
# Building the European Virtual Human Twin

**Call:** Accelerating best use of technologies (DIGITAL-2021-DEPLOY-01)
**Work program year**: DIGITAL-2021-2022
**Topic**: ID DIGITAL-2021-DEPLOY-01-TWINS-HEALTH
**Grant Agreement No**: 101083771

# Advisory Group of Stakeholders Meeting Minutes Online, November 15th 2024

**Start of the project:** 01 October 2022
**End date**: 31 December 2024
**Report date**: 15 November 2024

EDITH is a Coordination and Support Action funded by the Digital Europe program of the European Commission under the grant agreement n. 101083771.

## Executive summary

On November 15th 2024, the last meeting of the EDITH Advisory Group of Stakeholders took place online. This document contains the meeting agenda, the proposed recommendations for the VHT roadmap and the main discussion points.

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## Acronyms

| Acronym | Full name |
|---|---|
| AGS | Advisory Group of Stakeholders |
| AI | Artificial Intelligence |
| CSA | Coordination and Support Action |
| CDSS | Clinical Decision Support System |
| EC | European Commission |
| ELSI | Ethical, Legal and Social Issues |
| EU | European Union |
| HPC | High Performance Computing |
| MDR | Medical Device Regulation |
| VHT | Virtual Human Twin |
| WP | Work Package |

# 1 Purpose of the meeting

## 1.1 Advisory Group of Stakeholders: goal & composition

The Advisory Group of Stakeholders (AGS) is one of the advisory boards of the EDITH Coordination and Support Action (CSA)[1]. The EDITH-CSA is working on facilitating an ecosystem-driven creation of the roadmap for the Virtual Human Twin (VHT). The Virtual Human Twin (VHT) is envisioned as a systematic, ever-growing digital and quantitative representation of the actionable knowledge available on human pathophysiology. The European VHT platform will enable the pooling of resources and assets (data, models, algorithms, computing power, storage *etc*.) to develop digital twins in healthcare, assess their credibility and facilitate their uptake in industry and clinical practice. It entails the development of a federated public infrastructure and the collection of appropriate resources, driven by the engagement of a collaborative ecosystem.

The AGS is an important component for strengthening the VHT ecosystem, providing high level feedback and validation, and supporting its further development going forward. The AGS members informed input to the VHT Roadmap, elaborated by the EDITH consortium and the wider ecosystem through public activities onsite and online, carries an important weight in its validation, wide dissemination, and acceptance. AGS members will then discuss orientations for future research beyond the EDITH CSA and ongoing initiatives.

The AGS is composed of high level experts from academia, clinics, industry (large companies and start-ups), trade associations, regulatory agencies and notified bodies. The expertise of the AGS members covers the technological, ethical, legal and social (ELSI) aspects related to VHT.

## 1.2 Meeting objective

The European Virtual Human Twins (VHT) Initiative was officially launched by the European Commission on the 22 December 2023[2]. In 2024 the EU VHT Initiative activities kicked off with a core set of 12 ongoing actions supporting advanced VHT technology development, from foundational research through to evidence generation and deployment. A VHT Manifesto[3], summarizing the core elements and key challenges of the VHT was signed by over 90 organisations (academia, industry, hospitals, trade organisations, HPC centres, patient organisations and civil society organisations).

In the meantime, work on the EDITH-CSA led to the publication of the first draft of the VHT roadmap[4] in July 2023 and a further elaboration of its content since then, through a range of public activities and expert meetings. In light of the preparation of the final draft of the VHT roadmap, the AGS has been invited to meet and discuss the progress. At the last Ecosystem Meeting in Amsterdam (minutes published on EDITH website[5], videos of strategic sessions are available on youtube[6]), recommendations were discussed in an interactive plenary session.

