0 INTRODUCTION

0.1 Background

This Study Guide is meant for students who want to learn about the HL7® FHIR® communications standard. It will also prepare students for the HL7® FHIR® certification examination conducted by the HL7 organization (see www.hl7.org). It covers all HL7 FHIR technical interfacing skills that are highly desired for these professionals to do their job in a proficient manner. This guide is intended to be version agnostic, i.e. independent from the current version. Readers are encouraged to use the most recent on-line available FHIR version as a resource.

Please note that this publication does not cover HL7 version 3.0, the Reference Information Model (RIM), CDA and/or HL7 Version 2.x. A separate HL7 version 2.x study guide is available from OTech Inc.

0.2 How to Use This Guide

It is assumed that the user of this guide will study the standard documents available on-line at www.hl7.org/fhir. This study guide provides an overview of the relevant subject matter.

After thorough initial preparatory study, a reader can use this guide to focus specifically on topics that are relevant for the FHIR certification and as an index to supplementary material.

The durations listed for each section are the estimated durations for a diligent reading and study of the relevant material. The amount of time required for a student to master the material may vary depending upon the student's study habits and prior knowledge of the subject matter.

Students preparing for the certification exam are encouraged to complete all chapter-specific knowledge exercises, essay questions and summary tests for best comprehension of the material.

Note: Answers to the test questions and suggested answers to the exercises appear at the end of the guide.

0.3 Copyright and Trademark Notice

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0.4 About FHIR® Certification and Testing

The purpose of the HL7 FHIR Proficiency Exam is to evaluate the test taker's comprehension of the current HL7 FHIR specification. Within the United States, candidates may take the examination at any HL7 Working Group Meeting, the HL7 Educational Summit, in-person at an approved testing center, or online proctored.

Upon successful completion of the examination, and verification of a passing grade, the candidate is awarded an HL7 FHIR Proficiency Certificate of Knowledge, recognition of their success on the HL7 website and an e-badge. Although it is anticipated that many test takers have field experience, it is not a requirement for sitting for the exam. The test is a certificate of knowledge proving proficiency in the FHIR specification, not a professional implementation credential.

The proficiency certificate provides validation that its owner has demonstrated a thorough understanding of the following HL7 FHIR specification concepts:

Competency	**% of Test**	**Chapter(s) in this Study Guide**
FHIR Fundamentals	16%	1
Resource Concepts	20%	2,3
Exchange Mechanisms (includes RESTful API)	14%	4
Conformance and Implementation Guidance	12%	7
Terminology	4%	1,2,3,4,5 6,7,8,9,10
Representing healthcare concepts using FHIR resources	14%	2,5,6,9
Safety and Security	6%	8
The FHIR Maintenance Process	10%	10
FHIR licensing and IP	4%	10

The test is closed book and the question formats are multiple choice, multi-select, and true/false. There are 50 questions on the exam. Candidates will have 2 hours to complete the exam. Candidates must score at least 70% (correct answers to 35 questions) to pass the exam. There is no penalty for guessing.

Although all aspects of the online standard should be reviewed, extra attention should be paid to the following when mastering the materials:

Links from the 'Getting Started" page (http://hl7.org/fhir/modules.html)

- The executive summary (http://hl7.org/fhir/summary.html)
- The developer introduction (http://hl7.org/fhir/overview-dev.html)
- The clinical introduction (http://hl7.org/fhir/overview-clinical.html)
- The architect's introduction (http://hl7.org/fhir/overview-arch.html)
- The overview/roadmap (http://hl7.org/fhir/overview.html)
- The open license (http://hl7.org/fhir/license.html)
- The Resource Index (http://hl7.org/fhir/resourcelist.html)

Links from the "Documentation" page (http://hl7.org/fhir/documentation.html)

- Resource (http://hl7.org/fhir/resource.html)
- Conformance Rules (http://hl7.org/fhir/conformance-rules.html)
- Resource Life Cycles (http://hl7.org/fhir/lifecycle.html)
- References between Resources (http://hl7.org/fhir/references.html)
- Narrative (http://hl7.org/fhir/narrative.htm)
- Extensibility (http://hl7.org/fhir/extensibility.html)
- Change Management and Versioning (http://hl7.org/fhir/versions.html)
- RESTful API (http://hl7.org/fhir/http.html)
- Profiling FHIR (http://hl7.org/fhir/profiling.html)
- Terminologies (http://hl7.org/fhir/terminologies.html)
- Validating Resources (http://hl7.org/fhir/validation.html)
- Security (http://hl7.org/fhir/security.html)
- Clinical Safety (http://hl7.org/fhir/safety.html)
- Guide to Resources (http://hl7.org/fhir/resourceguide.html)

