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HL7 Survival Guide

A Publication of Caristix

Executive Summary

HL7 interfacing – while you cannot live without it - it does not need to be the painful integration experience you might be familiar with, as you work to connect the systems that make your environment hum along. This guide is meant to help you get a firmer grasp on the complete set of challenges, standards, and choices you need to make along the way, whether you are developing interfaces on your own or working with a third party.

Why You Need our HL7 Survival Guide

Whether you are an Analyst or a Leader serving at a hospital or healthcare provider organization, HL7 interfacing is likely top of mind. After all, it's what makes it possible for you to connect the diverse range of systems throughout your environment for the electronic sharing and retrieval of health information. While the HL7 standard provides guidance on organizing data, you are likely trying to unravel many misconceptions about HL7 interfacing. To make matters worse, you are up against multiple interoperability issues due to Meaningful Use requirements, forcing data integration among numerous systems. It is no small task keeping pace with all the HL7 standard developments, issues, and best practices. In fact, you are not facing this challenge alone: according to Frost and Sullivan, healthcare organizations spend $1 billion per year addressing system interoperability issues.

We developed this guide to help you take back control and simplify your daily professional life. Keep this guide handy as you are working on HL7 interfacing, and you will find that it eliminates many mind-numbing tasks, helping you focus on your greater mission. Simultaneously, we welcome your feedback to continue improving this guide, currently being used by thousands of professionals globally. As HL7 interoperability experts, we would *love* to have a conversation with you. You can book a virtual meeting with one of our team members here.

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Introduction

HL7 Defined

HL7 is a language that enables the standard, consistent, and uniform exchange and processing of health-related information between the various systems found in hospitals and healthcare provider organizations. Click over to YouTube to watch this video for a 3-minute overview of how HL7 works:

https://youtu.be/T6dZOPHe2Jc

Whether they work for healthcare providers and hospitals or state and federal government agencies, many people who don't deal directly with HL7 think it's limited to clinical information systems, including those associated with radiology, labs, and more. But HL7 data is also used in systems used to manage billing, finances, and any number of other information systems within healthcare. In fact, the codes used to designate a range of healthcare-related information are, in part, governed by HL7 and are embedded in HL7 messages.

HL7 Version 2 or 3?

Though HL7 version 3.0 was unveiled years ago, most implementations are done using HL7 version 2.3 or 2.4 as the base standard. The few implementations we've seen using version 3 have been limited to government agencies, including Canada Health Infoway and the US FDA. In fact, adoption is so low for version 3.0 that many call it a failure. Version 3 is not backward compatible with version 2, works within a completely different data structure, and requires different tools, technical skills, and implementation strategies. To avoid a steep learning curve, we recommend using HL7 version 2. Plus, Meaningful Use Stage 2 specifies HL7 v2.5.1 for lab data.

3 Main Challenges with HL7

All that said, it's healthy to approach an HL7 interfacing project with a clear idea of what you're up against. Here are three main challenges we routinely see.

1. Customizable HL7 Format

The HL7 v.2 standard specifies a data structure based on trigger events, segments, fields, and data types. The recommended structure must account for complex clinical workflows and data representations, so the standard allows for extensive customization even when product specifications exist. As a result of the many variances and adaptations of the HL7 standard, there's no truly standard way that systems are implemented, and data is handled. In other words, plug and play is not part of the vocabulary.

2. Configurable and Customizable HL7 Data Tables and Code Sets

The HL7 standard provides a recommended set of data values for transactions. But they can be customized – and in fact, should be customized or configured under certain circumstances. Again, this means that data can be handled differently in each system. Some translation and data mapping would need to occur during data exchange, so each system sends and receives data it can understand.

3. HL7 Data Semantics

Good data semantics implies that the meaning or intent of the data – not simply the data value itself – is exchanged accurately. It's essential for HL7 interfaces to convey their interpretation of the HL7 standard in use – or confusion will ensue. It's the difference between NA standing for "Not Applicable" or "No Allergies".

Chapter 1: How to Integrate and Exchange Data

Regardless of the HL7 version you choose to for interfacing, the first step is to define your healthcare integration strategy – will you use a point-to-point architecture? Do you need an interface engine? What integration capabilities do you need? Your choice will impact the scoping of your project, so it's critical to nail down your strategy from the get-go. The key takeaway? Integrating several systems will require more extensive mapping and configuration than simple point-to-point architectures.

Interfaces Enable Data Exchange – But Require Development Effort

Even systems that are 100% HL7-compliant may not be able to exchange data because each one can use a variety of standard and custom message formats. These are the data exchange gaps that must be bridged through an interface, which can translate and manipulate the data. You can handle this manipulation by hand-coding changes to the messages in a point-to-point interface, or by using a central Interface engine application. Even then, HL7 interfaces always require some degree of customization.

Point-to-Point Interfaces

Hospitals, physician practices, and other healthcare provider organizations typically use several different computer systems for everything from billing and electronic medical records, to labs and pharmacy management. These systems need to exchange data with each other. The simplest way to do it is to establish a point-to-point interface, which is a connection between any two systems that enable the needed communication. Point-to-point interfaces are designed to send data from system A to another system B through a custom link (i.e., the interface) between the two. Because each system recognizes the other's data format and interface specification (i.e., language and grammar), they understand each other.

It's worth noting the number of interfaces needed to connect the ecosystem when using point-to-point interfaces. For example, if a system needs to exchange

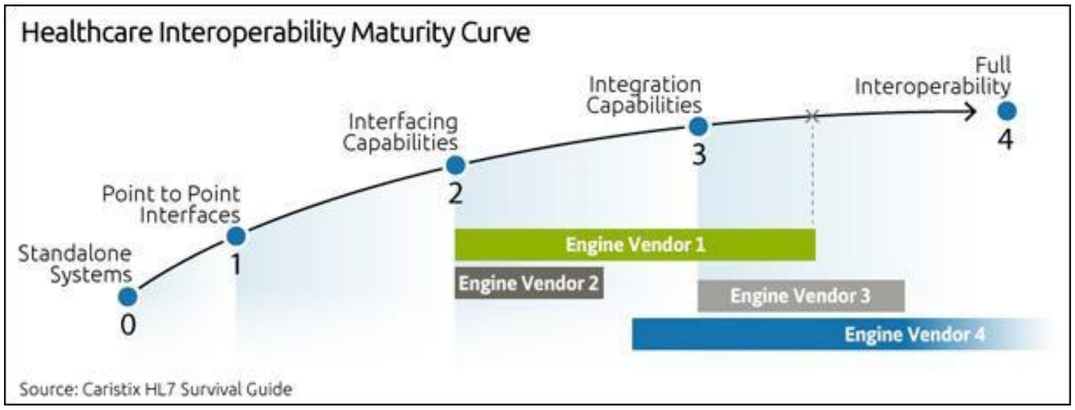
ADT data with three other systems, three interfaces need to be built. In the worst-case scenario, for an ecosystem featuring N system – all collaborating together and initiating information exchange – you would end up with (N-1)*N interfaces. For three systems, that's up to 6 interfaces; for six systems, up to 30. This is discussed in more detail in chapter 2.

Interface and Integration Engines

An interface engine or integration engine is middleware explicitly built to connect systems. The engine eliminates the need for individual connections between systems, and orchestrates the message workflow, transforms message formats as needed, and guarantees message delivery. Integration engines go one step further than interface engines and simplify system interoperability by enabling workflow (not simply message) orchestration.

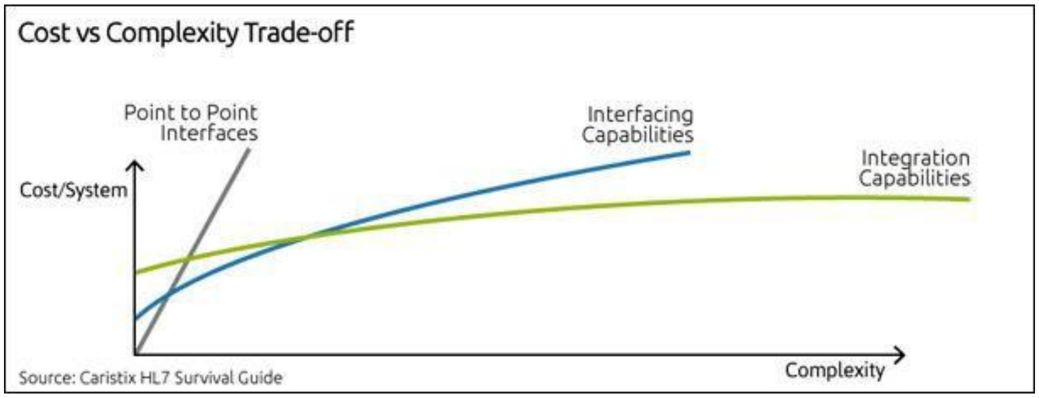
What's the Difference between an Interface Engine and an Integration Engine?

