

AI: Opportunities, Capabilities and Limits

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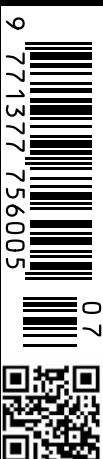
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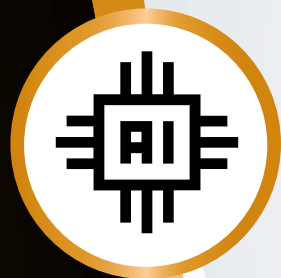
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AI: Opportunities Capabilities & Limits



Hospitals-on-FHIR: Preparing Hospitals for European Health Data Space

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Hospitals and other healthcare organisations are where health data is predominantly created. If the European Health Data Space (EHDS) is to become a reality for citizens, both via supporting primary use as well as secondary use of health data, data located in these organisations needs to be able to be shared. Experts, industry, and EU-funded projects are converging on the HL7 FHIR as a route to interoperable healthcare and a central tenet of the European Electronic Health Record and its Exchange Format. The Hospitals-on-FHIR is an initiative that aims to boost interoperability maturity in organisations by fostering a progressive and collaborative approach to gearing up to the EHDS ethos of creating value to patients through data sharing.



Key Points

- The European Health Data Space (EHDS) needs data that flow through interoperable channels all the way from inside hospitals to the regional, national and EU levels.
- Organisations need to be ready for safe, secure and interoperable data exchange to support increasingly relevant Personal Health Data Spaces as individuals also claim and desire to access their health data in a rekindled health data activism movement.
- Interoperability in healthcare has never been more needed as integrated care is required for quality, sustainability, and resilience. Maturity in interoperability relates to the level with which hospitals, and other healthcare organisations, make use of well-known and internationally accepted standards.
- The Hospitals-on-FHIR (HoF) initiative, started by HL7 Europe, aims to create a community of learning in data sharing and proposes a 10-step maturity model to realise the KIWI (Knowledgeable, Intelligence, Wise and Interoperable) principles, and can bridge with the HIMSS EMRAM® maturity levels.
- The HoF maturity model illustrates milestones in the path towards interoperability that apply to hospitals and health care organisations that wish to share and exchange health data.

Introduction

The growing trend and importance of citizen-generated health data, in the construction of Personal Health Data Spaces (Moen et al. 2022) can foster better health promotion or contribute

to real world evidence collection. However, hospitals and other healthcare providers are still, for the most part, hesitant and worried when health data is generated from healthcare encounters, captured, and indeed stored in often old legacy information systems, as they struggle to migrate to



new interoperable EHRs solutions.

The rise of the data economy brings changes in the role of hospitals and other large healthcare organisations in their capacity and their internal dynamics related to how they can support digital health services from personal, to national and even European levels. Healthcare providers and their managers

sharing between organisations in and between many of the EU countries and indeed beyond to non-EU countries. Also, to create the conditions to link health data holder organisations to a growing paraphernalia of new digital health solutions - often mobile and occasionally associated with digital therapeutics - being offered by a flourishing industry driven to satisfy citizens

Hospital and healthcare managers need to be aware of the importance of interoperability and capable of triggering the right investments to advance their capacity to share health data

need to see themselves as knowledge organisations but need to be more than that. They need to be Knowledgeable, Intelligent, Wise and Interoperable (KIWI) (Martins 2021).

The ability of hospitals to connect and share knowledge, their interoperability maturity, has to do with their use of the HL7 FHIR standards and associated specifications. The Hospitals-on-FHIR initiative, started by HL7 Europe, proposes a 10-step maturity model that builds upon the KIWI maturity principles.

Hospital and healthcare managers need to be increasingly aware of the importance of interoperability and capable of triggering the right investments to advance their hospitals capacity to share health data. Joining hospitals-on-FHIR network and progressing in HoF maturity levels will allow their organisations to become KIWI instances of efficient, knowledgeable and resilient, future proof healthcare organisations.

The continued need for healthcare interoperability

The need for interoperable health and care services has never been greater and so greatly appreciated as chronic diseases increase with the COVID-19 pandemic resulting now in thousands of long-term cases of either long-COVID or post-COVID patients requiring continuous respiratory or rehabilitation care. As citizens move along their health journey, life-long conditions require them to have more control and usage of their health data, and to benefit from articulated care networks spanning cross-borders of both nationality and public-private divides.

