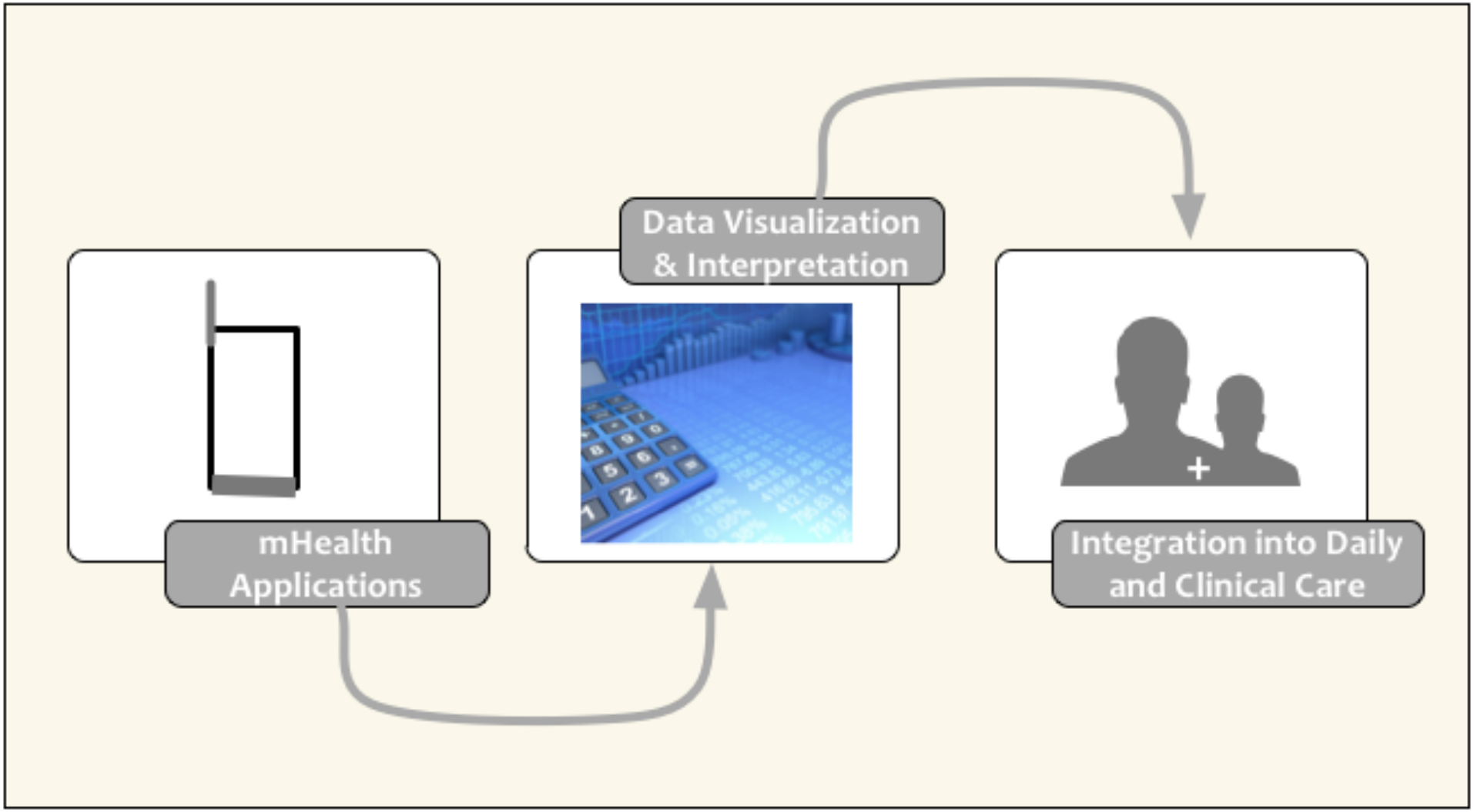
Open Architecture for Data Interchange

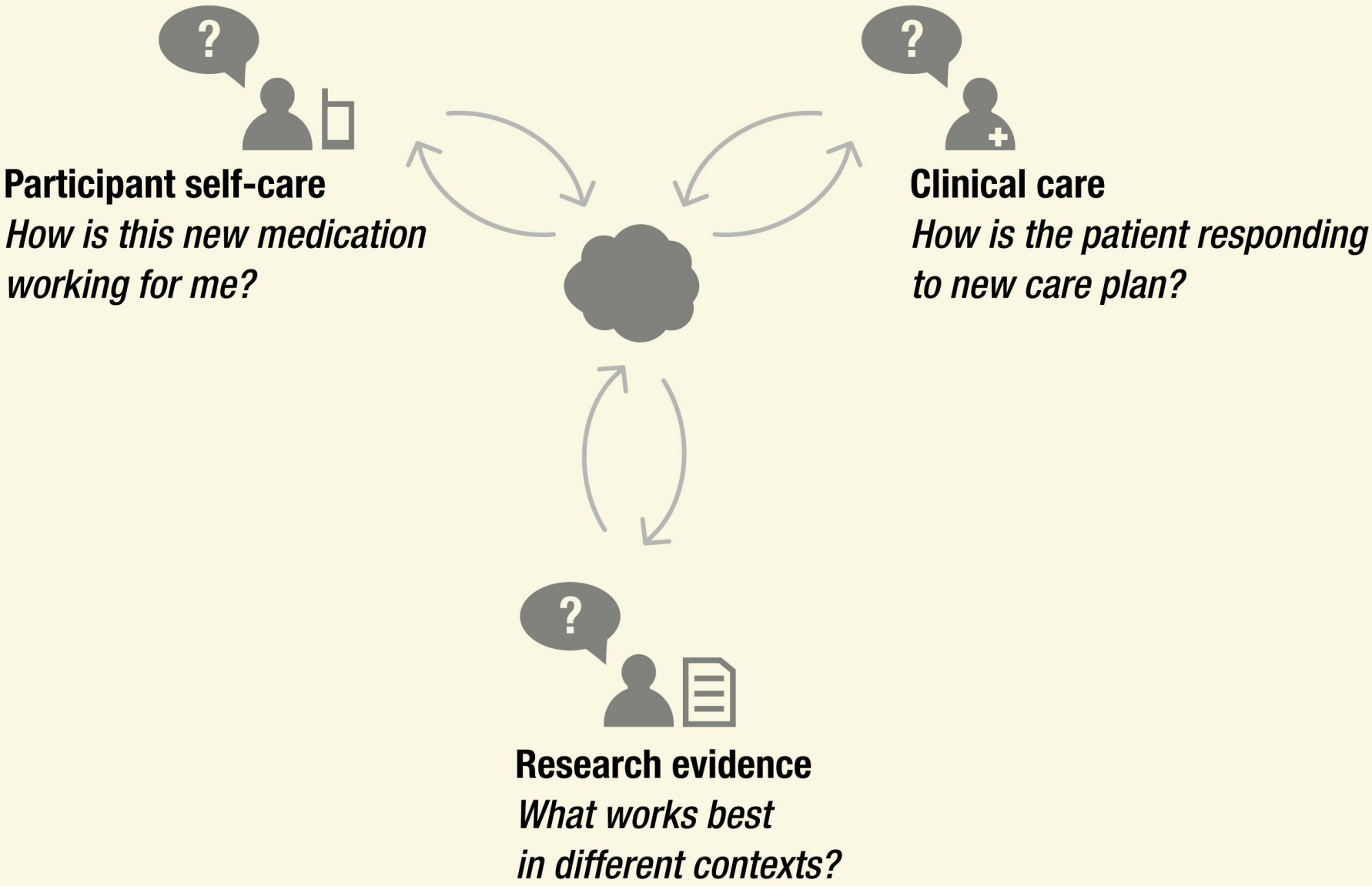
A project of the Tides Center

pioneer