While interface and integration engines are not exactly the same, they're very similar and can be difficult to distinguish from one another. The real difference is in the range of functionality and capabilities supported by each. In fact, they provide different levels of support for an organization's level of maturity when it comes to HL7, from zero interoperability and integration (standalone hospital information systems, for instance) through to full interoperability.



Another way to look at interfacing and integration needs is by comparing trade-offs between cost and complexity. Point-to-point interfaces are sufficient to get you going or for getting your feet wet. After all, they don't require a major time or financial investment. However, as soon as need more than a handful of interfaces, complexity, and costs increase exponentially (see diagram below). That's when it becomes more cost-effective to start working with an engine.

Again, you may find you simply need a plain-vanilla interface engine. But if your data exchange needs are more complex (i.e., dependent on clinical workflows, involving multiple systems and/or multiple locations), you probably want to consider a more sophisticated integration engine. While you won't get away from complexity with interface and integration engines, you will find they are more cost-effective for dealing with more complex environments.



Transporting an HL7 Message

HL7 suggests message structure but doesn't specify how to transport those messages. It's the role of integration engines to translate, mediate, orchestrate, and route messages. Each interface uses the transport mechanism making the most sense based on system requirements and limitations, whether LLP, TCP sockets, FTP, Web services, or email, to name a few.

Each system will use its favorite transport protocol/data exchange protocol. That's why you need a translator to transport the message in a format each system will understand. You can build the translator into a point-to-point interface. Or, if you're using an interface/integration engine, make sure it includes a translator (most engines do).

Fortunately, interface and integration engines handle message transformation between systems. In other words, they can pick up a message in a specific format and create a new message in a new format while retaining the same meaning across both messages.

However, interface and integration engines stand apart in how they move data. While a typical interface engine moves information from point A to point B using a hub-and-spoke model, an integration engine taps into business workflows to transfer information. In other words, compared to an interface engine, an integration engine provides more flexibility and control/visibility over data semantics.

Questions about integrations? Skip the next chapters and contact us directly, we'd love to help!
Schedule a meeting with us!

Chapter 2: The Pros and Cons of Interfacing Capabilities

In Chapter 1 of the HL7 Survival Guide, we covered what it takes to exchange data. To help you make the most suitable choice among interfacing approaches, we've laid out the pros and cons of each approach or set of capabilities.

	Advantages	Trade-Offs
Point-to-Point	• Get up and running quickly if you have a few systems only. • Small system volume makes it easier to work with • Works well and is cost-effective for fewer than five healthcare information/clinical systems as infrastructure investment is minimal, and complexity is reduced. • Easier to get going quickly when you're starting from scratch • No need for technical resources; vendors can set up interfaces	• Harder to grow/evolve over time because systems are tightly coupled together and any change to one might impacts all others • Doesn't scale well since there will be N(N-1) interfaces in ecosystem (e.g., 5 systems – 5(5-1) = 20 interfaces) • Inflexible – systems must understand other systems' expected data structure and semantics • Limited monitoring capabilities • Costs can grow rapidly if you rely on vendors to change or add new interfaces
Interfacing Capabilities	**Advantages** • Mediates transport protocols between systems • Scales elegantly to reduce number of interfaces required (N + 1) • Centralizes and facilitates monitoring of message flows	**Trade-Offs** • Steep learning curve – need to be well versed in a specific vendor's technology to develop interfaces • Vendor lock-in can mean additional costs for

	and interfaces • Systems are loosely coupled, enabling you to add new interfaces and modify existing ones without impacting other systems • Provides tools and infrastructure, so interface adapts to different HL7 message and data formats • Reduces interface costs by using single application capabilities across all applications • Reduces dependency on multiple vendors for changes to the message format	integration engine infrastructure, as well as costly interface engine technology conversion that involves large projects impacting several systems
Integration Capabilities	**Advantages** • Includes workflow management features that enable the interface to respond as clinical workflows evolve and that offer a more flexible migration path for systems and ecosystems • Provides a single point for system integration to ensure consistent management • Built to scale	**Trade-Offs** • More complex and expensive than smaller-scale interface engine due to shortage of skilled analysts and need for extensive training • Expensive software licenses • Need to create a dedicated team (if you don't already have one)

Vendors of Integration Engines and Technologies

To help you get a jump-start on your research, we've listed some of the major interface engine providers below. Each of these providers addresses different needs: while some are best suited to small hospitals, others scale to support multiple locations and stakeholders, such as for an 80-hospital IDN. Still, other engine vendors focus on interfacing with EMR solutions (for example, Summit and Iatric are fairly Meditech focused).

Check out the relevant vendors below and evaluate other players in the market. Use the grid above to figure out the questions you should ask based on your organization's needs.

- Cerner Open Engine
- Cloverleaf
- Corepoint
- Ensemble
- Iatric EasyConnect
- Iguana
- McKesson Pathways
- Microsoft BizTalk
- Mirth Connect / NextGen Connect
- Oracle Fusion
- Oracle JCAPS/ICAN/e*Gate/DataGate
- Rhapsody
- Siemens OpenLink
- Summit Exchange

Note: This is a partial list. We welcome your suggestions for other vendors you feel should be added.

Engine Vendor Performance Rankings and Market Share

• For vendor performance rankings, see the KLAS Research website.

• For a current view of the HL7 interface market within healthcare, see the 2018 HL7 Interface Engine Rating survey results published by Core Health Technologies.

Chapter 3: The Heart of the Matter: Data Formats, Workflows, and Meaning

We covered many details about interfacing architecture and data exchange in Chapter 2. All that said, your main challenges are not with the plumbing, or with the methods used to transport or route data. In fact, interface and integration engines handle this quite well.

Interface Engines Don't Address the Real Issue

The real issue is with data formats, workflows, and meaning – and interface and integration engines don't address these problems. It's quite common for two or more departments (and by extension, the systems they use) within the same hospital or IDN to use different definitions and data structures to indicate the same information, such as "temporary patient."

Consider another example. A physician adds a note "NA" (i.e., Not Applicable) to a patient's chart indicating that information was never gathered about allergies to medications. Later on, another physician looks at the patient file, interprets the NA code as "No Allergies," and orders an antibiotic drug. The patient dies from an allergic reaction. While this is an extreme case, it's well within the realm of possibilities. This is why meaning – the semantics of data – is everything.

Here's another scenario. A physician submits a pharmacy order for a pain relief medication not recognized by the system receiving the order. The order is dropped, and the patient endures more pain for longer until the situation can be remedied.

Even the definition of a procedure can vary from one physician or clinician to the next. If a physician requests a complete blood workup on a patient, but the lab technician omits some tests because she doesn't consider them to be part of the order, the doctor will wonder when she will be receiving results for the outstanding tests. When they never show up, she'll be forced to follow up with the lab, wasting valuable time for her and her patient.

Or consider something as simple as date-time data. If you don't specify AM and PM in your scheduling application, you're going to be continually wasting time rescheduling appointments set for 8:30 at night when you mean 8:30 in the morning, for example. The same holds true when you don't account for time zones, such as data in one system set for MST and the other set for CST.

Data and Information Challenges

The real challenge is at the information level. What information is needed by whom, when, and in what format? Once you have these answers, you need to
validate that information being transferred is using the same semantics.

	Issue	Example
Data structure	The HL7 standard specifies a data structure based on trigger events, segments, fields, and data types. The recommended structure must account for complex clinical workflows and data representations.	There might be a gap based on the maximum length of data elements. A field in one hospital system specifies a maximum length of 50 characters. The same field in the system under implementation is set at a maximum length of 20.
Data tables	HL7 provides a recommended set of data values. These can be modified.	HL7 v2.6 "suggests" six different values for patient gender.
Data semantics	Good data semantics implies that the meaning or intent of the data is exchanged accurately – not simply the data value itself. It's essential for HL7 interfaces to convey their interpretation of the HL7 standard in use.	Patient identification is the classic example. It is important to determine which fields are in use. Possibilities include: PID-2 Patient ID, PID-3 Patient Identification List, PID-18 Patient Account Number, PV1-19 Visit Number, or a combination thereof.
Z-segments	Z-segments are custom message segments. They are used when an application must convey information outside the scope of the HL7 standard. Development teams also resort to Z-segments to work around technical limitations.	By definition, all Z-segments result in gaps. If Z-segments aren't mapped accurately, critical information can be lost.

The bottom line is that it's critical to understand the data, the source systems involved, and how each system handles data semantics. Here are some tips and questions to help you get at this information.

6 Questions to Help Your Team Understand Healthcare Data

1. Understand the message/interface specification provided by your vendor. "We are HL7 2.4" is not enough. Ask the vendor to provide details about messages, segments, fields, the need for z-segments, etc. Also, find out how they handle data semantics. In other words, what does the data mean? What is it used for? By extension, understand workflow-related information, event timing, vocabulary definitions, and who will use the information and how. The examples we listed above (lab results, two meanings of NA) speak to this.