The seamless navigation of a health system by an individual, and the capacity to receive integrated holistic care rests heavily on the degree to which healthcare providers, particularly hospitals, can use and exchange health data in real time. This requires that information systems in use can utilise modern and advanced connections that follow interoperability rules. International standards, like HL7 FHIR, have helped industry and implementer teams in healthcare institutions to advance with some degrees of integration, particularly inside the realm of each hospital or healthcare organisation. The challenge is now to advance further safe and secure

and patients as the new clients in the growing digital health market. The member states and the EU are also envisioning more access to health data, for policy, system management and public health. This desire, the value and its justification have increased in a pandemic crisis era. The recent proposal for a [Regulation on the European Health Data Space](#) is the hallmark of this trend.

Personal health data spaces

If each one of us is to have access and the capacity to use and control all of his or her health data de facto, then that data needs to be accessible in a sophisticated manner. A data lake of paper printouts, PDF files, or some visually accessible digital format through a patient portal without the possibility to search, use, and reuse are no longer sufficient. It is to be in a plastic, almost fluid, manner. Certainly mobile, mouldable, and manageable (3Ms) according to mobility needs (over distance and time), edit desires (corrections, comments and cocreation) and digital health literacy requirements, respectively are at the top of the list. These 3M Personal Health Data Spaces (PHDS) are likely to materialise first in mobile apps fully integrated to hospitals and any other healthcare points along the health journey, and later to dematerialise into more ubiquitous computing solutions, as these integrate into different IoT-enabled medical and common devices as well as into the smart health working and living environments of the near future. Many healthcare providers are already offering their users/clients mobile access to increasing amounts of health data and do so using HL7 protocols, and increasingly HL7 FHIR due to its simplicity and links to web protocols such as REST.

European Health Data Space

The European Health Data Space will need health data. It is pointless without it. Large amounts of good quality health data. Ideally clinically relevant health data good for research analysis. Clinically relevant health data has been produced during healthcare encounters in healthcare providing institutions and



stored in numerous Electronic Health Record (EHR) systems using different terminologies and database structures. Thus, the data needs of the European health data space can only be satisfied by creating interoperable digital bridges between the past and the future. Between locally installed EHRs or departmental information systems in healthcare organisations and the envisioned federated European health data space, regional or national databases can serve as midpoint standard data aggregators.

Understanding the EHDS as a big data project for secondary use can be misleading. It equally encompasses what is increasingly called primary use of health data reflecting the capacity

What is Hospitals-On-FHIR (HoF)?

Hospitals-on-FHIR is an HL7 Europe triggered initiative that aims to deliver on the transformation of health and care and the needs of European citizens, by understanding the needs of hospitals and supporting their interoperability journey towards comprehensive HL7 FHIR implementations, including the EHDS, with grassroots sharing of experience, collaboration, and synergies.

To achieve this objective HoF provides a maturity model, the neutral grounds for a community of practice and the encouragement and knowledge through different experience sharing events.

The European Health Data Space will need health data. It is pointless without it

to use a digital health service to support the provision of care. Through Myhealth@EU services, the EHDS will continue to support the expansion of cross-border sharing of ePrescriptions and Patient Summaries, enlarging and refining the scope. Laboratory data, imaging reports, or hospital discharge letters as the new domains of the European Electronic Health Record exchange format (EHRx) (www.x-ehealth.eu) are to be shared in the EU space as citizens may request healthcare services to access home-located health data when traveling and when requesting a second opinion. Such scenarios are complementing PHDS covering personal health care between healthcare encounters and call for the same data to be made available and is seamlessly integrated. Again, HL7 FHIR standards and implementation profiles are the key to this coherent health data ecosystem and critical to patients and citizens experience with digital health services based on reliable health data and information for their empowered decision making about their health and care needs.

The EHDS regulation proposal, somehow anticipates this need when it foresees the establishment of national EHRs certification/appraisal systems. There is a clear recognition that the IT industry needs to supply healthcare with advanced solutions, but also that regulators need to intervene. From an EU level perspective, advancements in the European EHRx will hopefully create a referential. Nationally, adoption and verification of conformance will need to be promoted. Finally, at each hospital or healthcare provider, if high quality interoperable solutions are not installed and the organisations are not capable of using REST APIs (seen as clear reference to HL7 FHIR implementation needs) and other technical gateways for seamless flows of health data, then that data will not be able to flow out, to patients and their PHDS, or to national and European health data spaces.