Robert Wood Johnson Foundation

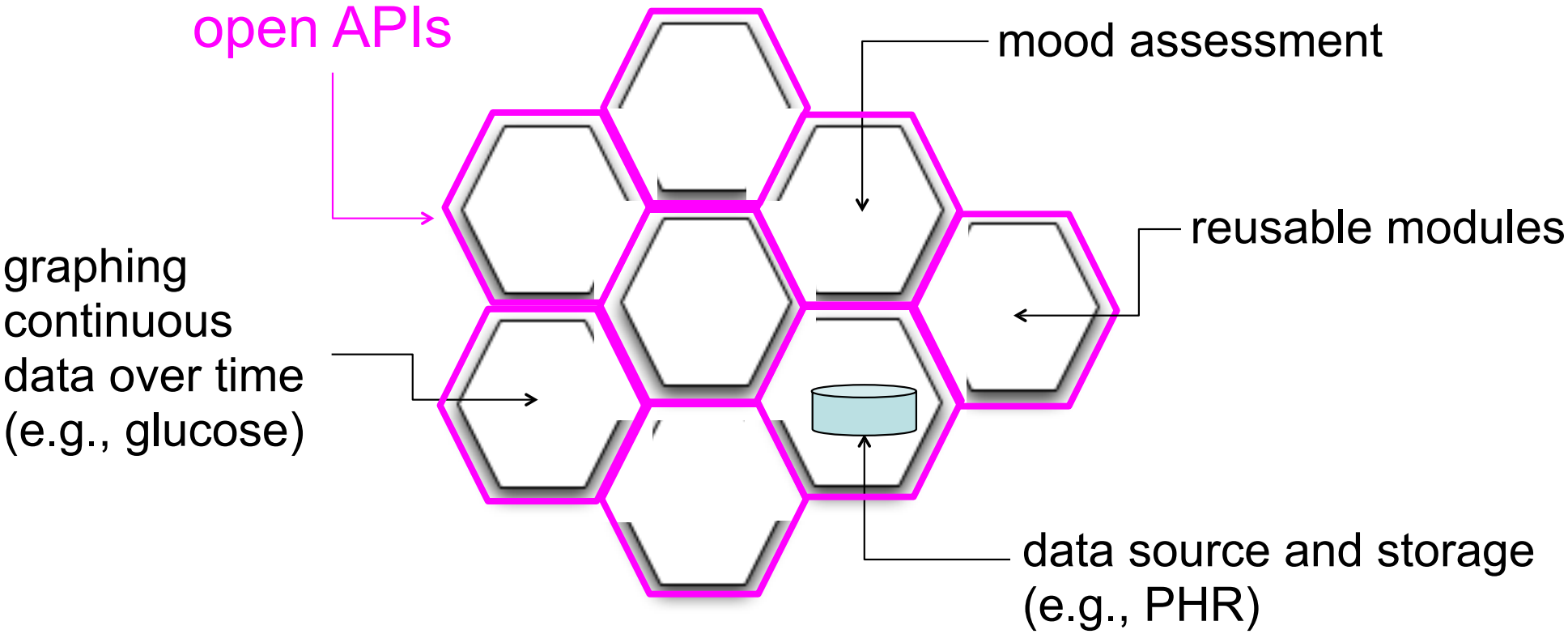

Data Visualization & Interpretation
mHealth Applications
Integration into Daily and Clinical Care