2. Understand the type of message that will be generated based on the event (e.g., a patient admission, patient visit, canceling a transfer, sending a partial lab result). Understand what data is provided with the event, including the various code sets. Click over to watch this video for a 4-minute overview of an HL7 message:

https://blog.interfaceware.com/understanding-hl7-messages/

And, if you want to have a quick look of all HL7 message types and segments defined in the HL7 standard, look at the Caristix HL7 Definition website.

https://hl7-definition.caristix.com/v2/HL7v2.5.1

3. How do the code sets and content evolve over time, and who handles the updates and how?

4. Where does the data go? Is there a need to protect sensitive data?

5. How does the new system manage errors? What happens to messages that aren't understood by the destination system? What happens to rejected messages? We all agree that in a perfect world, no piece of information and no messages would be dropped, but the reality is it that it can and will happen. How would users and the overall workflow be impacted in such a situation? How can you mitigate the risk?

6. How do you handle workflow changes? If it's a matter of adapting the interface, how is this handled, how much time does it take, what does it cost, and who pays? You want to avoid Frozen Interface Syndrome, which occurs when you are trying to implement a new interface and need all participants to switch over at the same time but can't get their cooperation. Worse yet is Interface Black Box Syndrome, when you lack full visibility into all the work that has gone into interface development handled by a third party, making it nearly impossible to upgrade, tweak, and manage the interface without spending lots of money and time.

Answers to these questions will help you understand the source and target systems. This is important for new product implementations (like EHRs and EMRs). Once you've nailed down these details, you need to pinpoint the gaps with the receiving system(s), so you can bridge them with an interface.

Here are some questions you'll need to ask of the vendor and your internal teams about the receiving system(s).

5 Questions for HIT Vendors and Internal Interfacing Teams

1. Map out the message process or workflow. For instance, if your interface transfers data from a remote application via FTP, what is the flow? Do messages start in one application, get routed to an engine, then another engine, and then finally reach the destination system?

2. Map out the business impacts of the interface. If you make changes to a patient charge interface, what is the business impact? What if you choose not to implement the interface? For example, will it result in more manual data entry for a clinician?

3. What information does the destination system need? Where in the message structure is the information found?

4. Is the vocabulary used in the destination system different from that used in the source system?

5. Is all of this information documented? If not, how will the vendor keep you updated on changes? This is an especially important question to ask vendors since they simply won't be as responsive two years down the road as they were during implementation and go-live.

Chapter 4: Your EHR Strategy and Working with Vendors

With Meaningful Use in full swing, chances are your hospital organization is implementing an EHR or converting to a new system or upgrade. Watch out: when you implement a new system or migrate from one to another, it can impact your systems' ability to continue exchanging information. That's why many organizations call upon third-party vendors for guidance and project assistance. You just need to make sure you stay in control and avoid hidden expenses as you work with these vendors. By getting answers to the following interface-related questions from your clinical system vendor(s), you can maintain the upper hand in the relationship.

Nine Critical Questions You Need to Ask Your Clinical System and Interface Vendors

1. "Who provides the hardware, if any?"
When you implement a new EHR or clinical system, validate it doesn't need extra hardware for data exchange. If it does, find out about any hidden costs associated with this extra hardware, and who will maintain it (you or the vendor or another company?). If the vendor or a third party will provide support, what response times do they guarantee when you report an issue? And how does the vendor determine who is accountable for issues that arise? For example, if data exchanges are problematic between the interface and a medication distribution machine, is the vendor going to help troubleshoot it or offload you to the vendor of the third-party software?

2. "What standard does your system use for data exchange? HL7? Which HL7 2.x version are you using?"
These questions lay the groundwork for the next one.

3. "Can you supply a list of customizations you made to the HL7 v2.x standard you are using?"
While most vendors will claim they deviated very little from the standard, you will probably find they deviate in several ways (custom messages, Z-segments, customized data types, customized code sets, etc.). The list of customizations will

help you understand the overall interface and the amount of work required to integrate with the other systems.

4. "Within your HL 7 2.x based interface, can you tell me which elements and values are configurable?"
You need the details. If they can't provide details on "configurability," you might be facing a longer test cycle than anticipated. Trial-and-error interface validation can slow down implementation.

5. "When you send us the interface spec for sign-off, do we get a fully documented list of gaps and exceptions for specific data values and data elements?"
You want a full list, or you'll be facing a lengthy validation process, waiting for super-users and clinical testers to flag bugs in the test system. Also, if the vendor doesn't share this knowledge, you are a candidate for the black-box syndrome, wherein the vendor maintains control of the interface. This limits your flexibility and ability to negotiate with the provider, and also reduces your capability to evaluate impacts that a change within the ecosystem might have on this interface and the systems exchanging data.

6. "Will you provide a list of the interface customizations you create for us?" No interface specification works perfectly out of the box; it has to be customized to your environment. You need a list of those customizations for troubleshooting and maintenance, or your interface analysts will be waiting on vendor trouble tickets while clinician calls are piling up at the hospital IT help desk.

7. "How do you document changes and upgrades throughout the lifecycle of the interface? Do you automatically provide us with updated documentation?"
If there's anything worse than missing documentation, it's partial or out-of-date documentation. What you get at go-live will not be usable two years out. Make sure the responsibility for documentation updates is clearly spelled out.

8. "Does the interface you built contain any intellectual property?"
This is crucial! Validate if a license will apply to the code, and you will own the interface – or if the vendor will own it. If the vendor owns it, you might not be able to change the interface or re-use the code for another, similar interface project. You will need to engage the vendor for every tweak or a new project, and that will likely leave you paying big bucks…

9**. "How guaranteed is message delivery? Does each message get an "acknowledge" (ACK) or "no acknowledge" (NACK) reply?"**
This is part of the HL7 standard and is an important piece of the message delivery process, as you cannot guarantee the message was delivered without it.

3 Bonus Technical Questions

While the following questions may not apply to all systems, be sure to ask them of the vendor, so nothing is left to chance.
1. "If an application makes an information request, does the replying system acknowledge that it received the message, or does it just reply?"
In the case of information requests (query messages for instances), the system will respond with one or several messages containing the information. In most scenarios, no ACK/NACK is involved as few systems implement Query/Response messages.

2. "What happens if the replying system does not have the requested information?"
The response format allows systems to return a message stating no information was available based on the criteria requested, rather than just sending a reply with blank fields.

3. "What happens when a message requests data is updated or inserted?" Let's say the lab system sends results to the EHR, but the patient ID is not recognized at the EHR – what happens? The role of a message is to publish an event once it occurs and provide related information. How the information is handled is system-specific, and in some cases, the system might do nothing. While the system is responsible for handling the information received, the interface needs to provide information the system can handle.

Next Steps

After you've assessed high-level clinical system interoperability issues, you need to actually build and implement the interfaces. That's where the next sections of the HL7 Survival Guide come in.

Chapter 5: Vendors, Consultants, and Interface Specifications

After you've assessed clinical interoperability issues (covered in Chapter 4), you'll be ready to start building interfaces. If you're building your interfaces in house, you'll be dealing with clinical system vendors. And if you're outsourcing interface development, you'll be working with consultants. Either way, you want to know what issues to avoid. That's where this chapter comes in handy.

Make Sure You Check Off These Boxes

Conduct your due diligence on the following points, and your interface project is much more likely to run smoothly.

1. Negotiating an Interface

When a hospital buys a clinical system, interoperability and HL7 are usually not addressed during the negotiation. The vendor's sales rep often glosses over the requirements and simply mentions the "thousands of interfaces they've got in a library." The problem is that analysts like you get pulled into the project after the contract has been executed only to discover it's challenging to interface with the new system – but you're stuck with making it work. Approach your manager before the negotiation phase and ask to be involved. By highlighting the issues that can arise when interoperability and HL7 are not addressed during the vendor negotiation, you can help avoid lots of project complications and will set you and your manager up for a smoother, more successful project.

2. Black-box Syndrome

In this scenario, the vendor keeps control of the project and interface, leaving you to pay for any tweaks or additional needs going forward, including documentation. Just as painful is the fact that the knowledge walks out the door when the consultants leave. How do you ensure this doesn't happen? Ask for documentation, including the interface specification, as part of the contract. This should detail which systems are linked/interfaced, which messages are exchanged, and which message formats are used, at a minimum.

3. Vendor Lock-in

Some interface vendors or consultants introduce their own intellectual property into the interface. In such cases, your organization has a license to use the interface, but not full ownership of the interface, which means you need to pay the vendor for any required changes or updates you'd like to see.

4. Who Drives the Interface Specification?

In the past, the clinical technology vendor would drive the spec, and customers had to conform to the requirements. Nowadays, the opposite approach is increasingly common: the hospital drives the spec, and vendors must conform. While this approach is more expensive initially, down the road, it makes the process smoother for the hospital, especially as hospitals are increasingly part of HIEs and merges to form large hospital groups or IDNs. This is good for hospitals and providers, but you need the right infrastructure (i.e., the right HL7 software and integration engine, configured to meet your organization's needs) and culture to support this approach, whether you take care of interface implementation in-house or outsource it.