The idea of HoF was first presented in 2021 in this publication in a brief article on Fast Healthcare Interoperability Resources (FHIR), as hospitals and their interconnections were seen as a critical asset and the next step for European health data interoperability (Martins and Cangioli 2021). The Hospitals-on-FHIR launch event took place on March 31, 2022 online. Although it was planned as a small family event, it attracted more than 140 participants from hospitals, research organisation, industry, and academia. The European Commission was represented and shared its key interoperability initiatives, to illustrate the importance of grassroots community initiatives like Hospitals-on-FHIR. At the same time, the website www.hospitalsonFHIR.eu went live inviting hospitals and HL7 FHIR experts to join. A number of initiatives planned for the rest of 2022, aim to spread the word and set the groundwork of the HoF Virtual Community of Practice.

Why HoF?

For a long time, interoperability standards have been a purely technical affair engaging health professionals, business analysts, and software engineers. Implementations were local and the budget involved rational and limited. This is no longer the case.

With the advent of the data economy and the digital transformation of health and care, hospitals and healthcare organisations in general rely on digital health services, connectivity, and reliable data. Sharing experience and supporting each other within and across jurisdictions, hospitals can align their implementation strategy and accelerate developments, potentially at reasonable costs and realistic timelines. Moreover, HoF uses HL7 FHIR to discuss interoperability plans and associated maturity to the C-suite, making the adoption of HL7 FHIR, very much like EHDS as strategic priority.

