



**Department of Health and Human Services
National Coordinator for Health Information Technology**

**Development and Adoption of a National Health
Information Network**

Response to Request for Information

January 18, 2005

Noam H. Arzt, Ph.D.
President, HLN Consulting, LLC
7072 Santa Fe Canyon Place
San Diego, CA 92129
858/538-2220 (Voice)
858/538-2209 (FAX)
arzt@hln.com
<http://www.hln.com/>

Contents

1 Introduction..... 4

2 Question 1 5

3 Question 2 8

 3.1 Models of Data Integration 9

 3.1.1 Model 1: Smart Card..... 9

 3.1.2 Model 2: Peer to Peer..... 10

 3.1.3 Model 3: Information Broker 12

 3.1.4 Model 4: Partitioned Warehouse 14

 3.1.5 Model 5: Central Warehouse 15

 3.1.6 Discussion..... 17

 3.2 Models of Application Integration..... 18

 3.2.1 Model 1: User Access through a RHIO-provided Application..... 18

 3.2.2 Model 2: Data Exchange with User Access through a Local Application 18

 3.2.3 Model 3: Direct User Access through a Local Application..... 19

 3.2.4 Model 4: Data Access via Smart Card 19

 3.3 Bringing Integration Together 21

4 Question 23 23

List of Figures

Figure 1 - Data Integration Model 1: Smart Card..... 9

Figure 2 - Data Integration Model 2a: Targeted Peer to Peer..... 10

Figure 3 - Data Integration Model 2b: Broadcast Peer to Peer..... 11

Figure 4 - Data Integration Model 2c: Facilitated Peer to Peer 11

Figure 5 - Data Integration Model 3: Information Broker..... 12

Figure 6 - Data Integration Model 4: Partitioned Warehouse..... 14

Figure 7 - Data Integration Model 5: Central Warehouse 16

Figure 8 – Application Integration Model 1: RHIO-provided Application..... 18

Figure 9 - Application Integration Model 2: Data Exchange with Local Application 19

Figure 10 - Application Integration Model 3: Direct User Access through a Local
Application..... 19

Figure 11 - Application Integration Model 4: Data Access via Smart Card..... 20

Figure 12 - Data and Application Integration..... 21

Figure 13 - Data and Application Integration with Smart Card..... 22

1 Introduction

HLN Consulting, LLC is a privately held company whose main offices are located in San Diego, CA. The company has been operating since 1997 and is a California Certified Small Business. Through a network of employees and consultants, located all around the country, HLN Consulting, LLC specializes in technology needs assessment and software development in public health and related non-profit agencies. We provide technology planning and technical services; strategic planning for use of technology; and consulting in business process engineering/re-engineering. HLN also studies the impact of technology on organizations.

HLN's core competency is the assessment, planning, development and implementation of systems for public health organizations and the integration of those systems with other public and private health systems and with external systems used by providers, health plans and academic medicine. We provide technology planning and technical services; strategic planning for use of technology; and consulting in business process engineering/re-engineering. HLN also studies the impact of technology on organizations. HLN is made up of professionals who have extensive backgrounds working with providers, patients and payors, state and local health departments, health plans, hospitals, provider practices, and community and rural health centers and related non-profit agencies. We have experience working with HRSA in Maternal and Child Health (MCH), genetic screening and primary care, with CMS working with Medicaid and Medicare, and with CDC working on immunization registries, implementations of Public Health Information Network (PHIN), bioterrorism preparedness and response, and public health laboratories.

HLN is pleased to offer a response to a selected number of questions contained in this Request for Information. Over the past several years, HLN has assisted public health agencies in conceptualizing the role of public health in the emerging National Health Information Network by developing and discussing data and application integration models that span the public-private boundary. In this way we hope to promote the interoperability described in the Office of the National Coordinator for Health Information Technology's (ONCHIT) vision.

Specifically, HLN's response will cover just three RFI questions:

1. Working Definition of an NHIN: As the RFI points out, this will provide the basis for the reviewers to understand the material that follows.
2. Type of Models for an NHIN: This is where the majority of HLN's response will be contained.
23. Major Design Principles for a Technical Architecture: HLN will offer a sample set of principles developed for one RHIO project we are working with.

Our goal is to provide a framework for thinking about conceptual models of NHIN development at a high level.

2 Question 1

The primary impetus for considering a NHIN is to achieve interoperability of health information technologies used in the mainstream delivery of health care in America. Please provide your working definition of a NHIN as completely as possible, particularly as it pertains to the information contained in or used by electronic health records. Please include key barriers to this interoperability that exist or are envisioned, and key enablers that exist or are envisioned. This description will allow reviewers of your submission to better interpret your responses to subsequent questions in this RFI regarding interoperability.

We see the NHIN as the complete set of systems, standards, policies, data, funding, and organization that enables integration of healthcare information through interoperability. The objective is to make appropriate access to a wide variety of health information secure and straight-forward. By definition, the NHIN is a public-private partnership that will bring out the best that private industry, government, and the rest of the not-for-profit sector have to offer.