Links from the "Home" start page diagram (http://hl7.org/fhir/index.html)

- Foundation (http://hl7.org/fhir/foundation-module.html)
- Implementation Support (http://hl7.org/fhir/implsupport-module.html)
- Security and Privacy (http://hl7.org/fhir/secpriv-module.html)
- Conformance (http://hl7.org/fhir/conformance-module.html)
- Terminology (http://hl7.org/fhir/terminology-module.html)
- Administration (http://hl7.org/fhir/administration-module.html)
- Clinical Summary (http://hl7.org/fhir/clinicalsummary-module.html)
- Diagnostics (http://hl7.org/fhir/diagnostics-module.html)
- Medications (http://hl7.org/fhir/medications-module.html)
- Financial (http://hl7.org/fhir/financial-module.html)
- Clinical Reasoning (http://hl7.org/fhir/clinicalreasoning-module.html)

1 FHIR® BACKGROUND AND ARCHITECTURE

11 Hours

Overview

The FHIR® (Fast Health Interoperable Resources) healthcare interoperability standard is defined and managed by HEALTH LEVEL SEVEN® International. The standard incorporates many concepts included in HL7® versions 2.x and 3, as well as the Clinical Document Architecture (CDA®) supplemented with web-based protocols. Data elements are web-accessible via pointers to master records referred to as FHIR Resources. This information model reduces redundant copies of data, provides near real-time access to updates, and simplifies interoperability development time.

The standard is labelled “Fast” which means that its development cycle is about 12-18 months for a new version, allowing experiences to be fed back to the standard for future implementations. The drawback of being “Fast” is that there could be backwards compatibility issues, requiring upgrades in the interfaces, especially for resources that are defined with a maturity level other than “normative”.

Section Learning Objectives

At the end of this section, the reader should be able to:

- Understand how FHIR differs from other interface standards.
- Understand the relationship of FHIR with HL7 V2, the strengths and weaknesses of FHIR vs V2, and know when to use each of the standards for what application.
- Compare FHIR with V3 and understand how the experience with V3 was essential for the FHIR definition, especially regarding V3 being “all-inclusive”
- Recognize that FHIR is based on the 80/20 rule, i.e. of what portion is being defined vs actually used.
- Know when to use FHIR documents, when to use CDA documents, and when to use FHIR encapsulated CDA documents.
- Understand the architectural differences between the traditional HL7 distributed data model (exchanging messages) and centralized access to FHIR resources.
- Distinguish between the different levels of FHIR release maturity. Understand the varying levels of risk associated with each.

1.1 FHIR® Background and Interface Types

2 Hours

1.1.1 Learning Objectives

FHIR® is an interface standard which incorporates web-based RESTful services to exchange clinical data securely with less development overhead.

The reader will:
- Understand the evolution of the various interface standards.
- Know the differences between FHIR, SOA, messaging and document standards.
- Understand how FHIR is an “open API”.

1.1.2 Study Resources

Using resources with Service and SOA: https://www.hl7.org/fhir/services.html

1.1.3 Key Terminology

Interoperability	
Interface	
Messaging interface	
Documents	
Services	
API	
SOA	
SOAP	
REST	
RESTful	
Extensions	

1.1.4 Summary

- The objective of FHIR is to facilitate interoperability, which (according to HIMSS) is "*The ability of different information technology systems and software applications to communicate, exchange data, and use the information that has been exchanged."*
- FHIR provides an **interface,** which is a shared boundary across which two or more separate components of a computer system exchange information.
- Interfaces can be provided by:
    - Messages: these are sent typically with an instruction, e.g. "stop medications", "admit this patient", etc.
    - Documents: these are self-contained objects such as an image, a result, or consent form
    - Services: those are used to get a worklist or update a status
    - An Application Programming Interface (API): this includes the capability to invoke a command from a toolkit, launch an application, or display an image with this study number
- A SOA (Service Oriented Architecture) provides services connected to a network, typically using SOAP messaging (Simple Object Access Protocol), however, with a non-standard interface across different vendors.
- REST (Representational State Transfer) provides a uniform, standard interface, accessible using a URL using HTTP commands for state transfers.
- FHIR uses REST but can also provide messaging, exchange documents and has a service-oriented API, therefore, it is called **RESTful.**
- By design, FHIR addresses only 80% of the most common use cases, the remaining 20% is addressed using "Extensions".
- FHIR is "controlled-extendable", which means that the Extensions are well defined and available in a machine-readable format to be interpreted by a client making an inquiry about the extensions.