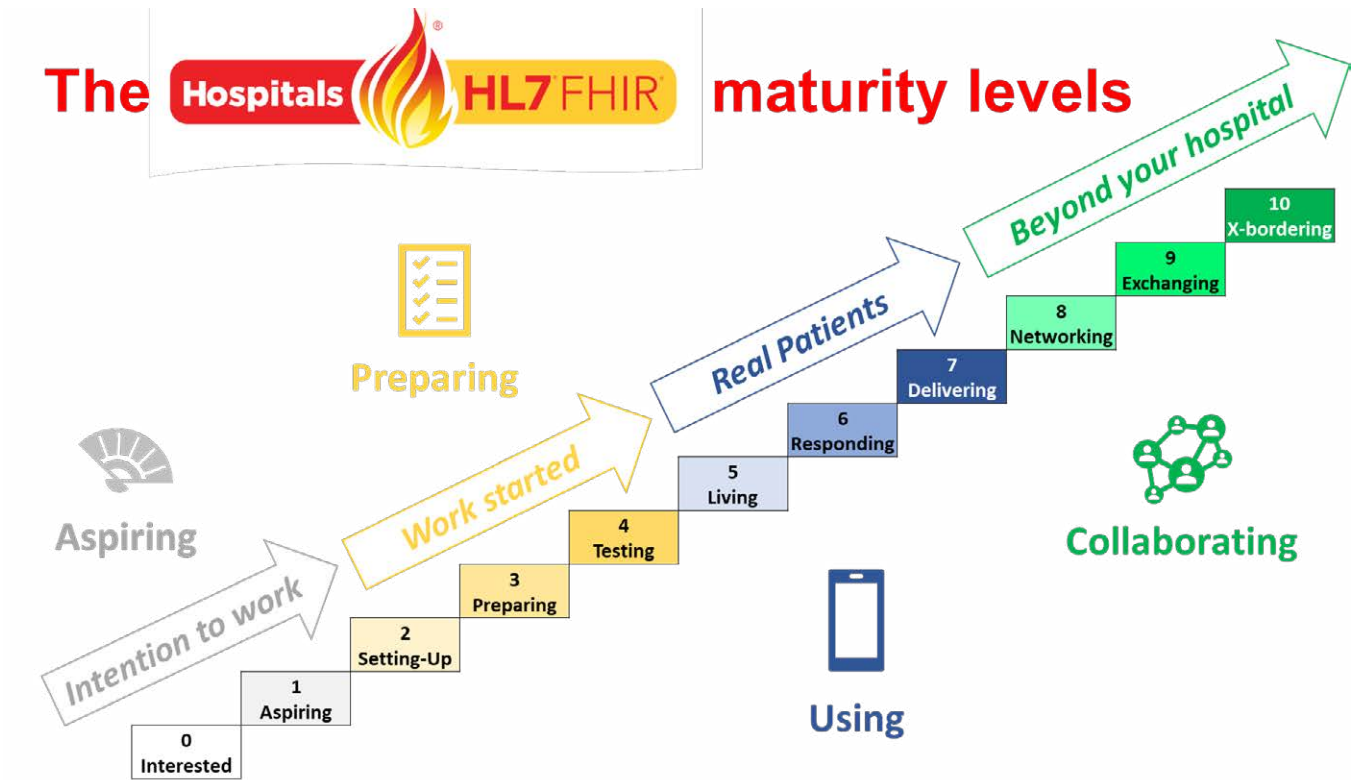


Figure 1: The Hospitals-on-FHIR maturity model in summary

Value proposition

Hospitals-on-FHIR places hospitals on the European map, expressing their intent to explore the adoption of HL7 FHIR and accelerate their progress towards safe, secure and effective participation in the EHDS. It also allows hospitals to assess their status, their maturity level, overall and in regard to specific domains, applications areas or use cases, linked to the European EHRxF.

HoF also is valuable for patients and for national and Europe level efforts to benefit from better digital health. The four levels value proposition can be summarised in a F.H.I.R mnemonics:

- **F**or patients who need to access, use, curate their health data and see it being used and shared for their benefit.
- **H**ospitals and other healthcare provider organisations need to share experiences, techy enthusiasm and do it together.
- **I**nteroperability and integration at national level depend on organisations opening their technical doors.
- **R**egions like Europe and even extending out, need to collect, secondary use and explore the value of health data.

How Can Hospitals Prepare for the Future and the EHDS?

Adoption the KIWI principles as part of the mission of the organisation, helps develop their capacity to become

interoperable with other organisations, offering comprehensive services to their patients/clients, and getting ready to use health data to support continuous improvement, resilience, and cutting edge health research programmes. For example, consider the support of seamlessly data integrated patient care journeys, across borders, providing data for exchange, via MyHealth@EU, in the context of the EHDS. These can be bilateral cross-border regional meaningful collaborations (i.e. stimulated by Interreg challenges) or support to care provision – what is commonly known are primary use of health data. It could also help to provide data for research and policy making, into national or European data spaces, where it can be analysed in big data efforts – commonly referred as secondary use of health data. For hospitals and other healthcare organisations to do this, as HL7 FHIR can serve as an accelerator, and a multiplier for organisations ready to collaborate, knowing and sharing with peers along the same interoperability readiness journey.

HoF Maturity Model

The HoF Maturity Model (HoF-MM) serves as a means for hospitals and other healthcare providing organisations to measure their capabilities in offering interoperability services through HL7 FHIR and communicate with other hospitals and relevant stakeholders. Therefore, the HoF-MM model is a means to reinforce interoperability and accelerate the potential



for continuous improvement, resilience, and mutual support.

The HoF-MM is not just a measure of the technical capacity of implementing HL7 FHIR (micro-)services, but taking in account also non-technical aspects that are essential for the success of such types of interoperable networks, it advances collaboration, sharing of experiences, and mutual learning. It establishes a non-technical language, that drives the capacity of building a community of adopters, create relationships with other organisations, share best practices, provide mentorship, and engage in joint projects. Moreover, it acknowledges the crucial role of decision makers in the C-suite, to understand the long-term implication of adopting HL7 FHIR for the participation of their hospitals in the EHDS. In fact, without a recognition of the role of HL7 FHIR by these decision makers, it is unlikely that all the supporting actions required to step-up in the HoF-MM levels will be realised.

or phases that indicate how advanced the organisation is in the process of putting HL7 FHIR to work:

- **Aspiring:** the organisation expressed its interest in using HL7 FHIR and connects with the HoF network.
- **Preparing:** the organisation has started the process to be “on-FHIR”
- **Using:** the organisation is internally using HL7 FHIR for real services: it is “on-FHIR”.
- **Collaborating:** the organisation has established external collaborations. This may include the sharing of HL7 FHIR data beyond its boundary.

Excluding aspiring, each phase includes three levels. The **Aspiring** category is the entry level for a hospital to be included in the HoF map: Level 0 indicates that a first connection between the organisation and the HoF network occurred; while the first real level (level 1) indicates that an aware deci-

Aspiring		
0	Interested to be On-FHIR	The hospital agreed/expressed an interest to participate in Hospitals-On-FHIR.
1	Aspiring to be On-FHIR	The hospital has filled in the participation and consent form - basic information necessary.