data driven feedback loops

Essential data driven feedback loops

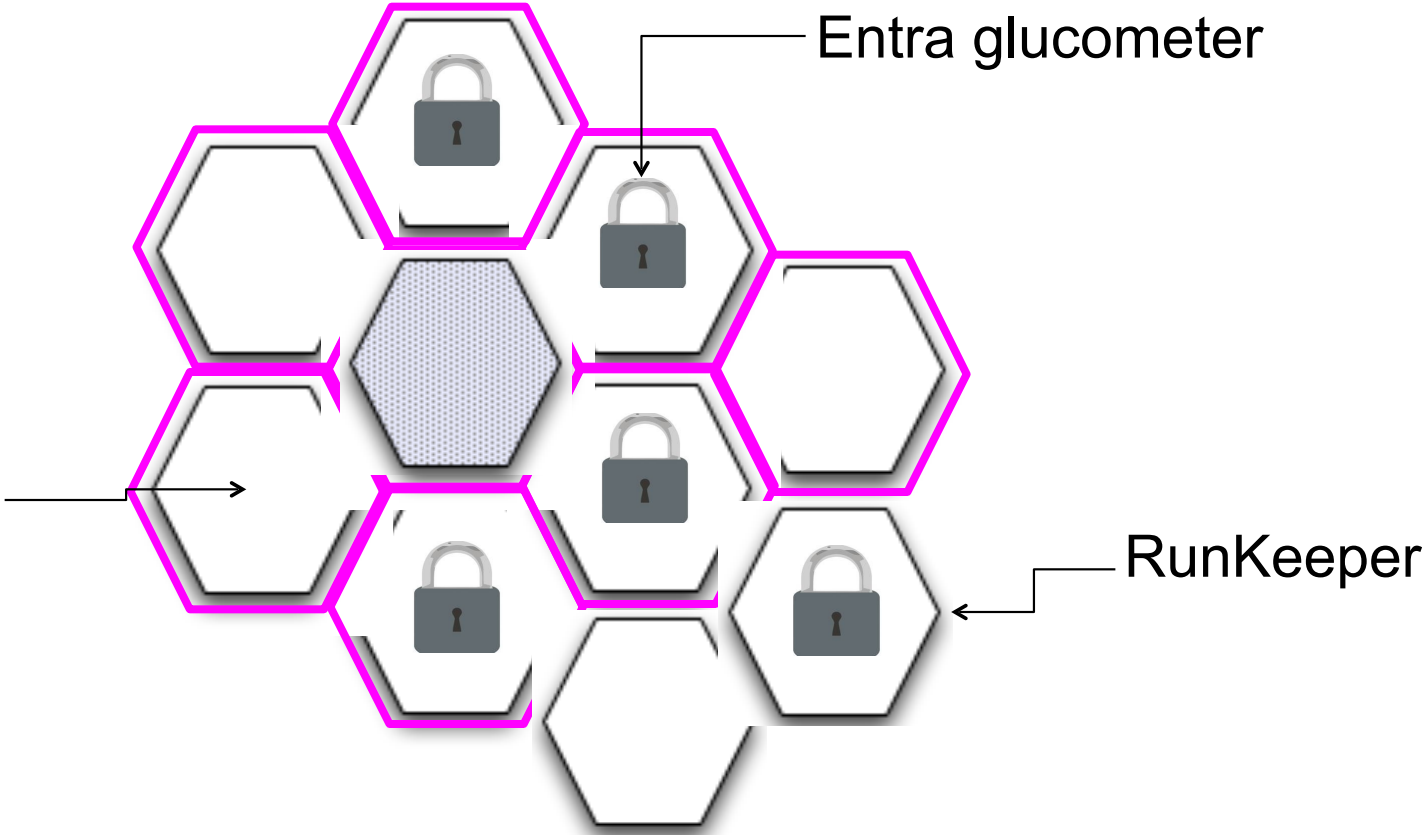


open architecture for mobile health



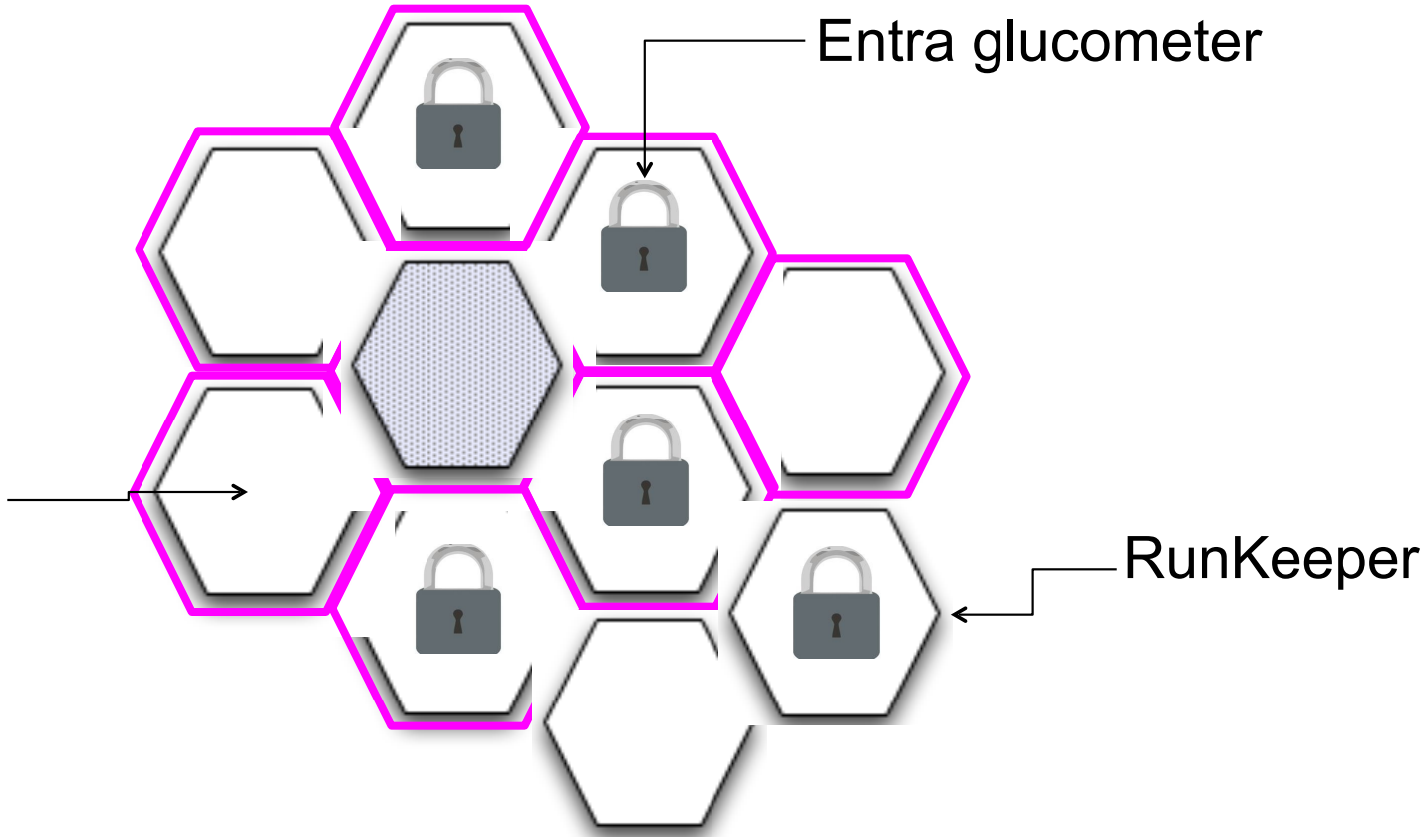
a small set of common principles/practices by which reusable modules are described and interface to one another

enabling reuse, integration, and innovation



more integrated and connected solutions

how to interoperate "glucose" data from the Entra glucometer?



