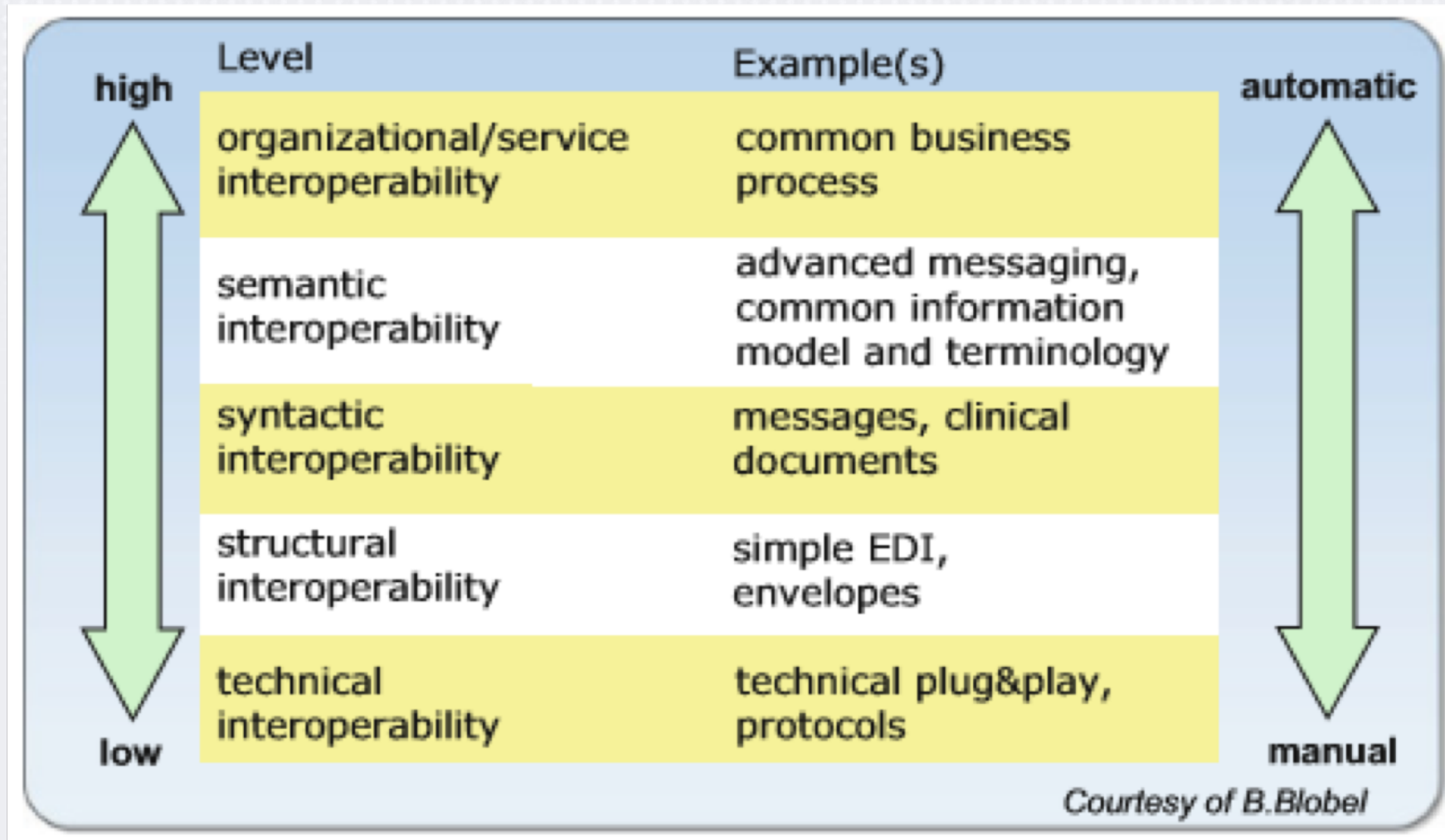


Interoperability

Levels

Interoperability Levels



Interoperability levels

Interoperability Levels

- Non-electronic information
- Machine Transportable
- Machine Organizable
- Machine interpretable

Interoperability Levels

- **Non-electronic information**

- Health information is recorded and shared on paper

e.g., a referral letter from a general practitioner to a specialist; a prescription from a doctor to a pharmacist