The HoF-MM is a top-down model constituted by 10 levels, grouped in four grades. The model provides a common framework that can be adapted to different jurisdictions or context of use, keeping however a consistency among the levels

sion to be part of HoF has been made.

The **Preparing** grade ranges from the initial self-assessment and planning to realise HL7 FHIR based services (level 2) to the testing activities before going live (level 4).

Preparing		
2	Setting-Up to be On-FHIR	The hospital has performed a self-assessment on conditions to establish and operate HL7 FHIR-based services.
3	Preparing to be On-FHIR	The hospital is preparing to technically have functional HL7 FHIR-based services.
4	Testing to be On-FHIR	The hospital is engaging in internal and/or external testing also with external (e.g., HL7 affiliate/HL7 Europe) support.

across possible different adoptions. The model in itself does not concern with the domain, use case, or medical specialty. These are left to specific layers in the HoF Map (Figure 1).

The HoF maturity grades roughly classify in four categories

With the **Using** grade your organisation is “on-FHIR”. This may imply that you are “just” using HL7 FHIR (level 5) or that some of your services comply with some relevant selected Implementation Guides (level 7).

Using		
5	Living On-FHIR	The hospital is piloting or has gone LIVE and has at least one HL7 FHIR-based service that is regularly used (minimum once/day).
6	Responding On-FHIR	The hospital formalised the capabilities offered by its HL7 FHIR-based services. This is technically done by means of HL7 FHIR capability statement(s) and providing access to them.
7	Delivering On-FHIR	The hospital implements at least one of the relevant selected HL7 FHIR-based services. That is, your HL7 FHIR-based service conforms to selected Implementation Guides (e.g., EEHRxF Lab, IPS).



Finally, the **Collaborating** category: your organisation is so mature in adopting HL7 FHIR that it can cross the hospital boundaries and start networking with other hospitals (level 8) or even be ready for exchanging data cross-border (level 10).

people with shared interests, and they join to produce an inventory of resources (that could be anything from developing tools and documentation, to seeking experience, to provision of solutions to frequently encountered

Collaborating		
8	Networking On-FHIR	The hospital is networking with other hospitals about offered HL7 FHIR-based services. This includes also mentoring activities.
9	Exchanging On-FHIR	The Hospital is using HL7 FHIR-based services to exchange health data with entities (e.g. hospitals, citizens, regions..) inside the country .
10	X-bordering On-FHIR	The Hospital is using HL7 FHIR-based services to exchange health data with other entities (e.g., hospitals , citizens.) cross-border . a) Europe (e.g., European EHRxF) b) Global (e.g., IPS)

HoF community of practice as a social innovation resource

x-eHealth, the support and coordination action funded by European Commission to support the development of the European EHRxF, analysed the role of the Communities of Practice as a mechanism to advance adoption of the interoperability standards and specifications it develops. Building on the preceding work on Patient Summaries in the Trillium II project and international-patient-summary.net, guidelines were produced for communities that wish to start their interoperability journey, considering interoperability standards as infrastructure for innovation.

According to Etienne Wenger (2015) communities of practice (CoPs) “are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly”. Compared to formal workgroups, informal networks and project teams, CoPs are driven by people that share a common interest for what they do and the need to do it better, therefore they interact regularly, collaborate and develop a sense of commitment.

There are three elements which when combined comprise a CoP and only by fostering them in parallel we can nurture the community (Wenger and Snyder 2000):

- The domain of knowledge: it is the area of shared interest and thereby of collective knowledge and combined experience and competence that defines the identity of the CoP and promotes commitment.
- The community: it is the members of the CoP, a group of persons or organisations who strongly care about the domain of knowledge to be willing to interact regularly, engage in shared activities and discussions, help each other, exchange ideas and expertise, advance mutual learning and eventually better their practice.
- The practice: a shared body of knowledge, experiences, and techniques among the members of the community. It is important to emphasise here that the community members are practitioners in a specific field, not merely

problems, etc.).

x-eHealth in itself aims to connect communities of practice that aim to further interoperability for specific domains or patient needs e.g. childhood cancer survivors. Diego Kaminker, Deputy Chief Implementation Officer at HL7 International elaborated on this concept (Figure 2).