5. Supporting Technology

A good integration engine is a great building block, as we mentioned in Chapter 2. But you also need supporting technology and a culture that help you – and anyone else who gets involved at any time – manages and updates the engine and interfaces over time. Look for software and technology that simplify the process of generating, updating, and managing specifications, requirements, test scenarios, and other documentation associated with your engine and data exchange work. You'll also want a repository that provides a central location for anyone with permission to access the documentation. A detail that may seem nit-picky at the beginning of a project just might be the essential connectivity information you need a year later, when an interface goes down at 5 pm, and you are the Tier 3 support on call.

6. Culture

Your organization's culture and approach can make or break a consulting engagement or in-house project. Ideally, you want to drive the show with consultants. Set clear expectations. Control deliverables by coming to clear agreement as to their definition and due dates. Use your project documentation from Point 5 above to ensure clarity and accountability throughout the interface lifecycle. Ensure a structured methodology is used to test the interface. And clearly define your acceptance criteria for the project.

Demand These Deliverables

Beyond addressing the issues above, regardless of whether you work with a vendor or a consultant, ask for these deliverables or interfacing artifacts:

HL7 conformance profiles (also known as profiles or interface specifications). HL7 profiles should, at a minimum, provide a list of messages, segments (including z-segments), fields, data types, and typical code sets or data.

Gap analysis between systems to connect. Gap analysis sets the scope of the interfacing project. Read more about gap analysis in this Caristix white paper.

Test scenarios. Vendors typically provide you with a boilerplate validation guide to ensure the interface works as expected. But your team needs to ensure that your organization's clinical workflows are covered. For example, let's say you have a duplicate patient record in the system. Some hospitals are going to perform a merge to get rid of the duplicate; others are going to ignore it; and yet another batch might delete one of the duplicates. But the boilerplate guide might just say to merge. So make sure the guide covers real-life and specific scenarios you encounter in your environment.

Test system. Understand how they're going to document test results and don't sign off on acceptance criteria unless your clinical workflows are covered.

Message samples and test messages. Critical for testing prior to go-live as well as post-go-live for troubleshooting.

Process and workflow maps. This rounds out your view of your interfacing ecosystem. Complement the message structure and content details from HL7 profiles with proper processes and workflow maps for future interfacing asset management.

Once you have a vendor or consultant strategy in place, and you've identified the artifacts you need, you'll need to start developing the interfaces. The next chapters walk you through that process.

Chapter 6, Interfacing Artifacts: HL7 Conformance Profiles and Interface Specifications

The first five chapters of this Survival Guide have helped you think strategically about your interfacing project. Now we're going to dive into the nitty-gritty of what you need in an interface specification and/or HL7 profile (note: we use the terms *specification, conformance profile,* and *profile* interchangeably in this chapter).

An HL7 interface specification should list:

1. Interface name

How do you refer to your interface in your integration environment? Some organizations manage thousands of interfaces. If you've got 10 or 20 interfaces, no big deal. But if you've got thousands, devise a naming system for easy name recognition and tracking.

2. Source or destination system name and version

System versions (and even product names) change over time. Make sure you've got a way to track this in your spec.

3. Message types used in the interface

A message type is essentially a trigger event, such as patient admission, lab request, lab results available, new appointment, etc. How you use and implement events is completely up to you – it depends on your system and hospital workflow. Each of the HL7 v2.x reference specifications contains hundreds of trigger events. Just focus on the ones you need for your interface.

4. Message definitions including segments, fields, data types

You need a list of the segments, fields, and data types used in each message type.

5. Segment and field attributes

These are optionality, repeatability, data type associated with a field, field length, tables associated with field.

6. Z-segments
Custom segments, if a vendor or your facility uses them.

7. Data types
Apart from a list of data types, you will also need attributes and customizations.

8. HL7 tables
You need the real-world data or code sets that are actually implemented – such as gender, race, and lab codes – not what the standard provides. Otherwise, you'll find yourself wasting lots of time trying to figure out what's really going on in your system, especially when data such as lab codes change over time. You can solve this problem by keeping track of the actual data and code sets used, along with where and how they're used, and the meaning of the information.

9. Specialized interoperability challenges
Without getting all the necessary information upfront (i.e., what we outline in this chapter), your challenges around interoperability become greater and more insurmountable. Consider lab interoperability and the example of Logical Observation Identifier Names and Codes (LOINC) codes – the LOINC dictionary contains more than 42,000 codes, and some codes mean similar things. That means two systems exchanging data could refer to that data differently – leading to confusion and information-exchange problems. Read more about addressing the challenges of lab interoperability in this *Clinical Innovation and Technology* article: Lab Interoperability Plays Catch Up.

Spec = Interface Requirements

Combine the elements above with any necessary clinical or workflow constraints. This becomes your specification or profile, which is the key interface artifact you need as you can use this document to compile and validate requirements. Make sure internal customers and vendors see this. And ask tough questions (including the ones we supplied in chapters 4 and 5) as you review this spec so you can pin down the right answers for your environment.

Leverage your interface specifications (and other interfacing artifacts) to generate your interface code. In most cases, the spec is delivered as a Word document, so look for tools that will help you connect the spec directly to your interface engine.

How to Develop an HL7 Conformance Profile

To build a profile, you have several options.

Messaging Workbench available via HL7 International (look for a file name that includes "MWB release") is open-source software designed to build conformance profiles. But keep in mind, with Messaging Workbench, you need to build out individual profiles for each message type. If you define 10 message types for an interface, you'll be building 10 separate profiles. You'll also have to read through messages to get the information you need.

You can also develop templates in Excel or Word and then populate them manually. Or you can take advantage of functionality in Caristix software that automatically creates profiles from HL7 messages. In our world, a profile corresponds to the spec for a source or destination system, with however many message types you need.

Regardless of how you develop a profile, you need to do it. The problem is that there's no industry-standard template available. That's why we've developed this HL7 profile template kit and made it available to you for download (available as part of the Caristix HL7 Survival Guide supplementary material). With it, you can avoid the time and effort to set one up, and make sure you clearly and concisely communicate what your integration environment expects in terms of data exchange. Feel free to download the template and tweak it to suit your needs.

Why You Need a Conformance Profile

- Gets analysts, developers, internal customers, vendors, and consultants on the same page
- Helps identify risks before interface development
- Eliminates time spent determining requirements, testing, and on trial and error during go-live
- Makes it possible to easily generate your HL7 interface specification, gap analysis report, and test and validation plan

The Dangers of a Missing Interface Specification

Without an interface spec customized to your requirements, you'll be stuck implementing a generic interface. If your organization is like most, your clinical resources are already stretched thin – and the last thing you can afford is to dedicate those resources to testing. But that's what you'll find yourself doing if you go with a generic spec. After all, your interface will likely be buggy when it goes live because your true requirements weren't gathered up-front. As a result, you'll find yourself bogged down with extensive troubleshooting after go-live, especially when you run into issues with clinical workflows because the interface doesn't work as expected, and clinicians report a lack of data, orders, lab results, and/or medication as a result.

Don't take any chances – create those profiles. Get started with our HL7 Profile Kit.(Available as part of the Caristix HL7 Survival Guide supplementary material)

Chapter 7: Gap Analysis

This chapter helps you set up a crucial HL7 requirements document: the gap analysis. Once you have profiles for your source and destination systems, you need to capture a list of all the gaps existing between the two systems in a requirements document. You unearth this list by conducting a gap analysis, which will tell you what's missing and what needs to be bridged by the interface. In essence, a gap analysis captures the differences in messaging between the new system and the existing IT infrastructure so the systems can exchange data (see the table in Chapter 3 for a list of data and information challenges associated with gaps). A good gap analysis will also document which system and who (you, the vendor, or another third party) will handle any issues.

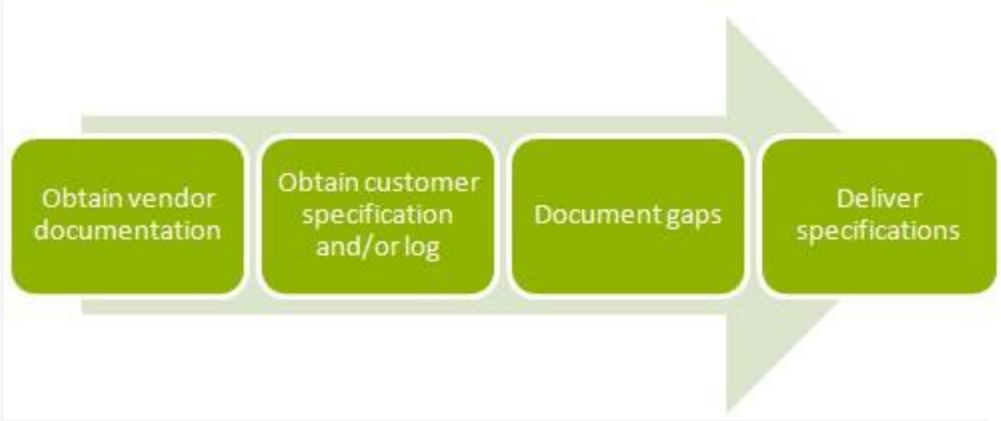
How to Develop an Interface Gap Analysis Document

Many analysts develop their own gap analysis templates in Microsoft Word or Excel. To fill in templates, they look at messages, run queries when they can, and manually document their findings. This can be a fairly onerous process if they're basing the analysis on real-world messages (as opposed to doing a vendor spec walkthrough). Another option is to take advantage of software that automates the gap analysis process.

