



CONCERTO

*Guaranteed Component Assembly with Round Trip Analysis
for Energy Efficient High-integrity Multi-core Systems*

Project Number 333053

Extending HL7 FHIR in order to support the capturing the Activity of Daily Life

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LIST OF ABBREVIATIONS

ADL	Activity of Daily Life
B2B	Business to Business
B2C	Business to Customer
FHIR	Fast Healthcare Interoperability Resources (part of HL7 standard)
HIS	Health Information System
HL7	Health Level Seven (standard)
URL	Uniform Resource Locator



EXECUTIVE SUMMARY

This document describes the extended FHIR model which enables the capturing of the ADL.

1 The motivation of capturing the ADL

The change of the lifestyle is one of the most important treatment instructions in significant part of the healthcare protocols. As with the classical methods the monitoring of the lifestyle was not possible, most data model and interface standards are focusing on capturing the vital values of the patient. The new lightweight standard the FHIR provides an extensible framework for the B2B and B2C interfaces between the HIS and other systems. The examples presented on the official site of the FHIR are focused on the traditional vital parameters such as blood pulse or imaging services.

In this white paper we describe our extensions for the FHIR observation object which enables the capturing the life style parameters important for the treatment of hypertonia.

2 FHIR extension methodology

In the course of development most entities were used based on the examples and regulations of the official HL7 hapi templates. The first case when an entity had to be extended was the Goal entities (these were used with extensions even in the official templates). In practice it means that even though the hapi strictly regulates what elements the JSON can have (or in some cases what kind and how many fields they can have), nearly all entities include a field called extension, an array, where the required values can be assigned. <https://www.hl7.org/fhir/extensibility.html>

In case of Goal it was created the following way. Originally this entity did not support the elements most important for us: the storage of exact target value, and the tolerance of its deviance, etc. Based on the official example of hl7.org the following solution was used:

```
{
  "resourceType": "Goal",
  "extension": [
    {
      "extension": [
        {
          "url": "goal-target.measure",
          "valueCodeableConcept": {
            "coding": [
              {
                "system": "http://loinc.org",
                "code": "29463-7"
              }
            ]
          }
        },
        {
          "url": "goal-target.detail",
          "valueQuantity": {
            "value": 80,
            "system": "http://units-of-measure.org",
            "code": "kg"
          }
        }
      ]
    }
  ]
}
```

```
    }
  },
  {
    "url": "goal-target.tolerance",
    "valueQuantity": {
      "value": 5,
      "system": "http://units-of-measure.org",
      "code": "%"
    }
  },
  {
    "url": "goal-target.min",
    "valueQuantity": {
      "value": 70,
      "system": "http://units-of-measure.org",
      "code": "kg"
    }
  },
  {
    "url": "goal-target.max",
    "valueQuantity": {
      "value": 100,
      "system": "http://units-of-measure.org",
      "code": "kg"
    }
  }
],
"url": "http://hl7.org/fhir/StructureDefinition/goal-target"
}
],
"subject": {
  "reference": "Patient/CON1"
},
"status": "planned"
}
}
```


The URL field officially points to a website, which can provide help in translation of the given data – in case of the external extension it is an official HL7 example, in case of the internal, proprietary values the links are not valid, but help the users in understanding given parts of the goal. Beside the URL, the elements of the extension array have one more value, which can be valueQuantity, valueSampledData, valueRange, etc., and stores the extended field's exact value. As shown in the example above, even extensions can have extensions.

3 Extension of the FHIR Observation object

The following parameters are important for the monitoring the life style in the case of hypertonia illness.

The change in lifestyle and the adjuvant medicine therapy are important elements of the medical attendance for patients either with or without anti-hypertensive treatment. With the change of lifestyle in many cases the medicine therapy can be avoided, delayed, the dosage can be decreased or even cancelled after a time.