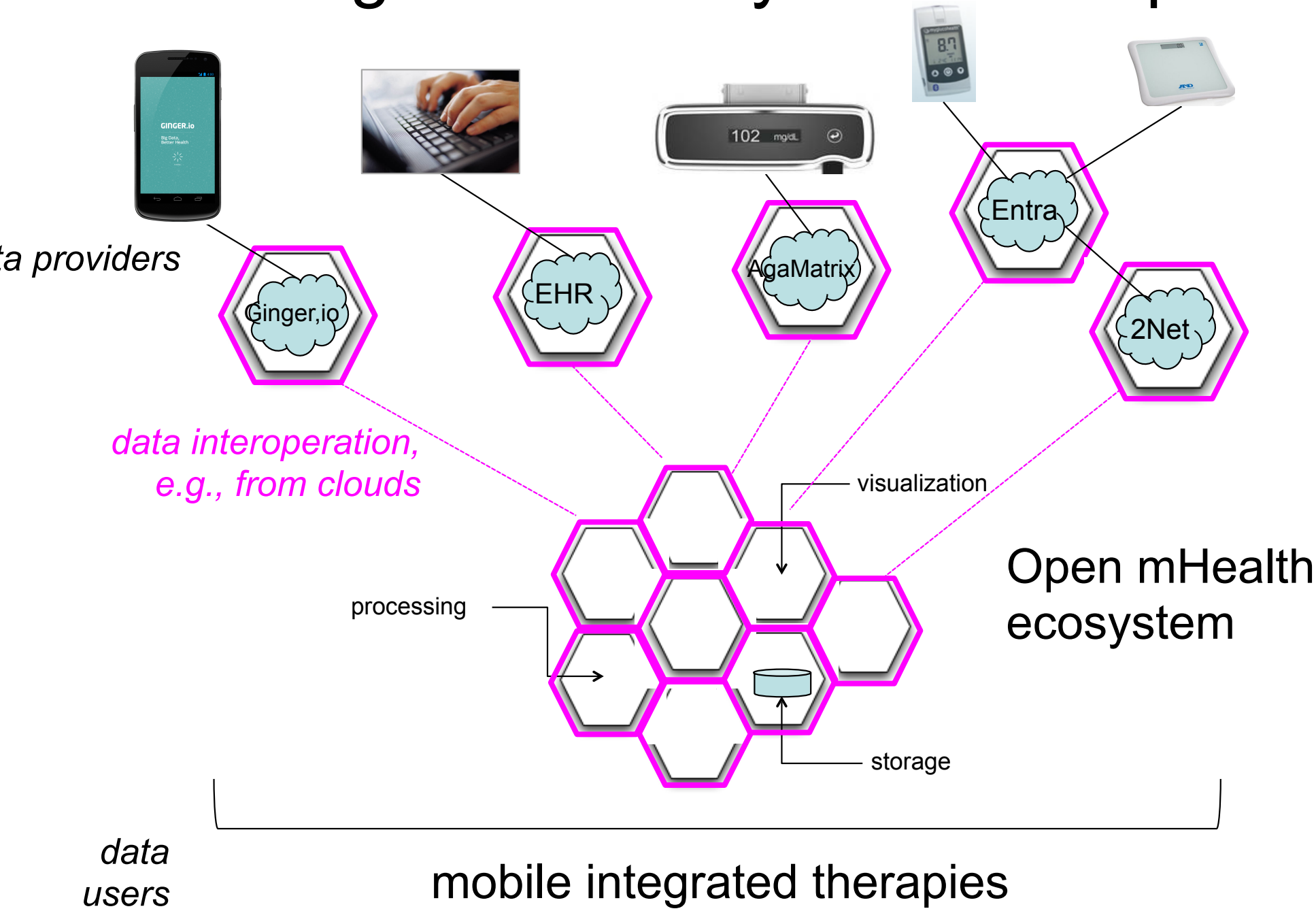
philosophical approach

we believe that imposed standards are difficult to get adopted

we are for use-case driven usage leading to emergent best practices and *de facto* standards

- our architecture and community is designed to enable these best practices to emerge and to become transparent to the community

Addressing *Data* not System Interoperation



syntactic data interoperation in Open mHealth

API calls are in JSON using the Concordia schema language that defines strongly typed JSON

Data should be divided into "payloads." A payload is a set of data that conforms to a set of definitions specified by a schema ID

Schema IDs are similar in definition to URNs, i.e., they are colon delimited strings

http://developer.openmhealth.org/developer/

schema ID

2nd section is the domain that will handle this API call

omh:mydomain:Glucose

first section must be "omh"

3rd section is a label for the payload

example schema

schema ID: omh:mydomain:Glucose

```
{
  "type":"object",
  "fields":[
    {
      "name":"glucose",
      "type":"number"
    }
  ]
}
```

semantic data interoperation in Open mHealth

use-case driven semantic commitment

- app producers are best positioned to know how specific and standardized their semantics need to be

late binding

- "binding" a data element to shared semantics should happen only when needed (e.g., not within the app itself, but only later when data is being exchanged)

multiple binding

- can bind to one or more shared semantics (terminologies, ontologies, etc) to meet multiple needs

binding to a standard terminology

schema ID: omh:mydomain:FastingGlucose

```
{
   "type":"object",
   "fields":[
     {
       "external_id": ["http://purl.bioontology.org/ontology/LNC/1558-6"]
       ,"name":"fasting_glucose"
       ,"type":"number"
     }
  ]
}
```