[1] www.edith-csa.eu (10/6/2024)
[2] https://digital-strategy.ec.europa.eu/en/policies/virtual-human-twins#:~:text=Launch%20of%20the%20Virtual%20Human,Human%20Twins%20(VHTs)%20Initiative.- (10/6/2024)
[3] www.virtualhumantwins.eu (10/6/2024)
[4] https://zenodo.org/records/8200955 (10/6/2024)
[5] https://www.edith-csa.eu/materials/, under public meetings (15/11/2024)
[6] https://www.youtube.com/@EDITHCSA (15/11/2024)

In a range of expert meetings, the consortium has continued working on these recommendations. The aim of the final AGS meeting was to discuss these recommendations with the AGS and get their feedback on the draft of the extended summary of the VHT roadmap.

# 2 Agenda of the meeting

The last general AGS meeting took place online on Friday 15th November from 13:30 to 15:00 (CEST), with the following **agenda**:

- 13:30 : Welcome & Introduction
- 13:35-13:40 : General update of EDITH
- 13:40-13:50 : Overview of the extended summary
- 13:50-14:40 : Recommendations – overview + discussion
    - Research & technology
    - Infrastructure
    - ELSI, standards & regulatory
    - Users & uptake
    - Sustainability
- 14:40-14:50 : Timeline & dependencies
- 14:50-15:00 : Final steps & comments

The meeting was **attended** by AGS members (representing academia, industry, notified bodies, and clinics), as well as representative members of the EDITH-CSA consortium (Sabato Melloni, UNIBO, Edwin Morley-Fletcher, Lynkeus, Janaki Raman Rangarajan, VPHi), its coordinator (Liesbet Geris, VPHi) and representatives of the European Commission (DG CNECT H3 – eHealth, Wellbeing and Ageing).

# 3 Content of the meeting

The last meeting of the AGS in the scope of the EDITH project was dedicated to the roadmap and its recommendation. The basis of the discussion was the extended summary of the roadmap, a high-level document aimed at policy makers explaining the rationale, reality and realization of the VHT initiative and infrastructure.

## 3.1 General update of EDITH

AGS meeting minutes available on website: https://www.edith-csa.eu/advisory-boards/

EDITH meeting A'dam

- Summary
    - 220 participants
    - 7 parallel breakouts
    - Plenary sessions on Proof of Concept infrastructure & Roadmap recommendations
- All meeting minutes available on website: https://www.edith-csa.eu/materials/ (Public meetings)

Upcoming outputs of the EDITH project

- D2.2: mapping of the ecosystem (late but content already in use)
- D4.2: PoC repository (30/11) > PoC infrastructure goes public 20/11
- D6.2: in-depth analysis of legal & ethical aspects (30/11)

- D6.3: business models & marketplace analysis (30/11)
- D3.2: Roadmap (31/12)

Foreseen publications of & based on the roadmap

- Full technical roadmap (31/12)
  - Inclusion of relevant work from deliverables
  - Published on Zenodo, not printed
- Extended summary of roadmap (sent to AGS)
  - For policy purposes
  - Published on zenodo (31/12)
  - English version printed (Q1 2025)
  - Translated to EU languages & published on zenodo (Q1 2025)
- Layman book (2025)

## 3.2 EDITH Roadmap Extended Summary outline

### *3.2.1 Outline of the summary*

PART1 : FROM DIGITAL TWINS IN HEALTHCARE TO THE VIRTUAL HUMAN TWIN

- Introduction
  - Digital Twins in health and care
  - The Virtual Human Twin
  - The roadmap for building the Virtual Human Twin
- Global trends in a European Context:
  - Trend 1: Escalating Healthcare Costs and the Need for Efficiency
  - Trend 2: The Imperative for Personalized Medicine
  - Trend 3: The Rise of Digitalization in Healthcare
  - Trend 4 : The EU Digital Agenda and the European Life Sciences Research Infrastructure
  - Trend 5: Contributing to the Sustainable Development Goals
- Need for the Virtual Human Twin initiative and infrastructure
- Current Status of Virtual Human Twins in Healthcare
  - Examples of Digital Twins in healthcare
  - Stakeholders and initiatives relevant for the Virtual Human Twin
  - Current and Future Market Appraisal
- Barriers to the wider adoption of the VHT