Lifestyle coaching (in itself or as part of the medicine therapy) should be applied continuously starting at the beginning of the therapy, which consists of the following:

- Giving up smoking – only decreases the blood pressure slightly, but decreases the cardiovascular risk greatly
- Healthy nutrition (BMI > 25 kg/m² or BMI > 27 kg/m² if the waistline is greater than 94 cm (male) or 80 cm (female); in case of increased blood lipids, special dietetic coaching), lowering sodium intake (table salt intake < 6g / day)
- Reduction or ideally elimination of obesity: low calorie, low fat and low carbohydrate (with high glycaemia index) diet, that provides 500 kcal less energy than it is normally recommended (RDI). It is proved, that the decrease of every 1 kg of excess (above normal) bodyweight reduces high blood pressure by 1-2%. A 10 kg decrease in bodyweight can result in a 10-20 mm Hg tension reduction. Target values: BMI 25 kg / m²; waistline < 88 cm (female), <102 cm (male).
- Regular physical activity: isotonic physical activity, that does not exceed the 70% of the aerobic capacity (walking, jogging, swimming). It is recommended for a duration of at least 30-60 minutes, three times a week.
- Avoiding excessive intake of caffeine and alcohol: limited daily intake of 20-30 gr (male) 20 gr (female).

Entity type	What is this	Lloinc / distinction code	Accessing useful data (within JSON of which the first field is resourceType)
Observation	Blood pressure (systole and diastole)	55284-4	Systole: component[0].valueQuantity.value Diastole: component[1].valueQuantity.value
Observation	Pulse variation	8867-4	component[0].valueQuantity.value (1...4 different Delta HR, SDNN values), the curve shown on the entity graph converted into string: vm.record.component[5].valueSampledData.data
Observation	Oxygen saturation	20564-1	component[0].valueQuantity.value
Observation	Body weight	29463-7	component[0].valueQuantity.value
Observation	Alcohol consumption (units)	74013-4	component[0].valueQuantity.value
Observation	Smoking habits (explanation: http://s.details.loinc.org/LOINC/63640-7.html?sections=Simple)	63640-7	component[0].valueQuantity.value
Observation	Coffee drinking habits (http://s.details.loinc.org/LOINC/61480-0.html?sections=Simple)	61480-0	component[0].valueQuantity.value
Observation	Exercise (in km)	55412-1	component[0].valueQuantity.value
Patient	Patient	-	Reading name: patient.name[0].family[0] + ' ' + patient.name[0].given[0]
Practitioner	General practitioners / doctors	-	

CarePlan	Care plan	-	<p>Related patient (id): subject.reference</p> <p>Start and End: period.start, period.end</p> <p>Array of Goal id's: goal</p> <p>Array of participants: (patients and practitioners): participant[0].reference, participant[1].reference, etc.</p>
Goal	Therapy goal	-	<p>Lloinc code of measurement: extension[0].extension[0].valueCodeable Concept.coding[0].code</p> <p>Goal value: extension[0].extension[1].valueQuantity. value</p> <p>Minimum: extension[0].extension[3].valueQuantity. value</p> <p>Maximum: extension[0].extension[4].valueQuantity. value</p> <p>Tolerance: extension[0].extension[2].valueQuantity. value</p>
Detected Issue	Alert, detected problem	-	<p>Severity: severity</p> <p>Implicated entities: implicated[x].reference</p> <p>Details: detail</p>
Observation	Different summaries in a timeframe	SUM_WEEK_BP, SUM_MONTH_WEIGHT, ...	<p>Average: component[0].valueQuantity.value</p> <p>Maximum: component[1].valueQuantity.value</p> <p>Minimum: component[2].valueQuantity.value</p> <p>If a measurement has more than one element (for example blood pressure has systole and diastole), the above three components are repeated respectively (example: component[4].valueQuantity.value will be the average of the diastole blood pressure values)</p>

3.1 Example of Observation entity (Weight)

```
{
  "resourceType": "Observation",
  "id": "172034",
  "meta": {
    "versionId": "1",
    "lastUpdated": "2016-02-10T10:02:36.263Z"
  },
  "status": "final",
  "code": {
    "coding": [
      {
        "system": "http://loinc.org",
        "code": "29463-7",
        "display": "Body weight"
      }
    ]
  },
  "subject": {
    "reference": "Patient/Ex2"
  },
  "effectiveDateTime": "2015-06-15T08:00:00",
  "performer": [
    {
      "reference": "Practitioner/PR2"
    }
  ],
  "component": [
    {
      "code": {
        "coding": [
          {
            "system": "http://loinc.org",
            "code": "29463-7",
            "display": "Body weight"
          }
        ]
      },
      "valueQuantity": {
        "value": 79,
        "unit": "kg"
      }
    },
    {
      "valueQuantity": {
        "value": 5,
        "unit": "%"
      }
    }
  ]
}
```