Whatever your approach, you want answers to the following questions so you can identify gaps related to messages:

1. Does the destination system handle all of the message types from the sending system?
2. Are there any differences between the message structures in each system? If so, what are they?
3. Are there any mandatory data elements on one side that are optional on the other? If so, what are they?
4. Do both systems use the same code sets? Are they the same values? Which values do I need to map?
5. Do both systems specify the same maximum length of characters for data fields?
6. What z-segments are in use?

7. Is the data semantically consistent? In other words, does the meaning or significance of an element always match across both systems?
8. What are the requirements for encryption or de-identification, usage restrictions, and HIPAA compliance related to confidential information?


Obtain vendor documentation
Obtain customer specification and/or log
Document gaps
Deliver specifications

The 4 steps to a gap analysis

Why You Need This Artifact

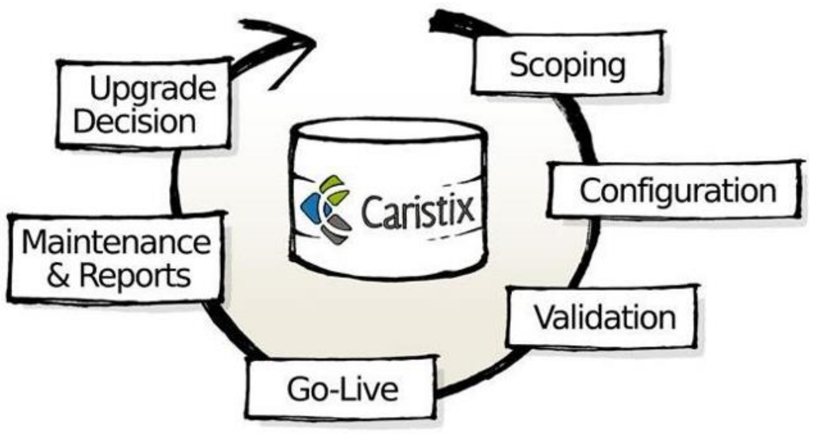
No interface matters unless those coding the engine can accurately scope the interfaces they need to build. You need a way to communicate who does what on an interface. Is the vendor changing a field? Is the interface engine handling the field transformation? It's critical that you pin all this down before interface development begins, or you will be wasting time iterating through multiple changes later in the interface lifecycle.
Business Impact of Missing Gap Analysis

Without a gap analysis that details your requirements, you'll end up implementing a generic interface that doesn't address your organization's unique needs. Your end-users will be frustrated that they can't easily access all the information they need. And you'll end up wasting time, money, and effort troubleshooting after going live. With a gap analysis, you can avoid extended go-live periods, significant maintenance at increased cost, and unhappy clinician end-users who are unable to access the data they need to deliver appropriate patient care.

Downloadable Gap Analysis Template

The best course of action? Use this sample gap analysis template to get started on the right foot! (Available as part of the Caristix HL7 Survival Guide supplementary material)

Chapter 8: Test Scenarios and Test Systems



The HL7 interface lifecycle. You need to test during Configuration, Validation, and Maintenance.

In the last two chapters, we covered some of the requirements-related artifacts you need. Now it's time for testing, which you conduct at different phases in the interface lifecycle: during configuration and development; during the formal validation phase; and during maintenance.

"Why to test?" you ask. When you start to develop and iterate on your interface, you run tests to avoid introducing new problems – you check and test your code to make sure not to inject errors. This is true both during interface development or configuration and while in maintenance mode. This testing helps you determine whether or not the interface makes sense and meets your requirements.

Once you're satisfied with the interface, you move to validation testing. This is when you determine if the interface will work with and meet the requirements of your clinical workflow. Specifically, you test performance, extreme data cases, and how well the interface supports large volumes. By figuring this out before go-live, you save a lot of implementation headaches and alleviate the time clinicians need to spend helping you validate the interface once you go live.

What to Look for in a Test Tool

So that's when and why you should test. But how do you handle this efficiently? The key is to automate your tests. While you need to spend time during the development/configuration phase setting up the tests, during the validation phase, you can take advantage of automation and save a lot of time. In fact, some interface engines include built-in test tools. Regardless of the source of your test software, make sure you can do the following:

- Be able to connect to web services or a database, such as by calling a web service, and check in the database after sending a message
- Validate inbound and outbound messages
- Validate ack and nack
- Generate values and test messages from a profile or specification, and generate a large volume of data/messages if you're conducting volume testing
- Repeat test plans/scenarios, and create reports

What to Test

So what test scenarios should you use? You need to test both normal use cases and edge cases.

That said, before you can conduct any testing, you must understand what to expect of your workflows. This should include common workflows – such as a patient being transferred – involving the use of the products that will be interfaced. For example, in many hospitals, emergency department and in-patient ADTs are two separate systems. A new patient that comes through the emergency department would be registered in the ED's ADT first. And if she is transferred to Med/Surg, you would need to populate the main ADT, either through an interface or manually, by re-entering the data.

Or if you're creating an interface to move patient charge data from a surgical information system to a billing system, you would need test scenarios in which:

- Patient demographics and patient ID are incomplete.
- Billing item information is incomplete.

With that understanding in place, you can test to make sure the interface engine behaves as expected for standard – as well as unexpected – workflows. When it comes to edge cases, you'll need to consider more possibilities. For example, if your interface engine does not accept a certain range or type of data, you'll need to send such data to it – e.g., date of birth of 1850 or entered in reverse – and see if the interface triggers an error.

During testing, you're testing the data format and confirming that you're not introducing errors. When you code an interface, your specification will be based, at least in part, on sample messages. By definition, you know that these messages work. So don't use only these sample messages in your texts. Let's say your test patient in your sample messages is called John Smith – with four characters in the first name. You test your interface using these sample messages, and everything works. But three months from now, your hospital admits a patient named Benjamin O'Donnell, only no one tested for 8 characters in the first name and an apostrophe in the last name. The interface doesn't like it, and you have a support call (and a none-too-happy clinician) to handle.

By automating your testing, you will feel freer to test at any time, and you'll be more confident about making changes because you'll know you can easily test each time you change the interface as you're coding.
Some vendors provide validation guides full of test scenarios. Use them. But check through them first – your workflows may differ.

Test Types

Make sure that your tests cover your interoperability requirements, and include the following:

1. Workflow. Confirm the interface engine handles your standard workflows as expected.
2. Edge cases: unexpected values. If you're testing birth dates, include 1899 as well as 2017. Include dates with the month and day reversed. Try different abbreviations for the days of the week. Check all caps on names. Check accented names. Check hyphenated last names and those with an apostrophe.
3. Performance, load, and network testing. Though interface developers don't normally test network infrastructure, you may want to do this during the validation phase to see how workflows and data are impacting overall infrastructure performance. A high-volume interface may need more load testing than a low-volume interface, depending on your interface engine and connectivity infrastructure.

4. Individual systems. You should test each system on its own, kind of analogous to unit testing in software development. For instance, in addition to making sure the surgical and billing systems handle workflow end to end, make sure they work separately.

Create a Test System

Once you've developed a test plan and test scenarios, you need to configure your interface in a test system. It's important that you do this in a test system, not a production system. It's easy to think it can't hurt to test in a live system, but here are three reasons why that's a big mistake:

- If you forget to cancel or delete all test transactions once you're through with testing, you'll end up with faulty transactions in your production system.
- You run the risk of impacting ePHI or HIPAA-protected health data.
- You don't want phantom data turning up in a CMS audit. Your clinical systems contain data that constitute a legal record.

So what's the right way to go about it? Set up your test system using the same configuration as your production system, including the same rights and versions (it's OK if IP addresses are different). Make sure you upload enough patient data, and that your tests cover your requirements (we can't say that often enough).

Test Reports

As part of the testing process, you'll want to run reports. The reports should document the following:

- Number of times the test was run, as well as test duration – if you're sending messages, this helps you understand performance.
- Test results, including positive validations and failures.
- The messages that were used; note the data source (SQL queries pulling from a database, an HL7 message feed, a batch file).
- Summary of test scenarios that were run.

Message Player for Basic Listening and Routing

When conducting development testing during the interface configuration phase, you need a basic listener/receiver tool as you are writing your interface. This allows you to play/test messages without implementing your interface engine in a production system. In fact, some interface engines come with a built-in player for testing. If you don't have one, you can use Caristix Message Player (it's free) to send or receive messages. Read about how we use Message Player here.

Chapter 9: Message Samples and Test Messages

In the previous chapter, we covered what you need to know when testing your interface. While the right test tool is helpful, you need to feed it the right message samples and test messages. After all, messages impact the entire interfacing lifecycle.