- **Machine Transportable**

- Information technology is utilized
- Shared messages are not standardized

e.g. using fax or emails to share information

Interoperability Levels

- **Machine Organizable**
 - Structured messages
 - Messages don't contain structured data
 - Interface between different information systems is required to translate the structures from one system to another

Interoperability Levels

- **Machine interpretable**

- Structured messages
- Standardized data
- Receiver understands the format and terms in the message without the need of external interface to interpret the message

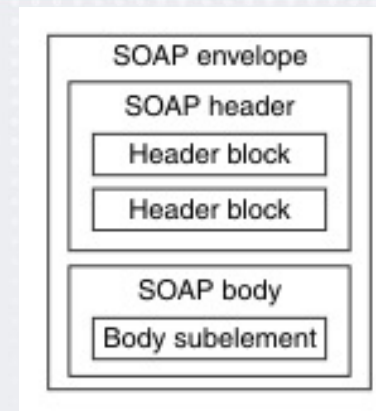
e.g., discharge summary can be transmitted from hospital health information systems to general physician, using structured format, used by both systems

Interoperability

Syntactic

Syntactic Interoperability

- Syntax: *the grammar and formal rules for defining a set of data*
- Syntactic interoperability is the ability of exchanging messages between systems
- Syntactic interoperability is domain independent; it does NOT know the meaning of the message being exchanged
- The data formats and communication protocols should be defined beforehand to establish syntactic interoperability
- e.g. XML and SQL standards - are examples of tools for syntactic interoperability



```
<?xml version="1.0"?>

<soap:Envelope
xmlns:soap="http://www.w3.org/2003/05/soap-envelope/"
soap:encodingStyle="http://www.w3.org/2003/05/soap-encoding"

<soap:Header>
...
</soap:Header>

<soap:Body>
...
  <soap:Fault>
  ...
  </soap:Fault>
</soap:Body>

</soap:Envelope>
```

SOAP message uses XML

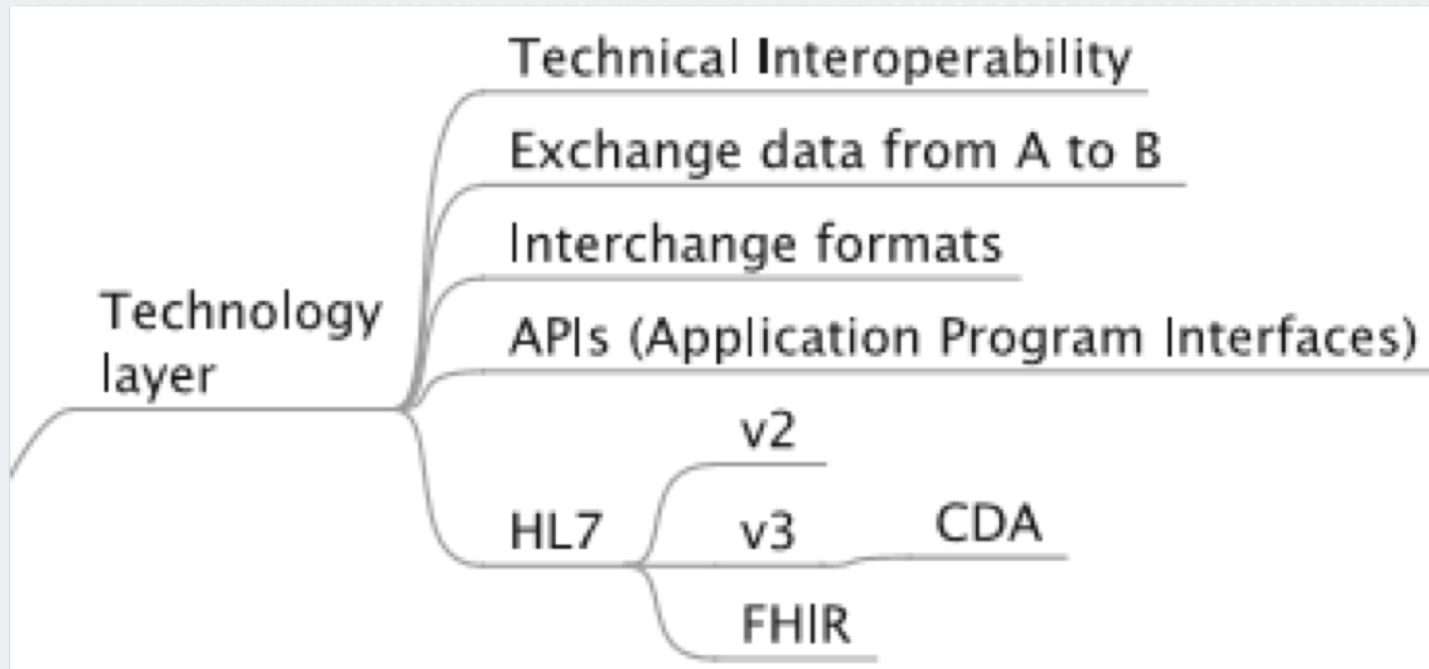
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Syntactic Interoperability