There is no “one size fits all” solution. The current state of electronic medical records deployment, coupled with the political reality of the diversity of the healthcare delivery system in the United States and its concomitant supporting infrastructure, necessitate a flexible approach. We believe in the development of Regional Health Information Organizations (RHIO) that will manage regional deployments that encompass sensible healthcare delivery areas. This type of organization should consider the patient central to its mission. In some parts of the country a RHIO may involve multiple jurisdictions and governmental agencies, and may even cross traditional boundaries.

RHIO projects and systems will need to interconnect nationally through a set of agreed-upon standards. This interconnection will need to be simple enough to enable projects with different architectures to participate. Transactions will need to be authenticated, and the accurate identity of patients across projects and jurisdictions will need to be ensured. ONCHIT will need to be particularly active in developing these standards.

While the need is real, there are some significant barriers to the development of RHIOs and their interconnectivity:

1. **Financial:** Deployment of electronic medical records (EMRs) has been slow in the United States, especially among small practices. While professional societies have been working hard to promote the use of information technology among their members, a strong business case still needs to be made and a compelling value proposition developed before EMR deployment will be widespread enough in many communities to make RHIO deployment comprehensive. Limited funding for community-wide efforts due to national and local economic conditions only further hampers efforts at project development.

2. **Standards:** While many useful standards exist, medical and technical, they are not fully developed. The consensus process around standards development is slow and cumbersome in many cases, especially when the topics are complex and the path uncertain. Competing or overlapping standards may exist for some areas. Once ratified, the path to wide-scale adoption can be even slower.
3. **Identification:** Patient identification is still a difficult system challenge. Without a national patient identifier, systems will surrogate identifiers or algorithms to perform patient matching and de-duplication. Personal privacy continues to be an important issue for many Americans.
4. **Authentication:** It is critically important to be able to authenticate a transaction accurately to ensure that only valid users are participating in transactions, whether they be interactive (user's fingers on a keyboard or other input device) or automated (computer to computer without human interaction). This is both a technical and organizational challenge as there is both technical and philosophical tension between confidentiality and security of data and access to information for data sharing.
5. **Organizational:** There are significant challenges in developing and sustaining the proper community-based organizational structures necessary to ensure the smooth development, roll-out, and operation of a RHIO. Participation is required across public-private boundaries, among business competitors, and among organizations potentially with strong and differing opinions and philosophies.
6. **Vocabulary and terminology:** RHIO projects involve the intersection of two of the most jargon-filled and acronym-laden fields of knowledge: medical science and information technology. While significant strides have been made to standardize the vocabulary in each, these are still complex areas that need consistent language to facilitate common understanding.
7. **Technology:** There are a wide variety of technical barriers to successful RHIO system deployment, including (just to name a few): long tails of legacy system deployment which will hamper participation in newer, more modern systems; data formats and coding that do not map well to the requirements of data exchange in newer systems or across organizations; and uneven deployment of basic infrastructure around the country that is required for system interconnection. As will be seen in the descriptions of RHIO technical models in question 2, (Section 3 of this document).

That being said, there are still a number of key enablers that hold out hope for the development of RHIO's within the timeframe declared by the President:

1. **Interest and Momentum:** There seems to be genuine interest in both the medical and business communities for the development of RHIO projects as evidenced by the excitement in both communities about the prospect of this activity (and likely the extensive and numerous comments to be received by ONCHIT in response to this RFI).
2. **Standards:** While standards were listed as a key barrier, they are also a key enabler, as the relentless drive to discuss and determine appropriate standards for data descriptions, structure, and sharing marches on with much success. The

- participants in these numerous efforts should be commended for their selfless contribution to their fields of expertise.
3. **Public Health Expertise:** Public health has been struggling with issues of data interoperability and sharing for years. Community-wide projects for such functions as immunization registry deployment and disease surveillance provide rich experience to be drawn upon related to medical, technical, and organizational aspects of RHIO planning and deployment. This experience should be leveraged wherever possible.
 4. **The Internet:** While barely ten years old in widespread use, the Internet is a pervasive, world-wide enabler of inter-system and inter-organization communications.

The NHIN's purpose, through RHIO deployments, is to provide a rich data and application environment for patient-centric *and* population needs to support clinical activities and population health. We will focus on issues of integration for the balance of this response.

3 Question 2

What type of model could be needed to have a NHIN that: allows widely available access to information as it is produced and used across the health care continuum; enables interoperability and clinical health information exchange broadly across most/all HIT solutions; protects patients' individually-identifiable health information; and allows vendors and other technology partners to be able to use the NHIN in the pursuit of their business objectives? Please include considerations such as roles of various private- and public- sector entities in your response.

In our response to Question 1, we defined the NHIN as the complete set of systems, standards, policies, data, funding, and organization that enables integration of healthcare information through interoperability. We then identified RHIOs as the entity that will manage regional deployments that encompass sensible healthcare delivery areas and provide a rich data and application environment for patient-centric *and* population needs to support clinical activities and population health.