So what makes messages "right"? Namely, you need message samples and test messages that reflect your environment: your ADT message flow, your specific lab codes, and your case mix – whatever information your interface is intended to share.

Just as you need sample messages elsewhere in the interfacing lifecycle (for instance, scoping), you need them for testing, too. (As a reminder, sample messages give you custom formats, structure, and data values).
For example, imagine you're interfacing LIS and ADT. You'll want to look at the issues that were highlighted during the gap analysis. Your test messages need to cover your use cases and the following:

- Events that are exchanged
- Code sets/vocabulary and varying field lengths
- Optional segments and fields, especially varying optionality

Go with Production Data

Now about the sources of your messages: we're going to come right out and say it – you need production data. Here's why: Once you have the right message samples and test messages, you need to make sure you have a sufficient volume of quality test data. And your production data accurately reflects the data you work with day in and day out, both in data type and format, as well as volume. And that means you'll be able to accurately test for load and performance, and avoid message workflow problems that can bring down interfaces.

It All Starts with De-identification

That said, you obviously can't use real production data. You need to find a way to remove protected health information (PHI). That's where a technique known as de-identification can help. You keep the clinical workflow in the messages, but

you remove patient identifiers and replace them with fake values. You can also replace them with off-the-wall fake values for edge cases.
And remember – even employer information can contain PHI. For instance, if two of your patients work for say, a 5-person law firm, it would be pretty easy to search publicly available information sources and re-identify them. You must remove their employer names – or insert replacement names – if you want to use this data safely.(For more on de-identification, check out these blogposts.

Here's what to keep in mind when you de-identify your production data:

- Satisfy HIPAA. Remove the 18 identifiers designated by HIPAA as protected health information (PHI).
- Maintain message flow. If "John Doe" in your production data becomes "Michael Smith" in your test log, ensure that Michael Smith in your A01 admission message is the same Michael Smith upon discharge.
- De-identify data in z-segments. PHI can hide in z-segments.
- Log volume. Aim for at least a week's worth of messages and ideally a few months' worths.
- Traceability. Record which data was de-identified and which fields and data types were transformed.

Without the right message samples and test messages, you'll run into the issues we discussed in the last chapter, namely lack of updated vocabulary and potential for downtime if messages contain unexpected values.

Remember, these messages are how you test the data format and confirm that you're not introducing errors. For example, you don't want to find out after go-live that your interface doesn't recognize the last name with an apostrophe.

Don't Fall into the Beginner's Trap

If you're just getting your feet wet with clinical and medical applications, you might think: "What's the big deal? I'll just hit Google for some sample HL7 messages and get started that way."

Don't do that! If you do, you'll get some basic structures right – like pipes and carets. But you won't have any information about the interface you're trying to build: the message types it uses, the segments and fields, positions, optionality. Yet developers need the information in messages in order to build a solid set of requirements for the actual interface. That's why real-world messages are the best option.

Consider that you're interfacing with a lab system. The lab is often the area of a hospital with the largest number of custom data values. After all, how you treat a lab order and lab results vary by hospitals and by vendors. To develop a viable interface, you need to work with realistic messages.

At the same time, many hospitals employ email security measures that block the sending of any emails containing HL7-formatted content – even if it is de-identified. So whatever you find on the Internet is likely to be so generic that it will be practically useless.

Chapter 10 Process and Workflow

In the last chapter, we explained what to aim for in test messages and message samples. Next, you need to map out your processes and workflows to understand how your interface can support them.

For example, your clinical workflow may look like this: a patient is admitted in the Emergency Department via the departmental ADT system. The doctor on duty orders lab work, and the patient is admitted to the hospital. The admission is now recorded as an in-patient in the standard ADT system. The attending doctor orders medications via the hospital's pharmacy system. The night nurse administers medications, and records this via the barcode medication administration. Not satisfied with the patient's progress, the attending doctor orders new labs and, after receiving the results, decides to perform a procedure, which requires that the patient be transferred to another location. The doctor's orders and the transfer are recorded in the in-patient ADT. The patient improves and is discharged – this event is captured in the same ADT. Finally, thanks to Meaningful Use, the patient's family doctor receives a discharge summary via the local HIE.

All of these events comprise a workflow representing a patient stay or visit. While some workflows are optional, some always happen in a certain way. What's important is knowing where the data is going and how it's going to be used.

Why You Need to Map Processes and Workflows

If you've documented your workflows and systems, it'll be easier to connect the next system because you won't need to start from scratch. Workflows also impact your test plan. For instance, all your destination systems might require different inputs from a single source system. As part of your scoping and requirements planning, you'll need to understand the workflow – for instance, who does what: a physician, a nurse, or a pharmacist? Capturing workflow is also critical for network monitoring down the road, so, for example, your IT team will know right away when a system goes down what workflows and processes are affected. (We'll discuss network monitoring in Chapter 11.)

Start with a Spreadsheet?

Many developers list their interfaces and workflows in a spreadsheet. You'll find examples of what to track in the HL7 Interface Asset Template here. (Available as part of the Caristix HL7 Survival Guide supplementary material)

While a spreadsheet provides a good start, you need to go beyond to capture the details and interconnections. After all, in most hospital environments, you'll be dealing with multiple workflows and systems, meaning your systems will be exchanging different sets of data. To efficiently and accurately test and manage all of this over the interface lifecycle, you need a clear mapping of workflows and processes – something that's nearly impossible to capture in a spreadsheet. Here's what you should capture when documenting your interfaces and workflows:

- Interface names
- Systems that are linked
- Connection information (IP address, credentials, port, connection type, location (location may be by unit or by data center)
- Security: SSL, VPN, firewalls, and any required certificates.
- Trigger events: List all trigger events and note which ones are used by which systems based on your spec.
- Connection types: could include database, web service, TCP, HTTP, file, FTP.

Note: here's why it may make sense to note the data center location. Let's say you run systems out of two data centers for redundancy, one in Skokie, IL and the other in Hyde Park, IL. If your Skokie, IL data center experiences failures, but your Hyde Park data center is still operating, you'll know it makes sense to start your troubleshooting in Skokie.

Consider one workflow in which data entered through an interface is first pushed to a database, then to an external system through a web service, and finally to archives or an enterprise warehouse. Without a diagram of this workflow, it's difficult – if not impossible – to track the data flow. Four months after deploying your interface, you may find that no data has been pushed to the archives.

Monitoring Beyond the Interface Engine

Some interface engines let you view workflow within the engine. But what happens with external systems, such as an HIE transmitting to an internal engine, or multiple systems from different providers connecting across a region? Monitoring workflow is a major issue in interoperability – even bigger than interfacing. You need a way to monitor beyond the engine.

While you can track interfaces and workflow to some extent with spreadsheets and can use a tool like Visio to diagram it all out, you ultimately need a tool that maps process and workflow. Such a tool lets you truly grasp your data and interfaces – not just your interface engine plumbing.

4 Capabilities to Seek Out for Monitoring

- Visualize all of your interoperability assets, from multiple interface engines to the interfaces themselves.
- Cover the entire interface lifecycle.
- Access a library of interfacing assets and manage assets so you can take an instant inventory.
- And it should provide all this regardless of the interface engine you're using

Tips for Artifact Management

Interfacing artifacts can grow over time. You maintain two profiles for your source and destination system. You conduct a gap analysis, and your engine handles message transformation. But message transformation is part of workflow. You need test plans and test data. Keep all these artifacts together and include workflow. As you develop and implement interfaces, these can grow.

Interface Asset Template: What to Capture

We can't emphasize it enough: profiles and spreadsheets are just a start; in order to fully cover workflow, you need software to map process and workflow. Nonetheless, we'd like to help you get started with a baseline spreadsheet. Our Interface Asset Template is a handy download that will show you what you need to track.(Available as part of the Caristix HL7 Survival Guide supplementary material)

Chapter 11 Maintenance, Troubleshooting, Monitoring

Now we're coming full circle. Throughout Chapters 6 through 10, we talked about creating interfacing artifacts, assets, and documentation: profiles, gap analyses, test plans, test messages, test systems, and workflow maps. In this chapter, we explain how you can get maximum value from all the work you put into creating all of those.

Why Document?

By documenting your profiles and specs, you can much more easily troubleshoot issues and tweak configuration once your interface is live. Plus, if you created electronic – i.e., machine-readable – versions of your profiles, you can use them in your monitoring. For example, you could shoot a message through a profile using the Caristix Message Player to see if there's anything anomalous, such as an extra segment or a field that is too long. Or you could run problematic messages against the test scenarios, you developed during the validation phase of the interface lifecycle.

All that's good and well, but no one can use your profiles and spec unless they're readily available. So be sure to store them in a central repository for your support team. Make the files read-only if necessary. What's important is that anyone can quickly access them when needed.

By using the assets you built in the earlier phases of the interface lifecycle, you can quickly and proactively address issues and avoid additional costs. Plus, you can keep users happy. Imagine rapidly troubleshooting an issue to avoid downtime rather than forcing clinicians to log a help desk ticket because the interface went down.