**Metadata fields such as time and location stamps are omitted from these examples for clarity. Schemas can be extended with custom metadata fields.*

multiple binding

schema ID: omh:mydomain:FastingGlucose

```
{
  "type":"object",
  "fields":[
    {
      "external_id":[
        "http://purl.bioontology.org/ontology/LNC/1558-6",
        "http://purl.bioontology.org/ontology/RCD/XE2mq"
      ],
      "name":"fasting_glucose",
      "type":"number”
    }
  ]
}
```

preferred schemas

schema ID: omh:preferred:FastingGlucose

```
{
  "type":"object",
  "fields":[
    {
      "external_id":[
        "http://purl.bioontology.org/ontology/LNC/1558-6",
      ],
      "name":"fasting_glucose",
      "type":"number”
    }
  ]
}
```

preferred schemas are shared across the whole Open mHealth ecosystem

the community will define which schema-IDs are preferred

- data elements in preferred schemas should bind to a standard terminology if at all possible

registry.openmhealth.org

(coming May 1, 2013)

a catalog of schema IDs, APIs, and modules

- will be living documentation about the ***state of the Open mHealth ecosystem*** where you can see ***who is using which standards for what*** and ***where the community is most active***
- together, the Open mHealth community will evolve a ***de facto common practice*** towards standardized data interchange (e.g., through preferred schema IDs)

data model interoperation

we believe that imposed standards are difficult to get adopted

we are for use-case driven usage leading to emergent best practices and *de facto* standards

- our architecture and community is designed to enable these best practices to emerge and to become transparent to the community

polymorphic data models

schema ID: omh:mydomain:FastingGlucose

```
{
  "type":"object",
  "fields":[
    {
      "external-id": ...
      "name":"fasting_glucose",
      "type":"number",
      "doc":"if units are missing
        then assume mg/dl"
    },
    {
      "name":"units"
      "allowed_values":[
         "mg/dl", "mmol/L"
      ],
      "optional":true
    }
  ]
}
```

```
{
  …
  "data":{
    "fasting_glucose":105,
    "units":"mg/dl"
   }
}
```

or

```
{
  …
  "data":{
    "fasting_glucose":105
  }
}
```

schemas can extend other schemas through inheritance

basic unit schema

schema ID: omh:omh:valAndUnit

```
{
  "type":"object",
  "fields":[
  {
    "name":"value",
    "doc":"The value of the element.",
    "type":"number"
  },
  {
    "name":"unit",
    "doc":"The unit of the element.",
    "type":"string"
  }
]}
```

Will pass schema validation:

```
[
  {
    "value":90,
    "unit":"meter"
  }
]
```

```
[
  {
    "value":90,
    "unit":"any string"
  }
]
```

Will fail schema validation:

```
[
  {
    "value":"sixteen",
    "unit":"gram"
  }
]
```

basic multiple-unit schema

schema ID: omh:omh:valAndUnit:distance

```
{
 "type":"object",
 "fields": [
 {
   "$ref":"http://example.com/
             omh:omh:valAndUnit",

   "allowed_values":[
       "miles", "yards", "inches"
   ]
 }
]}
```

Will not fail schema validation:

```
[
  {
    "value":90,
    "unit":"yards"
  }
]
```

Will fail schema validation:

```
[
  {
    "value":90,
    "unit":"meters"
  }
]
```

preferred stepLength schema

schema ID: omh:preferred:stepLength

```
{
  "type":"object",
  "fields": [
  {
    "$ref":"http://example.com/
        omh:omh:valAndUnit:distance",
  },
  {
    "external_id":[
        http://purl.bioontology.org/
ontology/SNOMEDCT/250000008,
      ],
    "name":"timestamp",
    "type":"string",
    "dateFormat":"dateTime"
    "doc":"W3C ISO 8601 timestamp"
}]}
```

```
[
  {
    "timestamp":"2013-03-19T12:52:01Z",
    "value":87.6,
    "unit":"centimeter"
  },
  {
    "timestamp":"2013-03-19T12:52:02Z",
    "value":91.4,
    "unit":"centimeter"
  }
]
```

daily step distance

schema ID: omh:omh:dailyStepDistance

```
{
  "type":"object",
  "fields": [
    {
      "name":"total_steps",
      "type":"number"
    },
    {
      "name":"total_step_distance",
      "$ref":"http://example.com/
        omh:omh:valAndUnit:distance"
    }
  ]
}
```

```
[
  {
    "total_steps":11951,
    "total_step_distance": {
      "value":5.38,
      "unit":"miles"
    }
  }
]
```

semantic data sharing

semantics handled via external references to URNs at terminology servers (e.g., BioPortal, HDD Access)

- servers can also offer web services for computing subsumption, transitive closure, etc.

reusable Open mHealth-compliant Data Processing Units (DPUs) can be mixed and matched for performing data alignment