To support our vision of a RHIO, two distinct types of integration are important:

1. **Data Integration:** This involves forming valid relationships between data sources.
2. **Application Integration for Data Presentation:** This involves making integrated data available by presenting a unified view of data to a user through a computer application (“computer” being broadly defined as anything from a personal computer to a web browser to a smart card).

These two types of integration ultimately come together in the tools, applications, and data that the end user ultimately can access and use. We will describe five models of data integration and four models of application integration in the sections below. Note that these are technical models for RHIO deployment, not organizational or governance models for their management. Therefore, the role of public versus private sector participants is not fully addressed in this response.

3.1 Models of Data Integration

Five models of data integration described below fall along a continuum of least centralized to most centralized implementation.

3.1.1 Model 1: Smart Card

Model Features

This first model (Figure 1) is the extreme in distributed databases: there is no central database at all. Providers of data store information about a patient directly on the patient's smart card which is carried with the patient from site to site. Authorized users have smart card readers which permit access to patient records contained on the card as well as the addition of new data. The patient controls access to his or her own data through possession of the card.

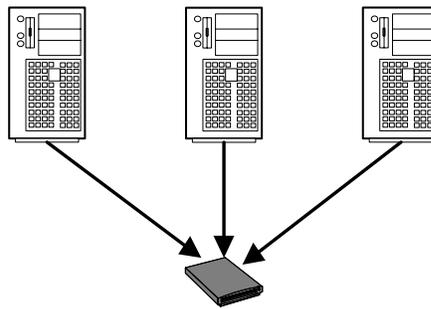


Figure 1 - Data Integration Model 1: Smart Card

Model Strengths and Limitations

This model has a number of strengths:

- + Allows incremental deployment: data providers and patients can be added to this system over time as quickly or as slowly as a RHIO requires.
- + Relatively inexpensive technology to read data from smart cards.
- + No requirement for expensive central database or system.
- + No requirement for consolidation of patient records, patient index, or record de-duplication.

This model also has a number of limitations:

- Patient must be physically present to access data.
- Data is replicated from provider systems to the smart card. If data changes at its source, there is no ability to update the smart card until the patient returns to the provider.

- Technology to write data to the smart card is not expensive, but its integration into existing or emerging electronic medical records systems that possess the necessary data may not be simple or inexpensive.
- Does not facilitate community-wide data analysis as there is no central consolidation of data.

It is possible (as displayed in Figure 2) for a central RHIO system to provide consolidated data to a smart card. See Models 3 through 5 below.

3.1.2 Model 2: Peer to Peer

Model Features

This model can be applied in a number of variations. In its simplest implementation (Figure 2 - Targeted), each participating system communicates as needed with its neighboring system. There is no central server. Data is displayed or stored for later display within a local participating system depending on the needs and capabilities of that system. Standards for communication exist for data formats and message types (*e.g.*, HL7), vocabulary (*e.g.*, SNOMED), and communications techniques (*e.g.*, Web Services, SOAP).

This implementation is called “targeted” because the user must know *where* to target a request for information for the patient. This implementation can support real-time or batch communications depending on the capabilities of the participating systems.

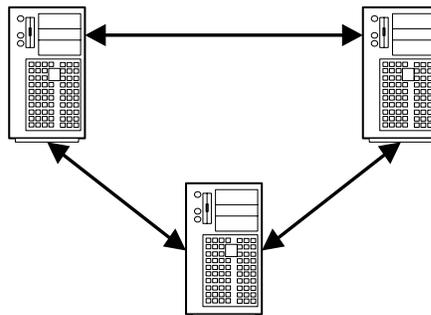


Figure 2 - Data Integration Model 2a: Targeted Peer to Peer

A variation of this model (Figure 3 – Broadcast) introduces the capability of a network broadcast. In this way, a participating system can inquire of a set of participating systems, by mutual agreement, as to whether data about a particular patient is found in those systems. An agreed-upon broadcast and response protocol must be developed and implemented for this to be successful.

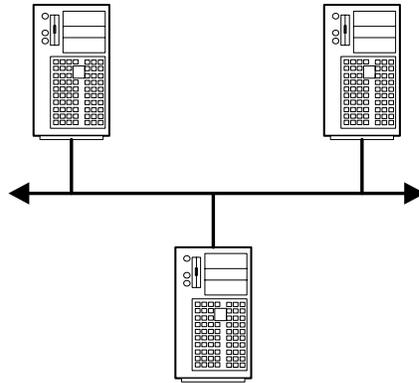


Figure 3 - Data Integration Model 2b: Broadcast Peer to Peer

A second variation of this model (Figure 4 – Facilitated) introduces a central directory server to help one facility identify participating providers without the need for a network broadcast. Note that this is *not* a directory of patients. Standards exist for this type of network-based directory service (*e.g.*, LDAP).