Maintenance, Monitoring and Troubleshooting

Another benefit of documenting profiles is that it streamlines processes when you are performing a system upgrade. Let's say you're changing or upgrading your pharmacy system – that change affects the interface of any other system that communicates with the pharmacy system. Imagine ten different systems connect to your pharmacy system – you'd need to tweak those ten interfaces. But you're smart, and you already documented the pharmacy system and the other systems through the use of profiles/specifications. That means all you need to do is create a new profile for the new/changed pharmacy system. Then when you redo the associated 10 interfaces, you will perform a new gap analysis, but the hard scoping work (those specs) will already be done.

Once your interfaces are in place, you want to monitor them to ensure they're supporting your processes as designed. The value of monitoring is that it empowers you to be proactive in troubleshooting issues. You can set up thresholds and then be alerted to potential issues. For example, you could say that only a certain number of messages should pass through the system for a certain process, and if that number is exceeded, you get alerted.

Many interface engines include monitoring capabilities, but some are limited to that particular engine. If that's all that you have at your disposal, take advantage of it. But if you have the option and your environment includes multiple interface engines, look for vendor-agnostic solutions that cover the entire integration environment. That's the easiest way to get a global overview of your environment.

Just remember – when you're sharing data across your infrastructure, sometimes an HL7 message is the problem. But the network or a specific system could also be the problem. For example, perhaps a nurse does not see orders in the pharmacy system. This may be because the network is down. Or it could be an issue with the ADT system or with the medication admin system. Or one HL7 message could be holding up the queue. You want to be able to quickly eliminate the HL7 message as the issue. Just remember that ideally, your monitoring should link back to your test cases and interface specifications.

4 Best Practices for Extracting Maximum Value from Your Artifacts

The fact is that the value of your interface-related artifacts increases over time. While they're useful for development and go-live, they are essential down the road, in a year or two or more. Here's how to get the most from these artifacts.

1. Work with real-world messages.
When you're developing deliverables such as profiles, it's important to start with real-world messages for the reasons we covered earlier in this chapter on HL7 interface specifications. You will refer back to these deliverables over and over throughout the interface life cycle. If you start with placeholders or fictitious information, you'll struggle when it comes time to troubleshoot issues.

2. Share your work. Share your artifacts.
Encourage diligence in documenting all aspects of your interface project. Consider a common scenario – the interface project wraps up, and a key analyst or engineer leaves your organization. You want the new employee to be able to easily take over for the departing employee. And that means having all related documentation on hand. This practice helps in another way: by documenting what changes have been made to the interface over time, it's much easier to quickly troubleshoot any issue. And keep an on-going to-do list, especially around gap analysis, as this will help you better approach maintenance tasks. And make it easy for people to share their work and documentation. Use SharePoint, or look for collaboration functionality in the software you purchase.

3. Archive your work.
Upgrades and updates to the interface engine will happen. You don't want to get stuck being the victim of Frozen Interface Syndrome, which occurs when you are trying to implement a new interface and need all participants to switch over at the same time but can't get their cooperation. You also want to avoid Black Box Syndrome, when you lack full visibility into all the work that has gone into interface development handled by a third party, making it nearly impossible to upgrade, tweak, and manage the interface without spending lots of money and time. Don't make the mistake of thinking you won't need certain documentation in the future. In fact, you'll probably re-use it for your next project or for an interface or system update.

4. Understand content management.
Effective documentation requires that you think beyond message structure and troubleshooting. You need to think about clinical content and how it changes over time. For example, lab orders have their own codes, and these codes get updated over time. You want ready access to the most up-to-date list as needed. And you need them reflected in your HL7 tables. That means you need to plan from the start how you'll map the code sets to the right fields and build that into your interface and the system at go-live.

To make it all easier for your organization to take full advantage of its interfacing artifacts, assets, and documentation, download this checklist of what to look for when you're researching collaboration software. (Available as part of the Caristix HL7 Survival Guide supplementary material)

Chapter 12: Definitions

Anonymization
This is another way of saying "De-Identification" (of data). See the definition below.

Code set
Also referred to as HL7, vocabulary or code table. It is a list of codes and their meanings used to codify information included in HL7 messages. Codes could be defined by the HL7 standard itself or information systems.

For instance, here is the list of suggested values for patient gender as proposed by HL7 v2.6

Code	***Value***
M	Male
F	Female
U	Unknown
A	Ambiguous
O	Other
N	Not Applicable

Component
The basic building block used to construct a data type. In the case of complex data types, each data element is a component.
Example: Patient Family Name (PID.5.1) is a component of Patient Name (PID.5)

Conformance profile
A description of the data and messages that an interface sends and/or receives. The description covers the data format, data semantics, and acknowledgment responsibilities. The description must be clear and precise enough so that it can act as a set of requirements for data exchange.

Data Type
From the Health Level Seven International (HL7) official site: "The basic building block used to construct or restrict the contents of a data field." In other words, a data type will describe the format of field data elements (components). Example: Personal names are constructed using several pieces of information and should

maintain the same structure across the board. The XPN data type describes such structure.

De-Identification
De-Identification occurs when all identifiers and quasi-identifiers (IDs, names, addresses, phone numbers, genders, etc.) are removed from the information set. This protects patient identity while most of the data remain available for sharing with other people/organizations, or for related uses.

ER7 encoding
This is a representation of an HL7 message using message, segment, field, component, and sub-component delimiters. This encoding is usually referred to as a "pipe delimited" message.
Example:

```
MSH|^~\&|MegaReg|XYZHospC|SuperOE|XYZImgCtr|20060529090131-
0500||ADT^A01^ADT_A01|01052901|P|2.5
EVN||200605290901||||200605290900
PID|||56782445^^^UAReg^PI||KLEINSAMPLE^BARRY^Q^JR||19620910|M
||2028-9^^HL70005^RA99113^^XYZ|260 GOODWIN CREST
DRIVE^^BIRMINGHAM^AL^35 209^^M~NICKELL’S PICKLES^10000 W
100TH AVE^BIRMINGHAM^AL^35200^^O |||||||0105I30001^^^99DEF^AN
PV1||I|W^389^1^UABH^^^^3||||12345^MORGAN^REX^J^^^MD^0010^UAMC
^L||678
90^GRAINGER^LUCY^X^^^MD^0010^UAMC^L|MED|||||A0||13579^POTTER^
SHER
MAN^T^^^MD^0010^UAMC^L|||||||||||||||||||||||||||200605290900
OBX|1|NM|^Body Height||1.80|m^Meter^ISO+|||||F
OBX|2|NM|^Body Weight||79|kg^Kilogram^ISO+|||||F
AL1|1||^ASPIRIN DG1|1||786.50^CHEST PAIN, UNSPECIFIED^I9|||A
```

The other allowed encoding uses HL7-XML.

Field
According to Health Level Seven International (HL7), a field is a string of characters. Fields for use within HL7 segments are defined by HL7. A field is the basic building block used to construct a segment. By default, fields are delimited by the "|" character (see the above example) and are built with one or more components.

Gap analysis
Gap analysis is the phase in a deployment project where analysts map the data elements between the product they are installing to the elements in the hospital's existing information systems, therefore, detailing the gaps existing between the two sources.

HL7[source]
HL7 is an international community of healthcare subject matter experts and information scientists collaborating to create standards for the exchange, management, and integration of electronic healthcare information.
The name "Health Level-7" is a reference to the seventh layer of the ISO OSI Reference model, also known as the application layer.
Hospitals and other healthcare provider organizations typically maintain many different computer systems for everything from billing records to patient tracking. All of these systems should communicate with each other (or "interface") when they receive new information, but not all do so. HL7 specifies a number of flexible standards, guidelines, and methodologies by which various healthcare systems can communicate with each other. Such guidelines or data standards are a set of rules that allow information to be shared and processed in a uniform and consistent manner. These data standards are meant to allow healthcare organizations to easily share clinical information. Theoretically, this ability to exchange information should help to minimize the tendency for medical care to be geographically isolated and highly variable.

HL7-XML encoding
This is a basic XML representation of an HL7 message where XML elements represent HL7 messages constructs like segments, fields, and components. The other allowed encoding is ER7.

Example:
```
<ADT_A01>
<MSH>
<MSH.1>|</MSH.1>
<MSH.2>^~\&amp;</MSH.2>
<MSH.3>
<HD.1>MegaReg</HD.1>
</MSH.3>
<MSH.4>
<HD.1>XYZHospC</HD.1>
</MSH.4>
<MSH.5>
<HD.1>SuperOE</HD.1>
</MSH.5>
<MSH.6>
<HD.1>XYZImgCtr</HD.1>
</MSH.6>
<MSH.7>
<TS.1>20060529090131-0500</TS.1>
</MSH.7>
```

```
<MSH.8 />
<MSH.9>
<MSG.1>ADT</MSG.1>
<MSG.2>A01</MSG.2>
<MSG.3>ADT_A01</MSG.3>
</MSH.9>
<MSH.10>01052901</MSH.10>
<MSH.11>
<PT.1>P</PT.1>
</MSH.11>
<MSH.12>
<VID.1>2.5 </VID.1>
</MSH.12>
</MSH>
<EVN>
<EVN.1 />
<EVN.2>
<TS.1>200605290901</TS.1>
</EVN.2>
    …
</EVN>
<PID>
    …
</PID>
  …
</ADT_A01>
```

HL7 v2.x Message (source)

HL7 version 2 defines a series of electronic messages to support administrative, logistical, financial, and clinical processes. The v2.x standards are backward compatible (e.g., a message based on version 2.3 will be understood by an application that supports version 2.6).