PART 2: THE VISION OF THE VIRTUAL HUMAN TWIN AND HOW TO GET THERE

- The vision of the Virtual Human Twin
- The Technological foundations of Digital Twins in Healthcare
  - Software: The Spectrum of Digital Twin Models
  - Hardware: The Foundation of the Digital Twin
- The Virtual Human Twin Infrastructure
  - Organisation of the Virtual Human Twin resources
  - Catalogue: The Gateway to Digital Twin Resources
  - Repository: The Secure Vault for Digital Twin Assets
  - Simulation platform: The Backbone of the Digital Twin Ecosystem
  - Integration of resource
  - Dependencies on Other Technological Advances
- Ensuring Responsible VHT Integration: A Detailed Examination of the Legal, Ethical, and Social Imperatives
  - Standards: The Cornerstone of Interoperability and Trust
  - Regulatory Landscape: A Complex Terrain Requiring Careful Navigation
  - Ethical Considerations: Placing Patient Well-being and Societal Values at the Forefront
  - Social Implications: Building a Foundation of Societal Acceptance and Trust

- Users and Uptake of the Virtual Human Twin
    - Users and Roles
    - Uptake in Industry
    - Uptake in Clinics
    - Sustainability of a Virtual Human Twin Infrastructure

PART 3: RECOMMENDATIONS FOR THE VIRTUAL HUMAN TWIN

- Recommendations for the Roll-Out of the Virtual Human Twin
    - Research & use cases
    - Infrastructure
    - ELSI, standards & regulatory
    - Users & inclusiveness
    - Sustainability
- Recommendations for the stakeholders of the VHT ecosystem
    - European Commission
    - EU Member States
    - Research Community
    - Industry
    - Healthcare Providers
    - Regulatory Bodies
    - Ethical, Legal, and Social Implication Experts
    - Patients and the Public
- Recommendations: timeline and dependencies

#### *3.2.2 Discussion*

- Members of the AGS are happy with the overall structure and tone of the current draft.
- Examples are the best way of showing the current status of digital twins – with some twins already in or at the verge of entering into the clinics
- Definition of the digital twin: the draft only mentions a broad and inclusive definition of digital twins. It does not go into the existence of more strict definitions. Given that this document is aimed at policy makers, the AGS thinks this is appropriate.
- For Trend 2 it is suggested to add climate and social determinants of health.
- The ELSI section is appreciated by the AGS, though it is not yet fully reflected into the recommendations section.
- The suggestion is made to add an overview of the trajectory for tools to transfer to the clinics/patient (passing through CE marking etc). This will be added to the extended version of the roadmap.

### 3.3 Recommendations VHT roadmap

The recommendations are still in bullet point format as they are under discussion. Once all elements are agreed on, they will be reformulated into sentences encompassing the points.

#### *3.3.1 Research & technology*

Proposed recommendations:

- R&I in the development, testing, validation, and verification of advanced VHT technologies
    - In synergy with existing digital services and capabilities
    - Basic research defined on identified knowledge gaps
    - Continuum of basic to translational research
    - Includes lower TRL work
    - Covering generic / population-specific and personalized digital twins
- Advancing the understanding of how VHT solutions, products, and services can be used across the disease continuum
    - Prevention, treatment and follow-up
    - Biomedical studies, clinical studies
    - Therapy development, diagnostics, remote care and self-care

- Generation of clinical, experimental and digital evidence for the (future) development of VHT solutions, methods, and tools and technologies.
- Identification, development and delivery of high-impact clinical and scientific use cases
    - Diagnostics, medical education, training, decision support, therapy development and intervention planning.
    - Credibility / risk-informed credibility
    - Inclusiveness & diversity

Discussion:

- It is not clear whether the first bullets are discussing the technology development (technical validation) or also the uptake of the technology in clinics (clinical validation).
- It would be good to include the notion of inclusion of end-users from the very beginning in technology development.