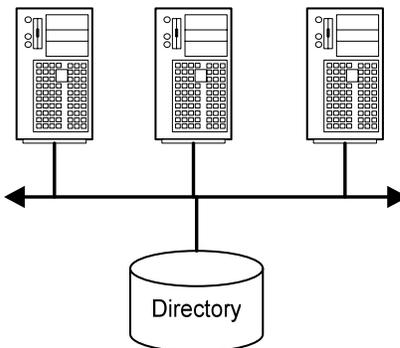
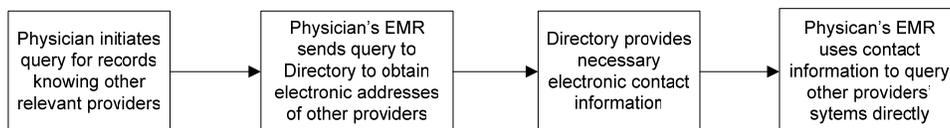


Figure 4 - Data Integration Model 2c: Facilitated Peer to Peer

For example, the following flow chart describes a typical information flow for a Facilitated Peer to Peer interaction:



Model Strengths and Limitations

This model has a number of strengths:

- + Allows incremental deployment as systems are ready
- + No replication of data required (though it is possible)
- + Any system can participate (even geographically peripheral) if they adopt the standards

- + Lower burden of central coordination
- + No dependence on a central database (other than Facilitated variation)
- + May work well when number of participants is small
- + May be less expensive to deploy

This model also has a number of limitations:

- In some implementations, need to know the destination system for your information request, or be patient while “the network” is searched
- Might allow some systems to fall behind and not support inter-system communication since it may be difficult to retro-fit some older systems to perform these data queries and transfers.
- Will not scale well to many, many systems
- Does not facilitate community-wide data analysis
- Performance may be slow

3.1.3 Model 3: Information Broker

Model Features

This model represents the first real step towards centralized operations. In this model (Figure 5), a central hub contains a master patient index of all patients contained in all participating systems. The hub does *not* contain any actual clinical records or other medical data. Within the index, each patient’s record is tagged with the participating system(s) that contain(s) data about that patient. Ultimately, patient data is retrieved through a two-step process: first the requestor queries the hub to identify where relevant parts of a patient’s record exist, and then the requestor can query those systems to retrieve the relevant data. Once again, standards for communication exist for data formats and message types (*e.g.*, HL7), vocabulary (*e.g.*, SNOMED), and communications techniques (*e.g.*, Web Services, SOAP). This model can support real-time or batch communications.

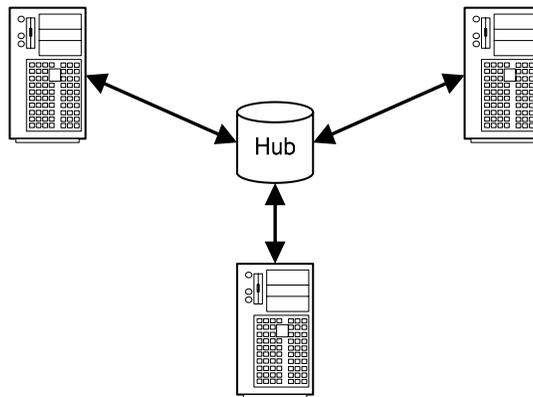


Figure 5 - Data Integration Model 3: Information Broker

The Santa Barbara (CA) Care Data Exchange is an example of a project that is being implemented using a similar model.¹

Model Strengths and Limitations

This model has a number of strengths:

- + System can discover where relevant records are housed community-wide.
- + No replication of clinical data, so data remains close to its source when additions, updates, or corrections need to be made.
- + System as a whole better protected from inappropriate disclosure since each participating system is still in full control of its patient data. A participating system is free to refuse to respond to a query it might deem inappropriate or insecure.
- + Scales well for many users and systems since only a patient index is located in the central hub.
- + Can facilitate community-wide data analysis by querying populations or sub-populations from the central hub.
- + May be easier to integrate existing systems into the network since they need only register their patients with the central hub.

This model also has a number of limitations:

- Strong central coordination is required. This is as much an organizational issue as a technical one.
- There is dependence on the central hub for inter-system communications, so if the hub is for some reason unavailable, system to system communications will stop.
- Harder for individual systems to participate since they must be able to communicate with the hub using a standard method.
- Requires two steps (and more time) to get data: query to the hub, then a second query to the authoritative system .
- May require a large effort to keep demographic records free from duplication since these records will be collected from numerous disparate sources.
- Once the central hub identifies where the subsequent data queries need to go, other systems may be unavailable at query time.
- More difficult to present a coherent, unified view of the patient since the clinical data continues to reside in distributed systems and not in a single central location.