1.1.5 Exercises

1. What is the difference between SOAP and REST?
2. Does FHIR guarantee interoperability?
3. Why is FHIR sometimes called an "Open API"?
4. What would you use when a patient leaves a hospital to give to his primary physician, a document or a message?
5. What does it mean that FHIR is "Stateless"?

Notes:

1.2 FHIR® Relationship with HL7® Version 2.x

2 Hours

1.2.1 Learning Objectives

FHIR® relationship with HL7® Version 2.x: FHIR uses a client-server-based approach while HL7 Version 2 is an event-driven protocol, sending unsolicited messages to each application who might need to know about the information be exchanged.

The reader will:
- Know when to use FHIR and when to use V2
- Understand the strengths and weaknesses of each protocol
- Be able to correlate the parts of the messages to each other between V2 and FHIR

1.2.2 Study Resources

Getting started: http://hl7.org/fhir/modules.html

V2 relationship: https://www.hl7.org/fhir/comparison-v2.html

1.2.3 Key Terminology

Event driven	
Client-Server	
Unsolicited messaging	
Segments	
Delimiters	
Resources	
Interface engines	
Z-Segments	
Extensions	

Human readability	
Backwards compatibility	
80/20 rule vs 99/1 rule	

1.2.4 Summary

- HL7 Version 2 is an event driven “push” protocol, for example, a patient admission causes an admission message to be sent to the interested parties and processes as an unsolicited message. Similarly, an order such as for radiology or pharmacy will result in the information to be sent to the applicable department system.
- When there are multiple systems connected, one typically uses an interface engine which determines who needs the event driven V2 message and which will forward the message to that destination.
- FHIR is based on a client-server or “pull” model, i.e. only when the information such as the outstanding orders are needed, a web-based query will be initiated to the applicable resource(s).
- Version 2 uses a delimited protocol, using, for example, the Pipe (|) delimiter, to identify the end of a component in a segment, end to identify its position (e.g. PID.3 is the 3rd item in the PID segment).
- FHIR uses a tagged protocol such as XML or JSON.
- Version 2 uses “Segments” which group related information together, such as the patient demographics being grouped in the PID segment. The V2 segments are comparable with a corresponding FHIR resource, for example, a PID segment containing patient demographics corresponds to a FHIR Patient resource.
- Version 2 messages have a great deal of information defined in their data fields, but there can be a need to add additional, either product or organization specific data, which is contained in Z-segments.
- FHIR resources have a core set of attributes (significantly fewer than HL7 V2) which address 80% of all use cases. Extensions are employed to address the remaining 20%. By contrast, V2 attempts to cover 99% of all use cases, and therefore needs relatively few additional proprietary additions in the form of Z-segments.
- V2 Z-segments are typically poorly defined and therefore not frequently re-used.
- Because FHIR extensions are well defined, machine readable and interpretable, they are often reusable.
- FHIR requires human readability, which is also required for CDA documents.
- V2 has strict rules for backwards compatibility as all additions are typically added to the end of the messages and/or components. Similarly, FHIR has strict rules for access paths that should not be changed in subsequent versions.

1.2.5 Exercises

1. Why would HL7 version 2 not be as suitable for mobile applications while FHIR would be easily accommodated?
2. What are the similarities and differences between Z-segments and Extensions?
3. If you would take a HL7 version 2 message and compare it to a FHIR message, what would the key differences be?
4. How would you map segments into the FHIR architecture?