- It can be defined on
 - *“...is usually associated with hardware/software components, systems and platforms that enable machine-to-machine communication to take place. This kind of interoperability is often centered on (communication) protocols and the infrastructure needed for those protocols to operate” [ETSI 2006]*
- It is associated with data formats
 - *i.e. it requires communication protocols that have a well-defined syntax and encoding, which simply carry data or content, such as HTML, XML or ASN.12*

Syntactic Interoperability

- In the interoperability layers, Syntactic is considered addressed in the technical layer



Source: Principles of Health Interoperability

- remember: Technical interoperability only guarantees the correct transmission of bits (i.e., messages), but nothing about the meaning of these bits and what they represent

Syntactic Interoperability

- Syntactic interoperability is achieved when two (or more) systems are capable of communicating and exchanging data
 - No domain specific knowledge is necessary in this level
 - It allows the exchange of messages without any consideration of their contents
- For example,
 - the string, “20170115” can be identified as a string, a code or a date
 - the string, “4548-4” may represent a code
 - However, these without any further identifying information is *meaningless*
- Syntactic interoperability is necessarily required to achieve next levels of interoperability

Interoperability

Semantic

Semantic Interoperability

- It can be defined as
 - *“the ability to import utterances from another computer without prior negotiation and have your decision support, data queries and business rules continue to work reliably against these utterances”, [Dollin and Alschuler]*
- In semantic interoperability, both the sender and receiver of the clinical message should **understand** the same data in the same way
- It allows computers to share, understand, interpret, and use data without ambiguity

* Dolin R, Alschuler L. Approaching semantic interoperability in health level seven.

34 JAMIA. 2011;18:99–103.

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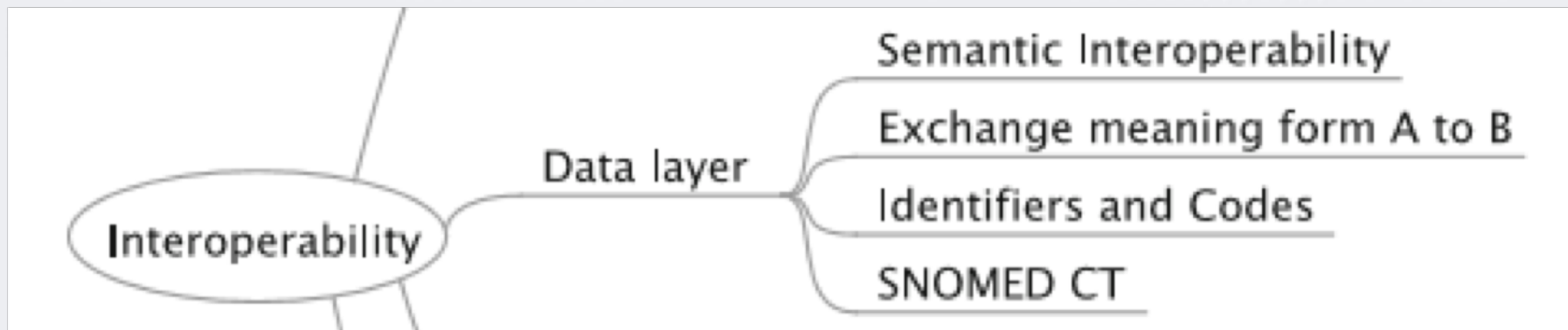
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Semantic Interoperability

- Semantic interoperability is beyond the ability of computer systems to just exchange messages,
 - It is the ability to communicate information and have that information correctly *interpreted* by the receiving system
 - It can be achieved by having both sides (i.e., the sender and receiver) to refer to the exchanged information to a *reference model*
- The correct *interpretation* of the received message is a necessary precondition to define, process, and store data entity correctly and *meaningfully*
- Syntactic interoperability is a *pre-requisite* for semantic interoperability (which defines the data format and communication protocols to structure the data being exchanged)