¹ See http://www.carescience.com/healthcare_providers/cde/care_data_exchange_santabarbara_cde.shtml

3.1.4 Model 4: Partitioned Warehouse

Model Features

Whereas Model 3 (Information Broker) only contains patient demographics in its central hub, Model 4 (Figure 6) introduces a central database operated by the RHIO which assembles complete, consolidated records of people and their medical data. The actual data is contained in segmented data “vaults” which isolate the medical data supplied by each participating institution and function as surrogates for the local data systems of the participating organizations. Similar to Model 3, the central database contains a master patient index where each patient’s record is tagged with the participating system(s) that contain(s) data about that patient. But unlike Model 3, the central index need go no further than its local data “vaults” to fulfill a valid query about a patient. All the medical data is available and assembled “on the fly” based on the needs of a particular query.

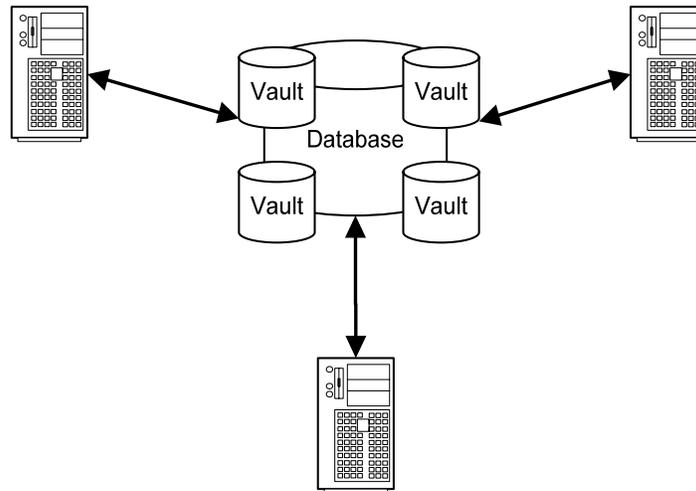


Figure 6 - Data Integration Model 4: Partitioned Warehouse

Participating systems are required to periodically update data in the central database cluster. As before, standards for communication exist for data formats and message types (e.g., HL7), vocabulary (e.g., SNOMED), and communications techniques (e.g., Web Services, SOAP). This model can support real-time or batch communications.

The Indianapolis Network for Primary Care is an example of a project that is being implemented using a similar model.

Model Strengths and Limitations

This model has a number of strengths:

- + Less real-time dependence on other participating systems, since all the data to satisfy a query about a patient is located centrally.

- + Implements a strict “need to know” policy for data access since clinical data is held in segmented “vaults” and only released as required.
- + Facilitates community-wide data analysis since data is easily consolidated centrally.
- + Scales well so long as appropriate investments made in central resources.
- + Economies of scale introduced through the use of large-scale central resources.
- + Likely better expertise in managing central resources due to their scale and class of products used.
- + Should be able to support existing systems well as data needs only to be extracted and sent to the central repository.

This model also has a number of limitations:

- Strong central coordination required since the central database cluster needs to be carefully managed and maintained for this system to work.
- Dependence on large central database for inter-system queries.
- Queries still require central system to consolidate data “on the fly” and therefore may take longer than desired to fulfill.
- Data timeliness issue: data submission from participating systems to central database cluster may lag resulting in inaccurate consolidated records at query time.
- May require a large effort to keep not only demographic records but *also* clinical records free from duplication since these records will be collected from numerous disparate sources.
- Harder to implement incrementally, as a larger up-front investment in central resources is required.
- Unclear how to economically implement a large number of isolated vaults for small data providers as the project matures and smaller data providers join.
- Likely fairly expensive option to implement, not only technically but organizationally.

3.1.5 Model 5: Central Warehouse

Model Features

Model 5 (Figure 7) builds upon Model 4, but rather than keeping clinical data isolated in vaults all data (demographic and clinical) is consolidated into a single central database, or data warehouse. Various methods can be employed to bring the data together, or relate data from multiple sources together in the same database. All the medical data is available immediately to fulfill the needs of a particular query. Participating systems are still required to supply data periodically to the central system.

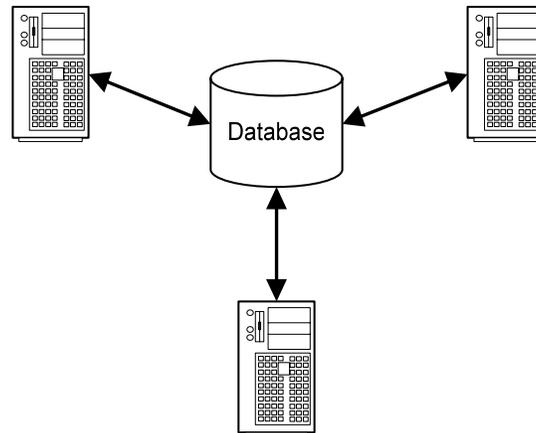


Figure 7 - Data Integration Model 5: Central Warehouse

As before, standards for communication exist for data formats and message types (*e.g.*, HL7), vocabulary (*e.g.*, SNOMED), and communications techniques (*e.g.*, Web Services, SOAP). This model can support real-time or batch communications.