Building on this body of work, guidance is provided by the x-eHealth support action in Deliverable 8.1 for communities of practice that wish to work together and learn from each other. In particular, these are some of the ways a hospital or health organisation can further adoption of the European EHRxF:

- Becoming a reference site for shared awareness and knowledge of the community.
- Enriching the knowledge base, creating datasets, improving tools.
- Enabling and empowering the connection between different partners and networks, engaging and educating all interested stakeholders.
- Promoting the use of best practices and ensuring that adequate attention is given to the x-eHealth project results.
- Facilitating discussions, gathering feedback from implementation efforts and case studies, sharing success stories but also identifying challenges.
- Supporting Proof of Concept developments of the European EHRxF.
- Participating in events such as hackathons, datathons, connectathons, projectathons, etc.

Conclusion: The EHDS and the HoF Learning and Piloting Space

Upon adoption of the EDHS, possibly in 2023, there will be a time for implementation. While between the Cross-Border Directive (2011) and the first ePrescriptions were exchanged between two countries using a EU infrastructure (late 2018) almost 8 years elapsed, COVID-19 has shown that when there

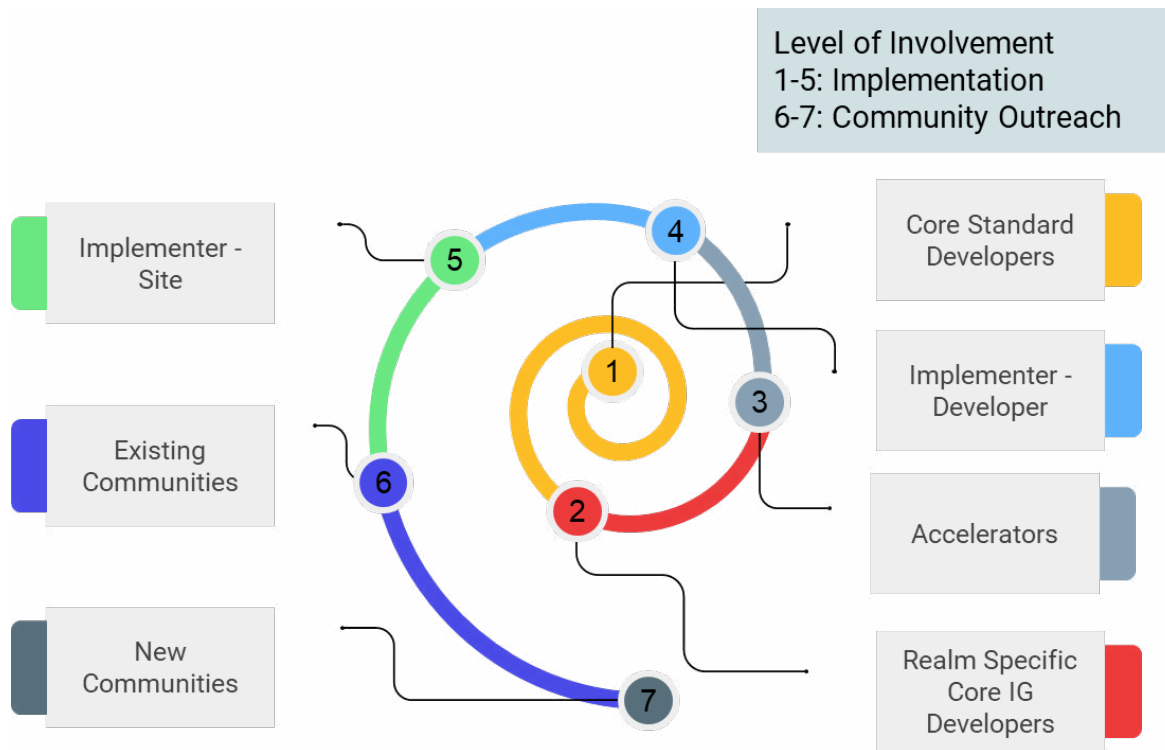


Figure 2: HL7 Communities: The path from 'Informal New Community' to 'Core Standard Developer' Why a spiral? Near the core: few persons, more 'abstract' / standard oriented work (Kaminker 2020).

is a will, some things in digital health can move faster.

Legacy systems, large needs for investment and upgrading in hospital IT services, and the existence of significant semantic challenges mean the road to seeing seamless data flows from each hospitals/HCP in Europe to the EHDS is a long journey. The HoF network can be a learning and piloting space, for increasingly higher levels of data integration and data usage

by each individual patient/citizen and the whole of our Union and beyond.

Conflict of Interest

None. ■

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