### *3.3.2 Infrastructure*

Proposed recommendations:

- Designing, building, and enhancing the VHT resource repository and simulation platform
    - In full compliance with applicable laws and regulations in Europe
    - Incentivize adoption of VHT in new developments
    - Incentivize sharing of resources
    - Co-design with end users and stakeholders
    - Attention for the environmental sustainability
- Support development, testing and implementation of advanced and interoperable IT platform architectures combining technology advances
    - Computational infrastructure, cybersecurity, HPC, cloud services and edge infrastructure
    - Continuous inclusion and update of domain-specific services
    - Longevity of infrastructure, continued investment
- Advancing the availability of and access to high quality, annotated and interoperable digital health data
    - Standardized in terms of format and semantics
    - Safeguarding patients' privacy, personal data, health and safety.
    - Include co-evolution with other initiatives
- Global vision for (life sciences) research infrastructures
    - Links to existing platforms
    - Longevity of support
- Inclusion in clinical workflow > scalability
    - Inclusion in hospital IT infrastructure, Inclusion in medical devices (imaging devices) or separate department providing services
    - transfer to other applications fields outside the one where it was developed for (e.g. AR/VR)
    - As separate service department in hospital for more complicated cases

Discussion:

- Co-evolution is mentioned (which is good) but in the point on availability of / access to data, the EHDS or other infrastructures are not mentioned. Might create confusion as to the aim of the VHT.
- Interoperability & standards are crucial. Will there be a VHT standard (like e.g. DICOM-VHT)? Check the standard recommendation in ELSI
- 'transfer to other applications fields' comment is very specific, not entirely clear and perhaps not even realistic > suggested to remove

### *3.3.3 ELSI, standards & regulatory*

Proposed recommendations:

- Development of common ground, trust, agreement and certainty on IPR management, and protection of Trade Secrets
    - Forms basis for partner collaborations among stakeholders
    - [harmonization or at least] monitoring national laws

    - Accountability
- Identification of opportunities, approaches, standards, tools, and techniques that enhance clarity of the regulatory landscape
    - To enable efficacy, safety, trustworthiness, performance and risk management, from early stages of development
    - Evolutionary framework
    - Standards-based interoperability
    - Credibility-by-design
    - Best practices, community-driven standards, consensus procedures, link to credibility & interoperability
- Inclusion in clinical guidelines
- Annotation
    - Data annotation: investigate commercial solutions (AI) that exist in digital health technologies spectrum (CDSS)
    - Model annotation: ontologies, metadata; explainability is key factor in risk class

Discussion:

- Most recommendations deal with standards, add recommendations on ethical (equity & fairness) and legal elements.
- Inclusion in clinical guidelines needs to be properly contextualized, along with its dependencies (e.g. CE mark requirement)
- Journey on how to get VHT applied into practice needs to be in roadmap > a high level version of the path needs to be clarified in the extended summary too (*cfr.* the summary of the model life cycle).

### *3.3.4 Users & inclusiveness*

Proposed recommendations:

- Ensuring the contributions, feedback, priorities, requirements, views, concerns and interests of citizens, patients, industry, healthcare professionals, and scientists are proactively captured and addressed
    - As part of the development, testing, verification, and validation of VHT tech
    - Active & outgoing ecosystem & user community
    - Adoption of extended reality technologies to facilitate interactions
- Building trust amongst users of the VHT & its developments
    - Trustworthiness vs trust
    - Responsible research & innovation
    - Communication & dissemination tailored to stakeholder categories
- Ensuring that VHT technology benefits people of all ages, genders, ethnicities, socioeconomic statuses, and disabilities
    - Fostering equitable and universal access to high-quality healthcare
    - Access to VHT: manage own health, personal health forecasting
- HTA: analysing effectiveness & efficiency
    - Value-based procurement
    - Analyse impact, harmonize approaches, inclusion in clinical cost structure, reimbursement
    - Competitive advantage, Leadership, Translation, Payers, Synergies
- Education & training on use and developments of VHT
    - For all stakeholders
    - Training & re-training
    - Use of VHT as training platform
- Clinical perspective – training > low-hanging fruit
    - Training next generation & life-long learning
    - Training as a way to increase quality of care
    - Training as a way to increase equity in healthcare

Discussion:

- Address challenge of digital literacy & aging population > to add in the section on social implications in the extended roadmap (focusing currently on trustworthiness and trust)

- Mention of extended reality is oddly specific – same comment holds for other technologies such as generative AI > talk about 'advanced technologies' in general to avoid this.
- Not clear why some of the recommendations are mentioned here and not in the ELSI section