3.2 Example of Patient entity

```
{
  "resourceType": "Patient",
  "id": "Ex2",
  "meta": {
    "versionId": "14",
    "lastUpdated": "2016-02-10T08:43:19.922Z"
  },
  "text": {
    "status": "generated",
    "div": "<div><div class=\"hapiHeaderText\"> Viktor <b>ALM</b></div><table
class=\"hapiPropertyTable\"><tbody><tr><td>Date of birth</td><td><span>05 October
1972</span></td></tr></tbody></table></div>"
  },
  "active": true,
  "name": [
    {
      "use": "official",
      "family": [
        "Alm<sup>si</sup>"
      ],
      "given": [
        "Viktor"
      ]
    },
    {
      "use": "email",
      "given": [
        "vik@stockmail.net"
      ]
    }
  ],
  "gender": "male",
  "birthDate": "1972-10-05"
}
```

3.3 Example of Practitioner entity

```
{
  "resourceType": "Practitioner",
  "id": "CONDOC1",
  "meta": {
    "versionId": "24",
    "lastUpdated": "2016-06-02T08:40:43.155Z"
  },
  "active": true,
  "name": {
    "family": [
      "Kotroczo"
    ],
    "given": [
      "Peter"
    ],
    "prefix": [
      "Dr."
    ]
  },
  "practitionerRole": [
    {
      "role": {
        "coding": [
          {
            "system": "http://hl7.org/fhir/v2/0286",
            "code": "RP"
          }
        ]
      },
      "period": {
        "start": "2001-05-22",
        "end": "2030-10-31"
      },
      "location": [
        {
          "display": "South Wing, second floor"
        }
      ]
    }
  ],
  "qualification": [
    {
      "identifier": [
        {
          "system": "http://example.org/UniversityIdentifier",
          "value": "12345"
        }
      ],
      "code": {
        "text": "Bachelor of Science"
      },
      "issuer": {
        "display": "Example University"
      }
    }
  ]
}
```

3.4 Example of Summary Observation

```

{
  "resourceType": "Observation",
  "id": "375812",
  "meta": {
    "versionId": "1",
    "lastUpdated": "2016-06-13T09:58:56.894Z"
  },
  "status": "final",
  "code": {
    "coding": [
      {
        "system": "http://loinc.org",
        "code": "SUM DAY BP",
        "display": "Blood pressure systolic & diastolic"
      }
    ]
  },
  "subject": {
    "reference": "Patient/CON3"
  },
  "effectiveDateTime": "2016-06-02",
  "performer": [
    {
      "reference": "Practitioner/CONDOC1"
    }
  ],
  "component": [
    {
      "code": {
        "coding": [
          {
            "system": "Concerto",
            "code": "AVERAGE",
            "display": "Blood pressure systolic & diastolic
average"
          }
        ]
      },
      "valueQuantity": {
        "value": 113.03492662037513,
        "unit": "mm[Hg]"
      }
    },
    {
      "code": {
        "coding": [
          {
            "system": "Concerto",
            "code": "MAXIMUM",
            "display": "Blood pressure systolic & diastolic
maximum"
          }
        ]
      },
      "valueQuantity": {
        "value": 143.01391133372425,
        "unit": "mm[Hg]"
      }
    },
    {
      "code": {
        "coding": [
          {
            "system": "Concerto",
            "code": "MINIMUM",
            "display": "Blood pressure systolic & diastolic
minimum"
          }
        ]
      }
    }
  ]
}

```



```
    ]
  },
  "valueQuantity": {
    "value": 84.96028511174224,
    "unit": "mm[Hg]"
  }
},
{
  "code": {
    "coding": [
      {
        "system": "Concerto",
        "code": "AVERAGE",
        "display": "Heart rate"
      }
    ]
  },
  "valueQuantity": {
    "value": 93.02248032981998,
    "unit": "bpm"
  }
},
{
  "code": {
    "coding": [
      {
        "system": "Concerto",
        "code": "MAXIMUM",
        "display": "Heart rate"
      }
    ]
  },
  "valueQuantity": {
    "value": 95.59344378020172,
    "unit": "bpm"
  }
},
{
  "code": {
    "coding": [
      {
        "system": "Concerto",
        "code": "MINIMUM",
        "display": "Heart rate"
      }
    ]
  },
  "valueQuantity": {
    "value": 88.6863602059416,
    "unit": "bpm"
  }
}
]
```