The emerging Arizona HealthQuery project is an example of a project that is being implemented using a similar model.²

Model Strengths and Limitations

This model has a number of strengths:

- + Querying system's response to a data request is quicker than other models since all the data is already centrally maintained and consolidated.
- + Less real-time dependence on other participating systems for the same reason.
- + Facilitates community-wide data analysis since data is available centrally.
- + Scales well so long as appropriate investments are made in central resources
- + Economies of scale introduced through the use of large-scale central resources.
- + Likely better expertise in managing central resources due to their scale and class of products used.
- + Should be able to support existing systems well as data needs only to be extracted and sent to the central repository.

This model also has a number of limitations:

- Strong central coordination required since the central database cluster needs to be carefully managed and maintained for this system to work.
- Dependence on large central database for inter-system queries.
- Data timeliness issue: data submission from participating systems to central database may lag resulting in inaccurate consolidated records at query time.

² See http://www.slhi.org/ahf_projects/mhip.shtml

- May require a large effort to keep not only demographic records but *also* clinical records free from duplication since these records will be collected from numerous disparate sources.
- Harder to implement incrementally, as a larger up-front investment in central resources is required.
- Likely fairly expensive option to implement, not only technically but organizationally.

3.1.6 Discussion

All of these models present viable alternatives for RHIO development and deployment. The specific requirements will dictate a best fit for a particular project. We hope that the above discussion of the strengths and weaknesses of each model provide some depth to assist in considering each one. Ultimately, a decision comes down to making various tradeoffs between different attributes of the models. Since issues of application integration affect a data integration strategy, see additional discussion on model choice at the end of Section 3.

3.2 Models of Application Integration

Four models of application integration are described below. The focus here is on how data is presented to the end user.

3.2.1 Model 1: User Access through a RHIO-provided Application

Using this method (Figure 8), users access data through a computer application that allows authorized query and presentation of patient and/or population data. This method allows the RHIO to serve users' data needs without concern for interoperability with any other computer applications the user might be accessing.

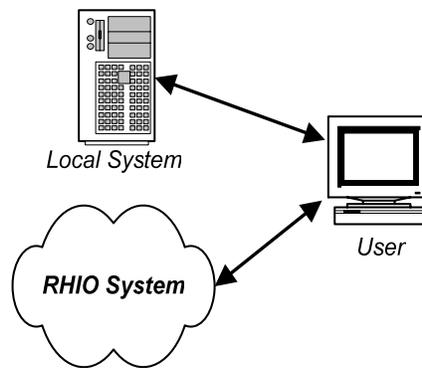


Figure 8 – Application Integration Model 1: RHIO-provided Application

For some users and organizations this provides some additional tradeoffs. Users can become confused about which application to use to access patient data when they have a local application/electronic medical records system (EMR) *and* the RHIO application as well. Some organizations may not want to provide technical support for multiple applications and may discourage (or even ban) the use of an external RHIO application.

3.2.2 Model 2: Data Exchange with User Access through a Local Application

Using this method (Figure 9), the user's local system queries the RHIO system for data, and presents the results of the query in the local system as if the data had originated there. This method allows users to continue to use their familiar, institutional systems *only* and avoid the potential confusion and support requirements of another application.

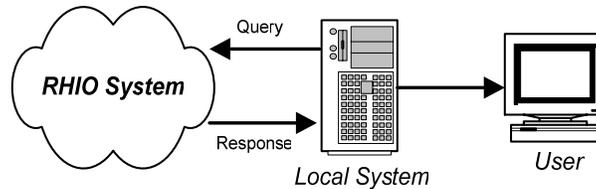


Figure 9 - Application Integration Model 2: Data Exchange with Local Application

For this method to function successfully, both the RHIO System and the local system need to be capable of supporting automated query and response. The local system needs to be able to queue queries when the RHIO System is not available, and must be able to recover when transactions fail or are delayed due to poor response time or network latency. Standards exist for this type of messaging (*e.g.*, HL7).

3.2.3 Model 3: Direct User Access through a Local Application

Using this method (Figure 10), the user accesses a patient in the local system. When data is required from the RHIO application, the user's local system initiates a login to the RHIO application using the credentials and patient identifiers already entered by the user. If the credentials are validated, and the patient is found, the RHIO application is executed and the user views the required record using that application.

