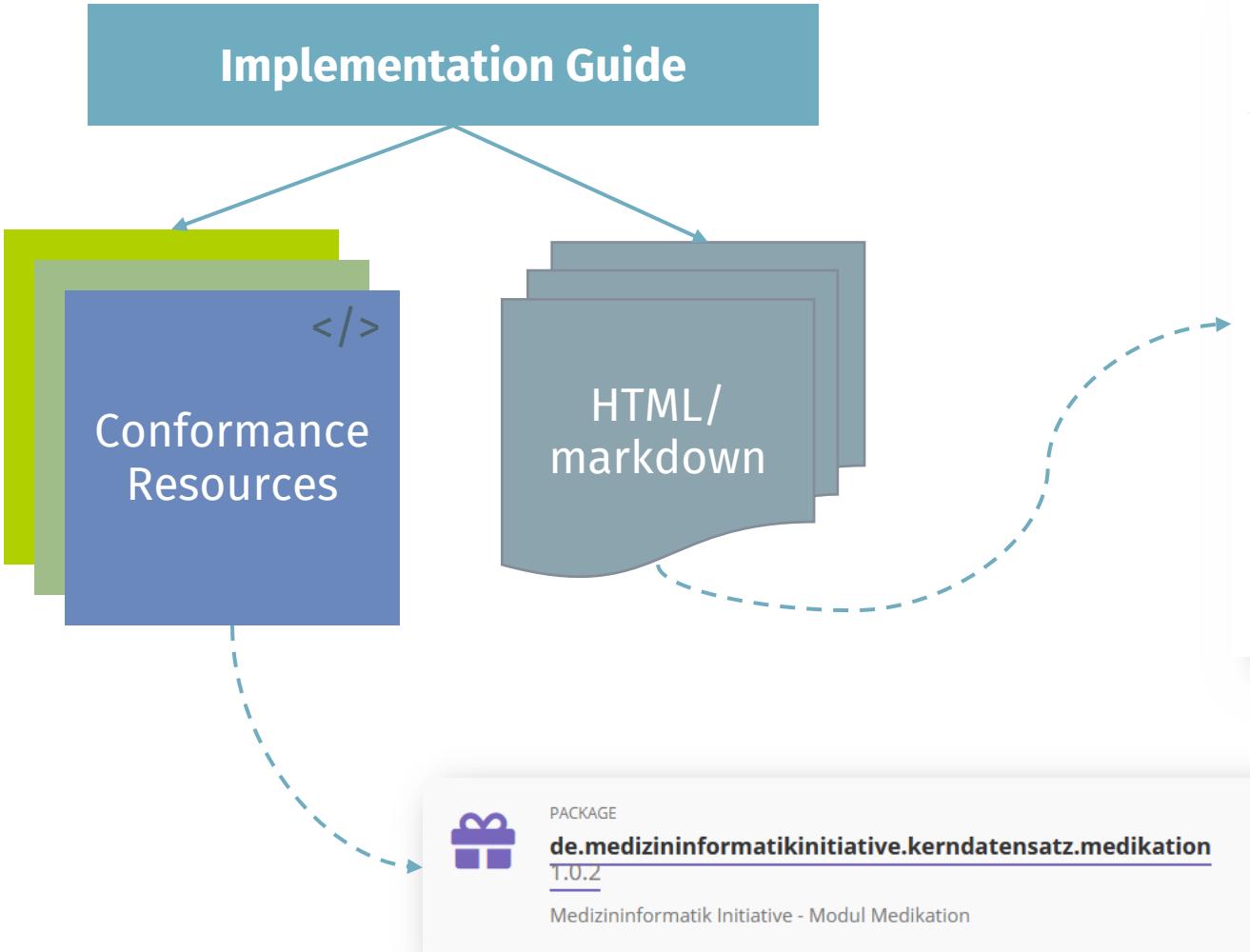
```
{  
  "resourceType": "Medication",  
  "code": {  
    "coding": [  
      {  
        "system": "http://fhir.de/CodeSystem/dimdi/atc",  
        "code": "B01AC06",  
        "display": "acetylsalicylic acid"  
      }  
    ],  
    "form": {  
      "coding": [  
        {  
          "system": "http://standardterms.edqm.eu",  
          "code": "10219000",  
          "display": "Tablet"  
        }  
      ]  
    }  
  }  
}
```