5. Would you expect the amount of traffic using FHIR to be the same as when using HL7 V2 messaging and why?

Notes:

1.3 FHIR® Relationship with HL7® Version 3 and CDA®

 3 Hours

1.3.1 Learning Objectives

The objective of this section is to create an understanding of FHIR®'s relationship to HL7® Version 3 and CDA® (Clinical Document Architecture), in particular:

- The FHIR datatypes and resources borrow heavily from the HL7 V3 Reference Information Model (RIM) specification.
- Unlike version 3, FHIR is limited to a "core" definition and not all-inclusive; FHIR provides context information through references to other resources instead of being self-contained.
- The XML-based CDA standard is used to exchange clinical documents (e.g. between different Electronic Medical Records systems) using standard templates. It addresses a very specific use case based on the HL7 V3 RIM.
- The FHIR standard allows for encapsulation of the large install base of existing CDA interfaces.

The reader will:

- ❑ Understand the key differences and similarities between V3 and FHIR.
- ❑ Know when it makes sense to use either standard based on their business cases.
- ❑ Interpret both the V3 messages and FHIR messages to allow for mapping between them.
- ❑ Have a high-level understanding of the HL7 V3 Clinical Document Architecture standard.
- ❑ Be able to determine when it is appropriate to implement FHIR documents vs CDA documents and know how to map CDA documents to FHIR documents.

1.3.2 Study Resources

Relationship with Version 3: https://www.hl7.org/fhir/comparison-v3.html
Relationship with CDA: https://www.hl7.org/fhir/comparison-cda.html

1.3.3 Key Terminology

RIM (Reference Information Model)	
V2 vs V3	
All inclusive	
Verbose	
Self-contained	
V3 tooling	
Re-usability vs stand-alone	
CDA (Clinical Document Architecture)	
C-CDA	
CDA Templates	
CDA narrative	
FHIR narrative	
CDA sections and entries	

1.3.4 Summary

- The all-inclusive HL7 V3 RIM (Reference Information Model) is the basis for all HL7 V3 data elements. Although it was used as the basis for the FHIR definition of datatypes and resources, there is no 1:1 mapping.
- V3 does not address a direct business need as V2 was already “kind of working” while FHIR does address the business need for fast, web-based interface development.

- V3 is verbose, it uses XML (tagged) encoding; V3 messaging implementations were rolled back to Version 2 due to bandwidth constraints.
- V3 tooling is complex and not widely available.
- V3 is “all-inclusive”, i.e. it tries to specify everything, FHIR is limited to a core sub-set.
- V3 messaging is self-contained, FHIR messaging provides context (such as which patient, provider, organization, etc.) through web-accessible resource references.
- The CDA (Clinical Document Architecture) is used as a document standard, mainly for exchanging documents between different EMR’s (Electronic Medical Records).
- The CDA is a persistent document and can be stared “as-is” or be parsed and/or interpreted and used to update a receiving EMR. Note that V2 does not have an equivalent mechanism to exchange documents, at least not in its template format.
- The Consolidated CDA (C-CDA) standard is the result of a stricter templating exercise and is widely adopted in the USA.
- Wide variations in codes, descriptions, and systems can make achieving CDA interoperability challenging, even with the use of available verification and testing tools.
- The CDA requires a human-readable narrative, identical to the narrative in the FHIR resources.
- Sections and Entries in the CDA documents could be mapped in a FHIR resource/document.

1.3.5 Exercises

1. What are the similarities and differences between V3 and FHIR messaging?
2. What are the advantages and disadvantages of being “all-inclusive”?
3. Why is HL7 V3 generally considered a failure?
4. What is the advantage of using references vs being self-contained?
5. What was V3 trying to solve, i.e. what are the differences between V2 and V3?
6. What are differences and similarities between CDA and FHIR?
7. Would CDA documents become obsolete when FHIR implementations are taking off, why or why not?
8. Would you parse a CDA and update the receiving EMR record with the info or store a CDA as an attachment to the EMR and why or why not?
9. What does CDA do better than V2?
10. When does encapsulating a CDA in a FHIR message make sense?

Notes:

1.4 FHIR® Architectural Considerations

2.5 Hours

1.4.1 Learning Objectives

FHIR® allows for a very different architecture than is possible with V2 and/or V3 implementations.

The reader will:

- Become familiar with FHIR implementation approaches and be able to determine if and how FHIR might be appropriately considered part of an interoperability endeavor.