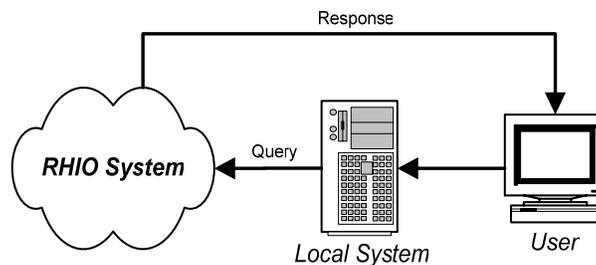


Figure 10 - Application Integration Model 3: Direct User Access through a Local Application

Like Model 1, the user is restricted to viewing consolidated patient information through a new application provided by the RHIO System. But like Model 2, access to this new application is facilitated by the user's local system through the sharing (and passing) of user credentials and patient search parameters within the context of the local application. Standards exist for this type of inter-application communication.³

3.2.4 Model 4: Data Access via Smart Card

In this model (Figure 11), data is stored directly onto a smart card possessed by the patient, and the patient brings the smart card to any healthcare provider requiring access

³ See HL7's Clinical Context Object Workgroup (CCOW), http://www.hl7.org/special/Committees/ccow_sigvi.htm

to the records. The provider uses a smart card reader to access the card received from the patient. Assuming the smart card is kept up-to-date, and providers are capable of both writing data onto it and reading data from it, the patient is ensured of possessing a complete medical record under his or her control.

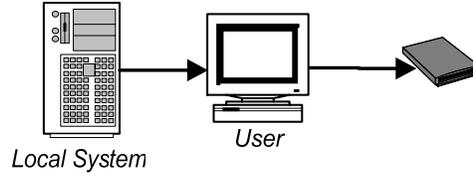


Figure 11 - Application Integration Model 4: Data Access via Smart Card

3.3 Bringing Integration Together

Figure 12 shows how, conceptually, a RHIO System deployment supports both data and application integration:

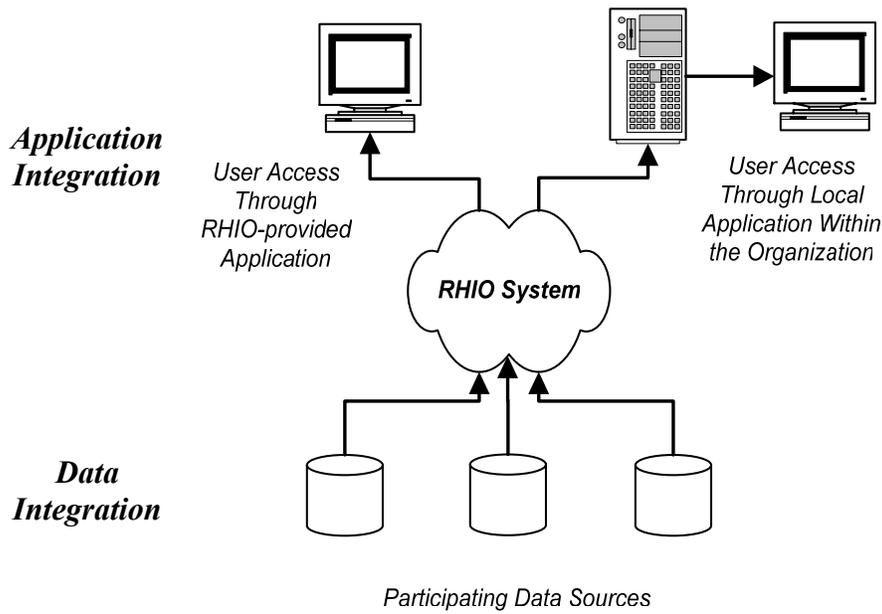


Figure 12 - Data and Application Integration

In the lower portion of the diagram, participating data sources contribute data to the regional effort through one of the data integration models discussed above. The RHIO System enables the presentation of that data to end-users in a variety of ways identified in the upper part of the diagram through one of the application integration models discussed above.

One additional method of data access is also envisioned and displayed in Figure 13. In this case, the patient travels *with* his or her data embedded on a smart card or other portable storage device. A user would only need the proper reader to access the patient's data.

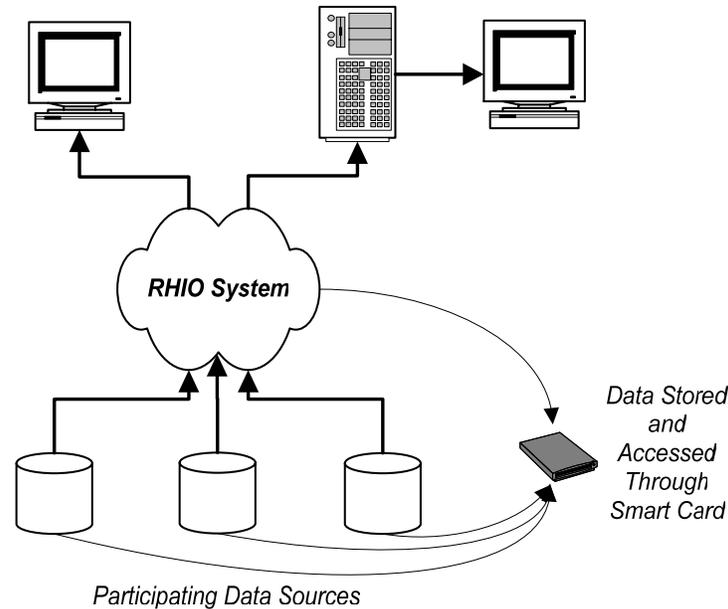


Figure 13 - Data and Application Integration with Smart Card

In the first case (Figure 12) the RHIO System performs some set of functions to relate, or integrate, data for the same patient received from the participating data sources. The method or technology for integration is not presumed. In the second case (Figure 13), both the data and application integration might take place on the smart card (lines showing data flow directly from data sources) or, theoretically, the data integration may be driven from the RHIO System if a consolidated system is the source of storage for the smart card data (single line from the cloud). In all cases, entities that provide data may or may not be the same ones that authorize users for data access.