Profiles & Implementation Guides

FHIR Profiling

- **Profile:** a set of constraints or modifications on a FHIR resource or on top of other profiles
- Can define e.g.:
 - Rules which elements shall or shall not be used
 - Additional elements (**Extensions**)
- Artifacts:
 - Implementation Guides (IG)
 - StructureDefinition

FHIR Implementation Guides



Medizininformatik Initiative - Modul Labor - ImplementationGuide



IG MII KDS Modul Labor	
↳	Beschreibung Modul
↳	Kontext im Gesamtprojekt / Beziehe zu anderen Modulen
↳	Referenzen
↳	Anwendungsfälle / Informationsmodell
↳	Beschreibung von Szenarien für die Anwendung der Module
↳	Datensätze inkl. Beschreibungen
↳	UML
↳	Technische Implementierung
↳	FHIR Profile
↳	DiagnosticReport
↳	Observation
↳	ServiceRequest
↳	Terminologien

Kerndatensatz Modul Labor

Die vorliegende Spezifikation beschreibt die FHIR Repräsentation des Kerndatensatz Moduls 'Labor' der Medizininformatik Initiative. Im Folgenden werden die Use Case des Moduls, sowie die dazugehörigen FHIR Profile und Terminologie Ressourcen in ihrer verbindlichen Form beschrieben.

Veröffentlichung	
Datum	10.02.2020
Version	0.9
Status	Draft
Realm	DE

Inhaltsverzeichnis

- IG MII KDS Modul Labor
 - Beschreibung Modul
 - Kontext im Gesamtprojekt / Beziehe zu anderen Modulen
 - Referenzen
 - Anwendungsfälle / Informationsmodell
 - Beschreibung von Szenarien für die Anwendung der Module
 - Datensätze inkl. Beschreibungen
 - UML

Realm	DE

Inhaltsverzeichnis

- IG MII KDS Modul Diagnose

Realm	DE

Inhaltsverzeichnis

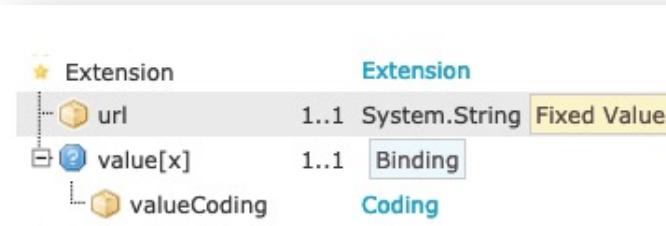
- IG MII KDS Modul Medikation
 - Beschreibung Modul



Extensions

FHIR uses the 80/20 rule.

- Use extensions for the 20%
- Extend resources, elements, data types
- May limit interoperability



The screenshot shows the FHIR Structure Definition editor interface. On the left, there is a tree view of the extension structure:

- Extension** (highlighted)
 - url**: Type **System.String**, **Fixed Value**
 - value[x]**: Type **Binding**
 - valueCoding**: Type **Coding**

On the right, detailed information about the **url** element is displayed:

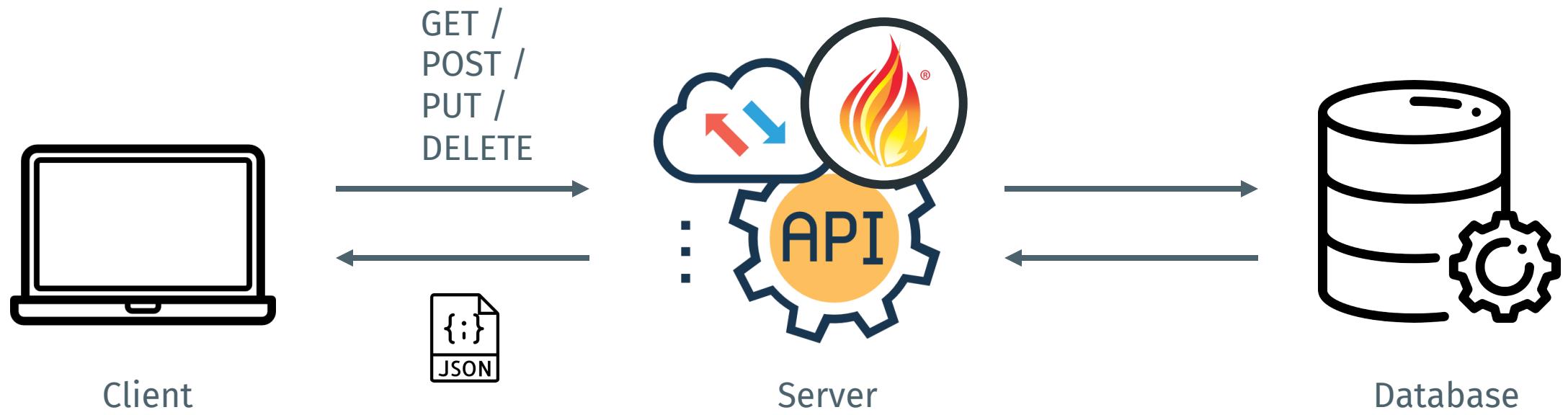
- Element Id**: Extension.url
- Short description**: identifies the meaning of the extension
- Definition**: Source of the definition for the extension code - a logical name or a URL.
- Comments**: The definition may point directly to a computable or human-readable definition of or it may be a logical URI as declared in some other specification. The definition S Structure Definition defining the extension.
- Data Type**: System.String
- Fixed Value**: <http://fhir.de/StructureDefinition/gender-amtlich-de>
- Mappings**: • rim:N/A

Extensions

```
{  
  "resourceType": "Patient",  
  "name": [  
    {  
      "use": "official",  
      "family": "Van-der-Dussen",  
      "given": [  
        "Maja",  
        "Julia"  
      ]  
    }  
  ],  
  "gender": "other",  
  "_gender": {  
    "extension": [  
      {  
        "url": "http://fhir.de/StructureDefinition/gender-amtlich-de",  
        "valueCoding": {  
          "system": "http://fhir.de/CodeSystem/gender-amtlich-de",  
          "code": "D",  
          "display": "divers"  
        }  
      }  
    ]  
  }  
}
```

REST API

REST API



FHIR and REST

- **RESTful API**
- HTTP: POST, PUT, GET, etc.
- CRUD-operations:
 - **Create (POST)**
 - **Read (GET)**
 - **Update (PUT)**
 - **Delete (DELETE)**
 - plus: Read Version, Search (resource/type/server), History (resource/type/server), Capabilities, Patch, Batch & Transaction

Instance Level Interactions

read	Read the current state of the resource
vread	Read the state of a specific version of the resource
update	Update an existing resource by its id (or create it if it is new)
patch	Update an existing resource by posting a set of changes to it
delete	Delete a resource
history	Retrieve the change history for a particular resource

Type Level Interactions

create	Create a new resource with a server assigned id
search	Search the resource type based on some filter criteria
history	Retrieve the change history for a particular resource type

Whole System Interactions

capabilities	Get a capability statement for the system
batch/transaction	Update, create or delete a set of resources in a single interaction
history	Retrieve the change history for all resources
search	Search across all resource types based on some filter criteria

FHIR RESTful Search

<http://hl7.org/fhir/search.html>

- General search syntax
 - `GET [base]/[type]?[parameter]&[parameter]...{&_format=[mime-type]}`
- Works on predefined parameters (e.g. “name”)
 - `GET [base]/Patient?name=Sven`
 - `GET [base]/Observation?code=600-7`
 - `GET [base]/Patient/1234`
 - `GET [base]/Patient?_id=100`
 - `GET [base]/Patient?identifier=G995030567`
- Search parameters can also be concatenated and chained
 - `GET [base]/Observation?code=http://loinc.org|600-7&subject.name=John`