1.4.2 Study Resources

Getting started: http://hl7.org/fhir/modules.html

Architectural considerations: http://hl7.org/fhir/2016sep/overview-arch.html

1.4.3 Key Terminology

FHIR Manifesto	
Client-server vs event driven	
Single source of “truth”	
Snapshot vs updates	
Distributed vs Centralized	
Agile development process	
Subscription model	
Use and definition of Resources	
FHIR paradigms: REST, documents, Messages, Services	

Levels and Foundation	
Architectural principles	
FHIR documents and bundles	

1.4.4 Summary

- FHIR enables a “fast” implementation scenario, i.e. agile development environment.
- The FHIR manifesto is as follows, FHIR:
  - Has an implementer Focus
  - Targets the 80% (common use cases)
  - Uses today’s web technologies
  - Includes a Specification as well as Artifacts
  - Supports human readability
  - Is paradigm & architecturally agnostic
  - Is Open Source (no licensing fees or having to pay for the specifications)
  - It is completely digital, on-line, i.e. paperless
- V2 is “event-driven”, e.g. messages are created based on certain “triggers” such as patient arrival, order creation, etc. FHIR clients access a FHIR server on an “as-needed” basis and therefore not relying as much on messaging. Updates and changes are not necessarily being broadcasted, instead, a FHIR client can always access a “snapshot” of the latest accurate information.
- FHIR clients can subscribe to a server as well.
- FHIR servers act as a “source of truth” for patient, provider, etc. information.
- FHIR servers can be centralized or distributed.
- The four FHIR architectural paradigms built on top of FHIR resources are:
  - REST: operations using standard web services
  - Documents: bundles of resources
  - Messages
  - Services
- There are five components to the FHIR Foundation:
  - Level 1: Foundation: base documentation, XML, JSON, REST API, search, data types, extensions
  - Level 2: Implementation Support: security, privacy, conformance, terminology, and implementer support
  - Level 3: Administration concepts: linking to real world concepts
  - Level 4: Record keeping and Data Exchange: clinical, diagnostics, medications, workflow and financial.
  - Level 5: Clinical reasoning: library, service definitions, etc.
- Architectural principles are:
  - Reuse and Composability – FHIR resources are designed with the 80/20 rule in mind. FHIR resources are commonly composed of other resources.
  - Scalability – Aligning FHIR API’s to the REST architectural style ensure that all transactions are stateless which reduces memory usage and therefore supports horizontal scalability.
  - Performance – FHIR resources are lean and optimized for exchange across the network.

- Usability – FHIR resources are understood by technical experts and non-technical people alike.
- Data Fidelity – FHIR is strongly typed and has mechanisms built in for clinical terminology linkage and validation. In addition, XML and JSON documents can be validated syntactically as well as against a defined set of business rules. This promotes high data fidelity.
- Implementability –FHIR is easily understood and readily implemented using industry standards and common mark-up and data exchange technologies.

- FHIR documents are groups of Resources that form a so-called “Bundle”

1.4.5 Exercises

1. What are the advantages and disadvantages of FHIR being “FAST”?
2. What is the advantage and disadvantage of FHIR addressing only 80% of the most common use cases?
3. What does it mean to be “stateless?”
4. Why is conformance a requirement for FHIR, and what is the advantage of having a machine-readable conformance statement?
5. How are documents “built” in FHIR?

Notes:

1.5 FHIR® Specification Maturity and Levels

1.5 Hours

1.5.1 Learning Objectives

The FHIR specification has several versions as specified on the FHIR website (see “Directory of Published Versions”). The FHIR version of a device is specified as part of conformance. Different versions are very likely incompatible.

The reader will:

- Become familiar with the levels of FHIR release maturity and understand the risks and benefits of each.

1.5.2 Study Resources

Version management: https://www.hl7.org/fhir/versions.html
Directory of published versions: http://www.hl7.org/fhir/directory.cfml

1.5.3 Key Terminology

FHIR versions	
Resource maturity	
FHIR maturity model (FMM0-FMM6)	
Backwards compatibility	
STU or DSTU	
Release cycles	
Draft vs normative	
Level of changes	
Capability Statement	