How does one evaluate these various models? There is no single set of criteria. A RHIO project must determine its functional requirements and then determine whether one or more of the data integration or application integration models represents a good fit. Many different attributes can be used to assess the relative usefulness of these models, but here are some more common factors:

1. **Timeliness:** How quickly will data be available to the end user given that it is likely coming from multiple disparate sources? Timeliness may depend more on the habits and capabilities of the participating organizations than the attributes of the RHIO since ultimately availability of data rises and falls on the ability of participating organizations to supply it.
2. **Reliability:** How reliable is the quality of the data being presented? Have the pieces of a patient's record assembled from different sources been properly compiled? Is the original source of the data authoritative and accurate?
3. **Comprehensive:** How comprehensive is the data being presented? Are parts of the patient's record missing or unavailable?
4. **Cost:** How expensive is the proposed solution, both to the RHIO centrally and to participating members?

4 Question 23

Describe the major design principles/elements of a potential technical architecture for a NHIN. This description should be suitable for public discussion.

As part of the planning for a RHIO deployment under development, we developed the following set of information technology principles to guide the effort. Principles serve as guides for information technology decisions to be made later in the project, and help establish a shared understanding through shared language. They should be resilient enough to endure through both the planning and implementation phases of the project.

Data

1. **Common base of data:** A common base of data must be created to facilitate sharing and minimize redundancy. This data may be physically *or* logically consolidated (there may or may not be a central database).
2. **Comprehensiveness:** The goal of the system is to create as comprehensive a patient record as possible, and to consider the complete patient record.
3. **Accuracy:** Data must be accurate and complete (there is often a tradeoff between these two). Clinical data must be reviewed by an appropriate person to ensure accuracy.
4. **Timeliness:** Data must be available in as near real-time as possible from the point of creation.
5. **Security and confidentiality:** Data must be safe from harm and accessible only to those with a "need to know." More specific rules should delineate the boundaries around data access from all perspectives (patient, provider, payer, others).
6. **Ease of access:** Data must be easy to access for all groups of authorized users regardless of their level of technical expertise. Ease of use comes first and foremost for healthcare providers who access systems.
7. **Multiple uses:** While the primary use for data is clinical support, the project must plan for multiple uses of data, including research, planning, evaluation, and public health surveillance.
8. **Purposeful Collection:** Data must be collected only once, as close to the source where it originated.
9. **Documentation:** Detailed information about data must be created, maintained, and made available to assist in data quality assurance.

10. **Population-based:** The system should populate records prospectively, starting with birth record information, and retrospectively using historical information, to construct as complete a health record as possible. Accurate patient matching is crucial to this capability. Accommodation needs to be made for patients who are born outside of the State to ensure that their records are included.

Applications

11. **Ease of use:** Applications must be easy to use for both novice and expert users, and should pose minimal adverse impact on existing business and clinical processes and activities.
12. **Consistency:** Interfaces should be similar enough to present a consistent look and feel, though different interfaces might be necessary for different types of users.
13. **Adaptability:** Applications must be easily adaptable to changing functional and technical requirements.
14. **Ensuring data quality:** Applications must help ensure valid, consistent, and secure data while presenting minimal obstacles to smooth and efficient user.
15. **Visible Benefit:** Applications must present visible, tangible benefits to end users.

Infrastructure

16. **Platform Neutrality:** Various platform architectures might satisfy the needs of the project.
17. **Reliability:** The system must operate reliably and be resilient to natural or technical disasters.
18. **Leverage Networks:** Wherever possible, existing networks should be leveraged to minimize cost and complexity.
19. **Use of the Internet:** Wherever possible, secure use of the Internet as a wide-area network should be supported and encouraged.
20. **Standards:** Where relevant, national standards for healthcare information technology should guide technical decisions.

Organization

21. **Support of Mission:** Information technology initiatives must support the specific mission and goals of the project.

22. **Cost effectiveness:** Information technology must contribute to the cost effectiveness of the processes it supports, and must be cost effective for each participant through a positive return on investment.
23. **Data Stewardship:** Data stewards serve as custodians for data in their care, and are responsible (along with all providers and users of data) for ensuring the proper documentation, collection, storage, and use of data within their purview.
24. **Governance:** The project should have clear and strong processes for governance, consistent with the project proposal and the highest standards of the participants.
25. **Scope Management:** The project is committed to clear identification and careful management of its scope and activities.