HL7 v2.x messages use a human-readable (ASCII), non-XML encoding syntax based on segments (lines) and one-character delimiters. Segments have composites (fields) separated by the composite delimiter. A composite can have sub-composites (subcomponents) separated by the sub-composite delimiter, and sub-composites can have sub-sub-composites (subcomponents) separated by the sub-sub-composite delimiter. The default delimiters are vertical bar or pipe (|) for the field separator, caret (^) for the component separator, and ampersand (&) for the subcomponent separator. The tilde (~) is the default repetition separator. The first field (composite) in each segment contains the 3-character segment name. Each segment of the message contains one specific category of information. Every message has MSH as its first segment, which includes a field that identifies the message type. The message type determines the expected segment names in the message. The segment names for a particular message type are specified by the segment grammar notation used in the HL7 standards.

Sample of a v2.2 message with customized segments:

```
MSH|^~\&|MegaReg|XYZHospC|SuperOE|XYZImgCtr|20060529090131-
0500||ADT^A01^ADT_A01|01052901|P|2.5
EVN||200605290901||||200605290900
PID|||56782445^^^UAReg^PI||KLEINSAMPLE^BARRY^Q^JR||19620910|M
||2028-9^^HL70005^RA99113^^XYZ|260 GOODWIN CREST
DRIVE^^BIRMINGHAM^AL^35 209^^M~NICKELL’S PICKLES^10000 W
100TH AVE^BIRMINGHAM^AL^35200^^O |||||||0105I30001^^^99DEF^AN
PV1||I|W^389^1^UABH^^^^3||||12345^MORGAN^REX^J^^^MD^0010^UAMC
^L||678
90^GRAINGER^LUCY^X^^^MD^0010^UAMC^L|MED|||||A0||13579^POTTER^
SHER
MAN^T^^^MD^0010^UAMC^L||||||||||||||||||||||||||200605290900
OBX|1|NM|^Body Height||1.80|m^Meter^ISO+|||||F
OBX|2|NM|^Body Weight||79|kg^Kilogram^ISO+|||||F
AL1|1||^ASPIRIN DG1|1||786.50^CHEST PAIN, UNSPECIFIED^I9|||A
```

HL7 v3 Message

V3 is the latest version of the HL7 message standard. It is not backward compatible with the v2.x standard. Instead, it implements a completely new top-down design approach based on the Reference Information Model (RIM) for better consistency and extensibility. HL7 v3 messages are XML documents exchanged between systems. Tags are defined through a suite of modeling mechanism. We see some adoption of this message standard around Clinical Document Architecture (CDA). However, most systems continue to exchange data using v2.x messages.

Integration engine

Middleware built specifically to connect systems by using a standard messaging protocol. The integration engine is responsible for mediating protocols, orchestrating message workflow, transforming message formats, and guaranteeing message delivery.

Integration engines simplify system interoperability by allowing message feed management. In other words, you don't need to manage a system-to-system connection. Instead, messages are sent to the integration engine. Messages will be forwarded to any system(s) meant to receive those messages. If needed, transformation can be applied so a message is translated to the expected message format.

Interface

Hospitals and other healthcare provider organizations typically maintain many different computer systems for everything from billing records to patient tracking. All of these systems should communicate with each other (or "interface") when they receive new information, but not all do so. HL7 specifies a number of flexible standards, guidelines, and methodologies by which various healthcare systems can communicate with each other. Such guidelines or data standards are a set of rules that allow information to be shared and processed in a uniform and consistent manner. These data standards are meant to allow healthcare organizations to easily share clinical information. Theoretically, this ability to exchange information should help to minimize the tendency for medical care to be geographically isolated and highly variable

Integration as a Service
Based on the SaaS model, this is a delivery model where a provider provides all required infrastructure to interface systems. Usually, instead of charging for licenses and hardware, the provider will charge per message.

Message
A message is the atomic unit of data transferred between systems. In the HL7 world, it comprises a group of segments in a defined sequence. Each message has a message type that defines its purpose. For example, the ADT Message type is used to transmit portions of a patient's Patient Administration (ADT) data from one system to another. A three-character code contained within each message identifies its type.

Optionality
According to Health Level Seven International (HL7), optionality refers to whether the field, segment or segment group is required, optional, or conditional in a segment.

Point to point
Direct integration between two systems where system A and system B directly exchange information without an intermediate system or middleware.

Pseudonymization
This process replaces data-element identifiers and quasi-identifiers with new data elements so that the relationship to the initial object is replaced by a completely new subject. After the substitution, it is no longer possible to associate the initial subject with the data set. In the context of healthcare information, we can "pseudonymize" patient information by replacing patient-identifying data with completely unrelated data. The result is a new patient profile. The data continues

to look complete, and the data semantics (the meaning of the data) is preserved while patient information remains protected.

Repeatability
According to Health Level Seven International (HL7), repeatability refers to whether the segment or field may repeat. The value set is the maximum number of allowed occurrences; if unspecified, there is only one occurrence, i.e., it cannot repeat.

Segment
A segment is a logical grouping of data fields. Segments of a message may be required or optional. They may occur only once in a message, or they may be allowed to repeat. Each segment is given a name. For example, the ADT message may contain the following segments: Message Header (MSH), Event Type (EVN), Patient ID (PID), and Patient Visit (PV1).
Two or more segments may be organized as a logical unit called a segment group. A segment group may be required or optional and might or might not repeat. As of v 2.5, the first segment in a newly defined segment group will be required to help ensure that un-parsable messages will not be inadvertently defined. This required first segment is known as the anchor segment.

Sub-Component
The basic building block used to construct a component. In the case of complex data types using complex data type as components, each data element of the component is a sub-component. Example: Patient Own Surname (PID.5.1.1) is a sub-component of Patient Name (PID.5)

Trigger event
Health Level Seven International (HL7) defines a trigger event as "A real-world event creating the need for data to flow among systems. For example, the trigger event a patient is admitted may cause the need for data about that patient to be sent to a number of other systems. The trigger event, an observation (e.g., a CBC result) for a patient is available, may require that observation to be sent to a number of other systems. When the transfer of information is initiated by the application system that deals with the triggering event, the transaction is termed an unsolicited update."

Chapter 13: Resources and Contributors

Resources

- Checklist: Collaboration Software for HL7 Integration *
- For vendor performance rankings, see the KLAS Research website.
- For a current view of the HL7 interface market within healthcare, see the 2018 HL7 Interface Engine Rating survey results published by Core Health Technologies.
- For more on de-identification, check out these blogposts.
- Frozen Interface Syndrome: Wes Rishel of Gartner weighs in on this interoperability issue
- How to automate your tests.
- How to figure out if you suffer from Interface Black Box Syndrome
- Messaging Workbench available via HL7 International (look for a file name that includes "MWB release")
- Read more about addressing the challenges of lab interoperability in this Clinical Innovation and Technology article: Lab Interoperability Plays Catch Up.

Samples, Templates and Tools

- HL7 profile template kit *
- Sample gap analysis template *
- Software that automates the gap analysis process
- Use Caristix Message Player (it's free) to send or receive messages. Read about how we use Message Player here.

*Available as part of the Caristix HL7 Survival Guide supplementary material

White Papers

Conformance Checking for HL7: Ensuring Messages are Understood by Healthcare – white paper by Lyniate
https://www.lyniate.com/knowledge-hub/conformance-checking-hl7/

Rethinking HL7 Integration: Start with the Gaps – white paper by Caristix
https://promo.caristix.com/li-whitepaper-offer/

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Health Level 7 Group
HealthCare Information Technology
Healthcare-IT/HER/HIS
HIStalk Fan Club
HL7
HL7 International
Mirth HL7 Network

About Caristix

We believe that better integration of healthcare systems means a healthier society.

Caristix software was designed to address your most painful and common needs. It provides an alternative to manually addressing HL7 interfacing projects.

The average US hospital runs up to 100 IT applications. Not a single one of them can share patient information out of the box. So, hospitals and vendors turn to data interfaces – 50 to 100 of them in an average hospital. Each interface can take months of painstaking manual work to set up.

Caristix has developed a software suite to automate manual interface work. Our software reads HL7 data and outputs a list of interface requirements. As a result, Caristix software can reduce months of work to a few days. Reduce interface deployment time by 50%, reduce hospital testing time by 75%, and cut interface maintenance time by 90%.

Learn more at www.caristix.com.

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