1.5.4 Summary

- The FHIR standard has different versions, with a release cycle of 12-18 months.
- Each version is specified as part of conformance.
- Each new release is assigned a unique version number. The FHIR version policy is based on Semantic versioning, but with some differences due to the fact that FHIR is a specification, not a software API.
- Each FHIR version is identified by a string composed from 4 parts: publication.major.minor.revision.
- Any element defined in any version of FHIR is automatically assigned an extension URL that uniquely identifies the element and can be used in the relevant FHIR version. The extension URL for an element can automatically be derived.
- CapabilityStatement.fhirVersion should be consulted while exchanging information across the FHIR servers.
- FHIR includes several Resources, each Resource has its own maturity. The levels of maturity vary between the different resources in a particular version.
- FHIR maturity model is intended to indicate level of stability for each Resource:
    - FMM0 – Resource is published as a draft
    - FMM1 – Resource is “done”, ready to implement
    - FMM2 – Tested at approved Connectathon

  - FMM3 – Passes QA, has passed ballot
  - FMM4 – Tested across scope, published, prototype implementation
  - FMM5 – 5 distinct production implementations, multiple countries
  - FMM6 – 6 Normative: FMM5 plus passed ballot
- Backwards compatibility is guaranteed after FMM5
- Changes between the different levels can be:
  - Breaking: not backwards compatible
  - Substantive: new capabilities are added
  - Non-substantive: backwards compatible
- The Capability Statement includes version definition which is required to be available for each resource in a defined, machine readable format.
- Prior to being a normative standard, the FHIR specification is published as a STU or DSTU: (Draft) Standard for Trial Use.

1.5.5 Exercises

1. Would you want to implement a resource which has maturity level 3? Why or why not?
2. Why does Connectathon testing play such an important role in determining maturity level of the release?
3. What is the relationship with the STU and maturity model?
4. Why is the capability statement essential for interoperability?
5. Which maturity level(s) provide backwards compatibility?

Notes:

essay questions

ESSAY QUESTIONS

Write an essay of at least one page that involves any of the following topics:

- Using FHIR for exchanging healthcare information between wearables such as smart watches, phones and activity trackers and electronic health record applications
- Using FHIR in the context of Health Information Exchanges (HIE)
- Using FHIR for the purpose of scheduling, especially from web-based apps such as used on smart phones and/or web access from tablets and computers

TEST QUESTIONS

FHIR BACKGROUND AND ARCHITECTURE

1. FHIR is a _____ interface

    a. SOAP based
    b. REST
    c. RESTful
    d. SOA based

2. FHIR mainly deals with:

    a. Documents
    b. Services
    c. Messages
    d. All of the above

3. FHIR covers _____ of the most common use cases.

    a. The majority
    b. 50%
    c. 80%
    d. 20%

4. FHIR uses a _____ protocol.

    a. Service Object
    b. Delimited
    c. State
    d. Web based

5. A FHIR resource is equivalent to a V2 _____.

    a. Attribute
    b. Component
    c. Section
    d. Segment

6. A FHIR extension is equivalent to a V2 _____.

    a. Standard segment
    b. Section
    c. Private component
    d. Z-segment

7. FHIR version compatibility is achieved by not changing the _____.

    a. Access path
    b. Data attribute definition
    c. Data type definition
    d. Resource definition

8. FHIR resources are equivalent to CDA_____.

    a. Segments
    b. Sections
    c. Messages
    d. Templates

9. FHIR can create _____ CDA document.

    a. a derived
    b. an encapsulated
    c. PDF version of the
    d. a replica of a

10. FHIR and CDA documents have a _____ in common.

    a. template
    b. structure
    c. protocol
    d. narrative

11. CCDA is _____ of CDA

    a. a non-markup version
    b. a consolidated version
    c. a more secure implementation
    d. an international version

12. The CDA is intended to _____.

    a. address 80% of the use cases
    b. be all inclusive
    c. replace FHIR
    d. be used for messaging only

13. FHIR architectural principles are:

    a. Scalability, readability, reuse and simplicity
    b. Scalability, usability, all-inclusive and performance
    c. Simplicity, re-usability, inexpensive and open source
    d. Strongly typed, scalability, performance and easy to implement

14. The four supported FHIR paradigms of exchange are:

    a. Documents, messages, services and resources
    b. Messages, services, documents and RESTful interface
    c. RESTful, documents, messages and trigger events
    d. Resources, messages, documents and templates

15. An artifact assigned Maturity Level FMM5 has been implemented in at least ____ independent production systems in more than one country:

    a. 5
    b. 15
    c. 1
    d. 8