HL7 FHIR in Germany



Reference Libraries

Java

- <https://github.com/jamesagnew/hapi-fhir>

.Net FHIR Client

- <https://github.com/FirelyTeam/fhir-net-api>

Python - SMART on FHIR

- <https://github.com/smart-on-fhir/client-py>

Swift - SMART on FHIR

- <https://github.com/smart-on-fhir/Swift-FHIR>

FHIR Server

☰ README.md

HAPI-FHIR Starter Project

This project is a complete starter project you can use to deploy a FHIR server using HAPI FHIR JPA.

Note that this project is specifically intended for end users of the HAPI FHIR JPA server module (in other words, it helps you implement HAPI FHIR, it is not the source of the library itself). If you are looking for the main HAPI FHIR project, see here: <https://github.com/jamesagnew/hapi-fhir>

Need Help? Please see: <https://github.com/jamesagnew/hapi-fhir/wiki/Getting-Help>

Prerequisites

In order to use this sample, you should have:

- This project checked out. You may wish to create a GitHub Fork of the project and check that out instead so that you can customize the project and save the results to GitHub.

and either

- Oracle Java (JDK) installed: Minimum JDK8 or newer.
- Apache Maven build tool (newest version)

or

- Docker, as the entire project can be built using multistage docker (with both JDK and maven wrapped in docker) or used directly from [Docker Hub](#)



<https://github.com/hapifhir/hapi-fhir-jpaserver-starter>

FHIR Chat

The screenshot shows a web-based chat application for the FHIR community. The left sidebar lists various streams, with the german (d-a-ch) stream selected. The main area displays a conversation between users. The top navigation bar includes a back button, forward button, refresh button, and a search bar with the query "stream:german+(d-a-ch)". The right sidebar lists user profiles and group messages.

Left Sidebar (Streams):

- All messages (3589)
- Private messages
- Mentions
- Starred messages
- ALL STREAMS
- # german (d-a-ch)
 - Veranstaltungshinweise
 - Diagnose-Typen und -Rangf...
 - eDMP & FHIR/standardterm...
 - AlphalD Code als Ableitung ...
 - DevDays Amsterdam 2019
 - [MED] ATC-Codes Kombiprä...
 - Call for Paper: DMEA 2020
 - Observation (Pflegestufe)
 - Wohnort in Stadtstaaten
 - Umgang mit Dokumenten i...
 - Leistungsstelle
 - Abbildung Packungsgröße ...
 - Barrierefreiheit
 - [basis] Issue#169: Identifier...
 - Coverage (Profil GKV)
 - ***Vorstellungsrunde***
 - Einwilligungsmanagement

Top Bar:

german (d-a-ch) stream:german+(d-a-ch)

Right Sidebar (Users):

- Julian Sass (you)
- Alexander Henket
- Gidon Gershinsky
- Grahame Grieve
- Lauri Karppinen
- Lloyd McKenzie
- Michaela Ziegler
- Morten Ernebjerg
- Oliver Egger
- AbdulMalik Shakir
- Adam Stevenson
- Al S
- Alexander Röck
- Amol Vyas
- André Sander
- Andrea Essenwanger
- Bjørn Erik Nordal
- Bob Dolin

Group PMs:

- Andy Iverson, Halina Labikova, Martijn Kersloot, + 2 others
- Alexander Zautke, Mareike

Bottom Buttons:

Drafts New topic New private message Reply

<https://chat.fhir.org/>

Thank you!

www.bihealth.org



Aus Forschung wird Gesundheit

Introduction to FHIR

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10178 Berlin

www.bihealth.org



Aus Forschung wird Gesundheit

Image sources

- Icon made by Freepik from www.flaticon.com   
- Icon made by Roundicons from www.flaticon.com 
- Icon made by Prosymbol from www.flaticon.com 
- Icon made by Smashicons from www.flaticon.com 

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