- community will define common context metadata

interoperation with the EHR

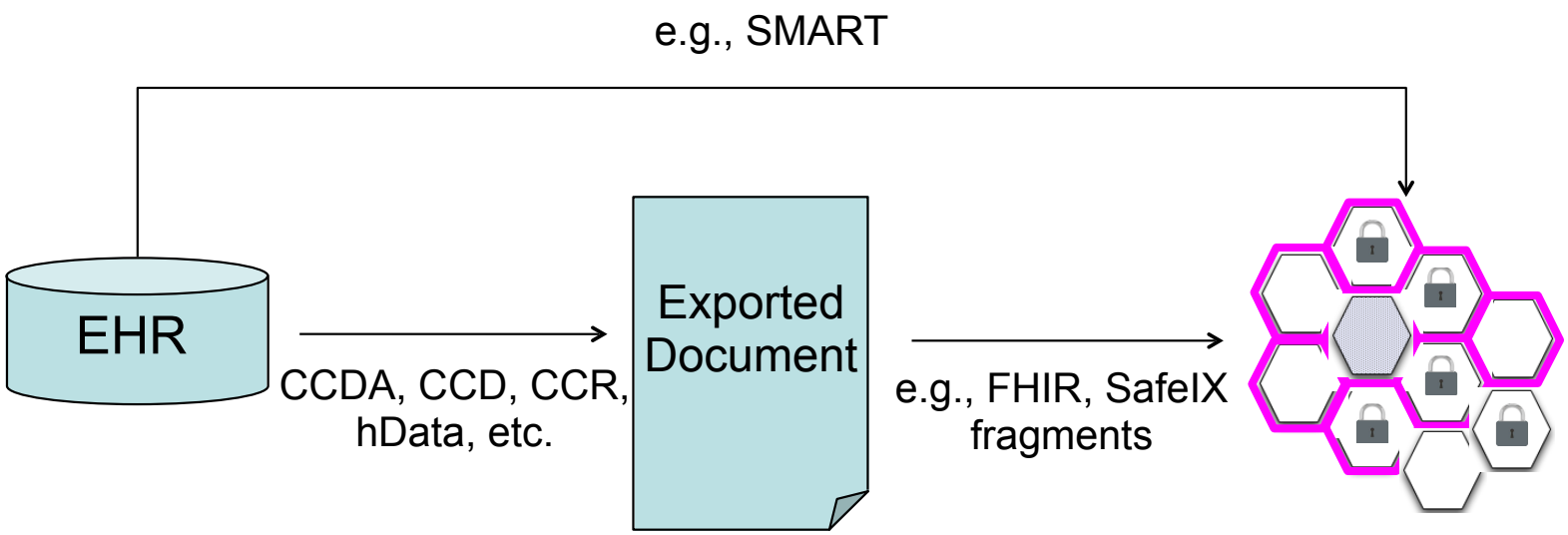
data *from* the EHR to mHealth

- focusing on a few highest-value atomic EHR data elements to get out of EHRs for self care of health and disease (e.g., meds, allergies, demographics, some labs)