3.6 Example of Goal entity

```

{
  "resourceType": "Goal",
  "id": "379909",
  "meta": {
    "versionId": "1",
    "lastUpdated": "2016-06-16T12:44:21.172Z"
  },
  "extension": [
    {
      "url": "http://hl7.org/fhir/StructureDefinition/goal-target",
      "extension": [
        {
          "url": "goal-target.measure",
          "valueCodeableConcept": {
            "coding": [
              {
                "system": "http://loinc.org",
                "code": "8867-4"
              }
            ]
          }
        },
        {
          "url": "goal-target.detail",
          "valueQuantity": {
            "value": 65,
            "system": "http://units-of-measure.org",
            "code": "bpm"
          }
        },
        {
          "url": "goal-target.tolerance",
          "valueQuantity": {
            "value": 5,
            "system": "http://units-of-measure.org",
            "code": "%"
          }
        },
        {
          "url": "goal-target.min",
          "valueQuantity": {
            "value": 60,
            "system": "http://units-of-measure.org",
            "code": "bpm"
          }
        },
        {
          "url": "goal-target.max",
          "valueQuantity": {
            "value": 70,
            "system": "http://units-of-measure.org",
            "code": "bpm"
          }
        }
      ]
    }
  ],
  "subject": {
    "reference": "Patient/CON2"
  },
  "status": "planned"
}

```

3.7 Example of CarePlan entity

```

{
  "resourceType": "CarePlan",
  "id": "380238",
  "meta": {
    "versionId": "1",
    "lastUpdated": "2016-06-20T14:20:04.090Z"
  },
  "subject": {
    "reference": "Patient/CON3"
  },
  "status": "active",
  "period": {
    "start": "2016-06-20T14:20:07.153Z",
    "end": "2016-06-28T22:00:00.000Z"
  },
  "participant": [
    {
      "role": {
        "text": "responsiblePerson"
      },
      "member": {
        "reference": "Patient/CON3"
      }
    },
    {
      "role": {
        "text": "adviser"
      },
      "member": {
        "reference": "Practitioner/CONDOC1"
      }
    }
  ],
  "goal": [
    {
      "reference": "Goal/380220"
    },
    {
      "reference": "Goal/380229"
    },
    {
      "reference": "Goal/380223"
    },
    {
      "reference": "Goal/380235"
    },
    {
      "reference": "Goal/380232"
    },
    {
      "reference": "Goal/380226"
    }
  ],
  "activity": [
    {
      "detail": {
        "category": {
          "coding": [
            {
              "system": "http://hl7.org/fhir/care-plan-activity-
category",
              "code": "observation"
            }
          ]
        }
      },
      "code": {

```

```
        "text": "hipotenzio kezeles"
      },
      "prohibited": false,
      "scheduledTiming": {
        "repeat": {
          "frequency": 1,
          "period": 1,
          "periodUnits": "d"
        }
      },
      "performer": [
        {
          "reference": "Patient/CON3"
        }
      ]
    }
  ]
}
```

3.8 Example of DetectedIssue entity

```
{
  "resourceType": "DetectedIssue",
  "category": {
    "coding": [
      {
        "system": "http://hl7.org/fhir/v3/ActCode",
        "code": "CRIT",
        "display": "criticality"
      }
    ]
  },
  "severity": "high",
  "implicated": [
    {
      "reference": "Observation/14336"
    }
  ],
  "detail": "Very high bloodpressure despite prescribed treatment",
  "date": "2016-05-10",
  "author": {
    "reference": "Practitioner/CONDOC1"
  },
  "mitigation": [
    {
      "action": {
        "text": "Asked patient for immediate examination"
      },
      "date": "2016-05-10",
      "author": {
        "reference": "Practitioner/CONDOC1"
      }
    }
  ]
}
```

Important, if POST is used for uploading, JSON cannot contain id field, as the meta will be assigned by the server.