### *3.3.5 Sustainability*

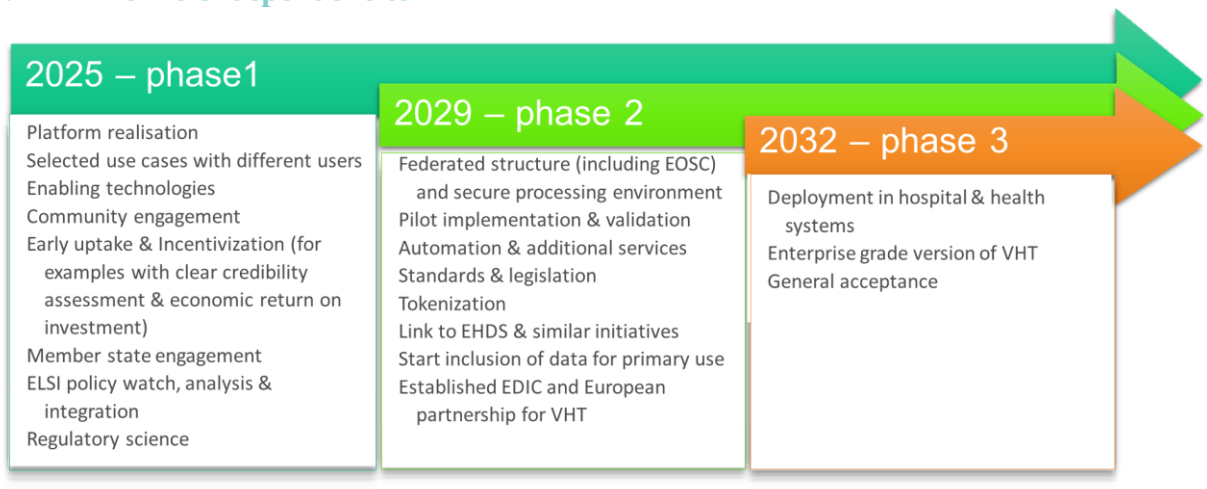
Proposed recommendations:

- Realising the embedding of the VHT as a European Digital Research Infrastructure
  - Co-evolution of existing infrastructure
  - Interoperable, federated, distributed
- Continuous source of support and ecosystem development
  - Top-down
  - Bottom-up
  - Incentivize adoption
  - Ecosystem & technology
  - Establishment of European Partnership for VHT
- Stimulate development of commercial activities
  - Marketplace services
  - IPR
- Digital twins of hospital/care facility
  - Bring care to patient after collecting real world data from patients
  - Cascaded events
    - data collected at one point serves also other purposes
    - Cross-pollination of ideas between different clinical fields

Discussion:

- Some of the points are more specific than others. This is because it is still work in process and meetings with different stakeholder groups result in points added that require balancing with the rest.
- It is not entirely clear why certain points are mentioned under certain headers as they are multi-faceted. It might be good to consider changing the structure from the current categories (reflecting part 2) towards something that reflects the life cycle of the VHTs : (1) create VHTs, (2) develop & use infrastructure, (3) uptake of the VHTs in health & care practice)

## 3.4 Timeline & dependencies




Discussion:

- Realizing VHT is a long trajectory. It hinges on trust to get it adapted. Add wording to that effect into he figure: change management, adoption readiness. This process also runs over the entire duration of the 10 year period and requires continuous attention. Make it clear from the figure – or the description accompanying it.

- Stakeholders are well described. Main groups involved in VHT could be condensed to creators and consumers, with additional partners surrounding them. Trust, quality and readiness (willingness to play) are crucial for realising the objectives. This holds true for both creators and consumers. Wording could be made more specific to clearly show which groups are intended (e.g. for incentivization or uptake).

# 4 Next steps

The AGS expressed it satisfaction with the extended summary and its tone, as well as the changes discussed during the meeting. This was the last meeting of the AGS in the scope of the EDITH project. All AGS members are asked to go through the extended summary document, if they have not yet been able to do so, and provide their final comments – related to the extended summary or the long version of the roadmap – in the coming weeks.