Semantic Interoperability

- Semantic interoperability is domain specific (e.g. clinical)
- Semantic interoperability is context specific (see next slides)
- It requires the use of unambiguous codes and identifiers



Source: Principles of Health Interoperability

Context: General Medical Summary

List of diagnoses and procedures

| | | |
|------|-----------|--------------------------|
| 1993 | Procedure | Appendicectomy |
| 1996 | Diagnosis | Meningococcal meningitis |
| 1997 | Procedure | Termination of pregnancy |
| 2003 | Diagnosis | Acute psychosis |
| 2006 | Diagnosis | Schizophrenia |



Can we safely interpret a diagnosis without its context?

Clinical Interpretation Context

| | |
|----------------------|---------------------------------------------------|
| Emergency Department | Seen by junior doctor |
| Reason for encounter | Brought to ED by family |
| Symptoms | "They are trying to kill me" |
| Mental state exam | Hallucinations Delusions Disordered thought |
| Diagnosis | Schizophrenia |
| Certainty | Working hypothesis |
| Management plan | Admission etc..... |

Junior doctor,
emergency situation,
a working hypothesis
so
schizophrenia is not a
reliable diagnosis

Semantic Interoperability

- Syntactic interoperability Versus Semantic interoperability
 - *Syntax: the grammar and formal rules for defining a set of data => Syntactic interoperability enables the exchange of clearly defined classes of data*
 - *Semantic: the meaning and the use of these data => Semantic interoperability enables the automatic recognition/interpretation of the individual data exchanged*

In the semantic layer, data becomes [meaningful] information

[Woods 1975]

Semantic Interoperability

- Semantic interoperability, can be achieved only if:
 - The semantics of data are defined and shared.
 - The data can be processed and sent from one system to another and it can be recognized and processed automatically, i.e. *machine processable*
- This requires a common definition for each data in every field of a data set
- The main issue is defining common definitions of exchanged data
- The problem is in the diversity and heterogeneity of existing codes
 - e.g. A non-health example: an electronic invoices sent from a supplier's computer system are automatically recognized, compared to the delivery notification, and processed by the accounting system of the customer. This can be achieved by identifying the date of the invoice, its number, and the amount to pay

Semantic Interoperability

- One of the solutions, from the Computer Science perspective
 - Using Ontologies: ontologies map objects within dedicated *domains*
 - Terminology standards are built using/as ontologies: terminology standards are developed for different clinical domains.
e.g. ICD10: diseases, LOINC: lab tests, RxNORM: Drugs)
- e.g. in healthcare system, the code “4548-4” is associated with an exchanged clinical message/data made with a LOINC system, a specific meaning is derived (i.e., “Hemoglobin Alc/Hemoglobing.total in Blood”)
- If this code is conveyed within an order to laboratory, a receiver may initiate a specific action

Interoperability

Benefits and Challenges

Benefits of Interoperability

- Patients to benefit from *enhanced treatment* received
- Delivery of healthcare when/where **required** - at any point of care.
- *Integrated care* plans by providers across one or more organisations
- National interoperability will facilitate emergency care **internationally**.
- Some health services can be become as **eHealth services** provided when needed
- Reduce **Clinical/medication Errors**, e.g. possible interoperability with pharmacy systems to reduce potential harm from drug interactions
- Better clinical decision making that leads to **safer quality care** by accessing health information linked to electronic patient record

Benefits of Interoperability

- Better **decision making process** by integrating healthcare systems across various points/organisations of care delivery
- Reduction of **duplication** of data entry
- **Cost saving** by reducing redundancy in duplicate diagnostic tests
- Benefit the software industry by enabling a single market for **digital healthcare** which leads to reduced cost of health information system development
- **Faster access** to care, diagnosis, tests, and treatments for health care providers, individuals, and insurance companies
- Patients can seek **alternative medical** treatment easily

Challenges of Interoperability

- A key challenge in implementing interoperability standards is the **heterogeneity** of information systems
- Different **software suppliers** have different **proprietary** standards
- No single health information system to support all health services e.g. administrative, clinical, technical, and laboratory requirements
- Hence, interoperability standards became evident

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Thanks!
Any questions?

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