data *into* the EHR from mHealth

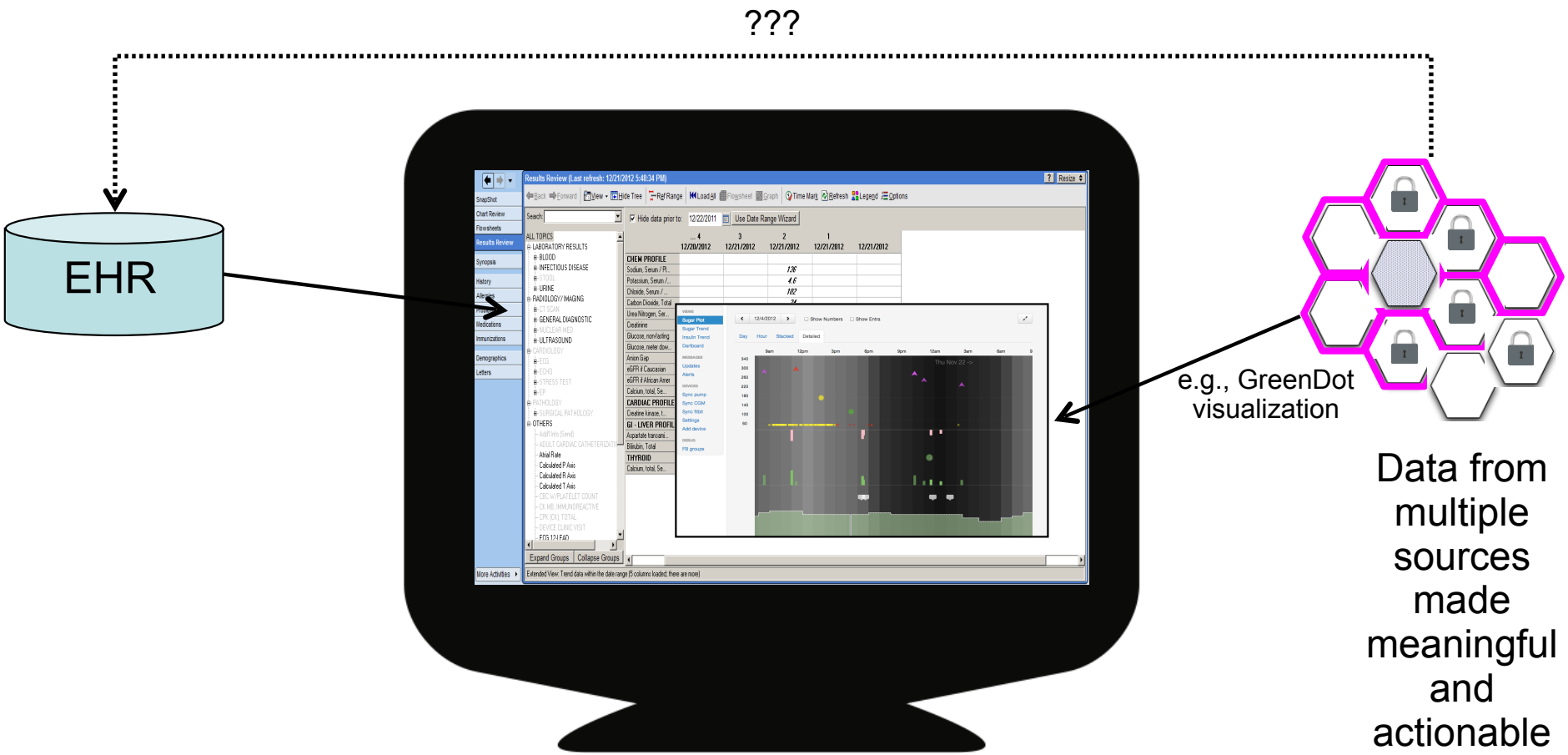
- greatest value for clinicians is tools for making sense of multiple sources of mHealth data to inform decision making
  - sometimes this needs to be part of the EHR, sometimes not
  - defer getting variables (e.g., 6 minute walk, PHQ-9, etc.) back into the EHR

data *from* the EHR



Atomic data elements in
Open mHealth compliant
form

data *into* the EHR



connect with us

- Web: www.openmhealth.org
- Data Interchange Working Group
  - http://wiki.openmhealth.org/Data+Interchange
  - coordinator: ida@openmhealth.org

daily activity summary

schema ID: omh:omh:dailyActivity

```
{
"type":"object",
"fields": [
  {
    "name":"date",
    "type":"string",
    "dateFormat":"date"
  },
  {
    "name":"activity_group",
    "type":"array",
    "fields":{
      "type":"object",
      "schema":[
         {
           "name":"minutes_of_activity",
           "$ref":"http://example.com/
                 omh:omh:valAndUnit"
         },
         {
           "name":"activity_level",
           "type":"string",
           "allowed_values":
           ["sedentary","light","moderate",
           "vigorous"]
}]}}]}
```

```
[
  {
    "date":"2013-03-25",
    "activity_group": [
      {
        "activity_level":"sedentary",
        "minutes_of_activity":{
          "value":1129.8,
          "units":"minutes"
        }
      },
      {
        "activity_level":"light",
          "minutes_of_activity":{
            "value":120,
            "units":"minutes"
         }
      },
      ...
    ]
  },
  ...
]
```

daily chunked activity

schema ID: omh:omh:dailyChunkedActivity

```
{
"type":"object",
"fields": [
  {
    "name":"date",
    "type":"string",
    "dateFormat":"date"
  },
  {
    "name":"activity_group",
    "type":"array",
    "fields":{
      "type":"object",
      "schema":[
         {
           "name":"time_start",
           "type":"string"
           "dateFormat":"time"
         },
         {
           "name":"time_end",
           "type":"string"
           "dateFormat":"time"
         },
         {
           "name":"activity_level",
           "type":"string",
           "allowed_values":
           ["sedentary","light","moderate",
           "vigorous"]
}]}}]}
```

```
[
  {
    "date":"2013-03-25",
    "activity_group": [
      {
        "activity_level":"sedentary",
        "time_start":"00:00",
        "time_end":"07:00"
      },
      {
        "activity_level":"light",
        "time_start":"07:01",
        "time_end":"08:00"
      },
      ...
    ]
  },
  ...
]
```

daily activity (non-sedentary)

schema ID: omh:omh:dailyNonSedentaryActivity

```
{
  "type":"object",
  "fields": [
    {
      "name":"date",
      "type":"string",
      "dateFormat":"date"
    },
    {
      "name":"minutes_non-sedentary",
      "$ref":"http://example.com/
         omh:omh:valAndUnit",
    }
  ]
}
```

```
[
  {
    "date":"2013-03-25",
    "minutes_non_sedentary": {
      "value":120,
      "units":"minutes"
    }
  },
  {
    "date":"2013-03-26",
    "minutes_non_sedentary": {
      "value":108,
      "units":"minutes"
    }
  },
  ...
]
```