InfraVis Strategic and Operational Plan 2024-2026

Updated March 2024

Swedish Research Council
CHALMERS
UNIVERSITY OF GOTHENBURG
KTH
LINKÖPING UNIVERSITY
Linnæus University
LUND UNIVERSITY
Mittuniversitetet MID SWEDEN UNIVERSITY
UMEÅ UNIVERSITY
UPPSALA UNIVERSITET

Table of Contents

TABLE OF CONTENTS **2**
PART I: STRATEGIC PLAN 2024-2026 ..... **3**
INTRODUCTION 4
VISION, MISSION AND AIMS 5
SCIENCE STRATEGY 6
RESEARCH FIELDS AND USER GROUPS 6
RELATIONSHIP TO AND INTERACTION WITH OTHER RESEARCH INFRASTRUCTURES 7
COMPETENCE ACCUMULATION AND OPEN SCIENCE 7
SOCIETAL BENEFIT AND INNOVATION 8
ORGANIZATION AND LEADERSHIP 9
OPERATION 10
TIME PLAN 11
DATA MANAGEMENT AND NEED FOR SUPPORTING E-INFRASTRUCTURE 14
PART II: STRATEGIC & OPERATIONAL PLAN FOR MODULES **15**
THE INFRAVIS MODULES 16
Module 1: Organization and Leadership *16*
Module 1: Operational plan 2024 16
Module 2: Outreach and Communication *18*
Module 2: Operational plan 2024 19
Module 3: Operational plan 2024 20
Module 4: User Support *20*
User Access to Visualization Laboratories and Resources 21
Module 4: Operational plan 2024 23
Module 5: Software Curation and Documentation *23*
Module 5: Operational plan 2024 24
Module 6: Infrastructure Development Projects to Improve Services *24*
Module 6: Operational plan 2024 26
Module 7: Internal Training and Self-Evaluation *26*

Part I: Strategic plan 2024-2026

This document is an adaptation from the InfraVis application submitted in 2021 to the Swedish Research Council. Part I consists of the updated Strategic plan for 2022–2026 and Part II is the Operational plan for 2024.

Introduction

Essentially all academic research of today relies on analysis of data from a wide range of sources such as: experiments, sensors, modelling, simulation, or mining of data repositories. Several underpinning, and rapidly developing, technologies are supporting the analysis of this data. Visualization serves as an interface to this ecosystem of tools and methods, and integrates them into environments supporting scientific workflows, effectively sharing cognitive load between computers and humans. Support for the introduction of new, improved and tailored visual data analysis environments thus has the potential to address challenges involving large and complex data, creating competitive advantages for Swedish researchers. To fill the gap between the state-of-the-art visual data analysis and current wide-spread academic practice, the national research infrastructure InfraVis has been created.

InfraVis is a distributed national research infrastructure consisting of visualization experts, software solutions, and access to high-end visualization laboratories, with financial support from the Swedish Research Council and nine Swedish universities. InfraVis started in January 2022 and is formed by the host organization Chalmers University of Technology (Chalmers), Linköping University (LiU), Linnaeus University (LNU), Lund University (LU), Mid Sweden University (MIUN), Royal Institute of Technology (KTH), Umeå University (UmU), University of Gothenburg (UGot), and Uppsala University (UU). InfraVis has not only a unique position in Sweden but also internationally with respect to providing services from over 50 skilled visualization experts to all scientific domains. This provides an excellent base for catering to the growing demands and needs of the scientific community. InfraVis entails expertise in data visualization, data collection and curation, statistical data analysis, machine learning (ML) and artificial intelligence (AI), as well as interactive and collaborative visual analysis. To our knowledge, there is no European counterpart to InfraVis, and the potential impact of this research infrastructure, both as a role model and as a service organization, is high not only on the national but also on the European arena.

The InfraVis Strategic & Operational Plan is revised annually to adapt the strategies and activities to the current context and expected circumstances including political, economic, social, technological, environmental, and legal factors during the coming 3-5 years. The Strategic & Operational Plan includes major activities, and the Communications Plan for 2023 and Communications Strategy 2022-2027 are appended as annexes.

The activities in the Operational Plan for 2024 are described in connection with each of the InfraVis organizational modules in Part II.

Vision, Mission and Aims

The InfraVis vision: scientific discovery through state-of-the-art visualization support.

The InfraVis mission: to provide all researchers in Sweden with visualization services and labs through a distributed and adaptable team of experts, thus elevating their global scientific impact.

The overarching aims of InfraVis are to provide researchers at Swedish universities with:

- visualization support to propel Swedish research and its impact nationally and internationally,
- education in state-of-the-art visualization methods,
- increased awareness of visualization and data analysis as research tools in all research areas.

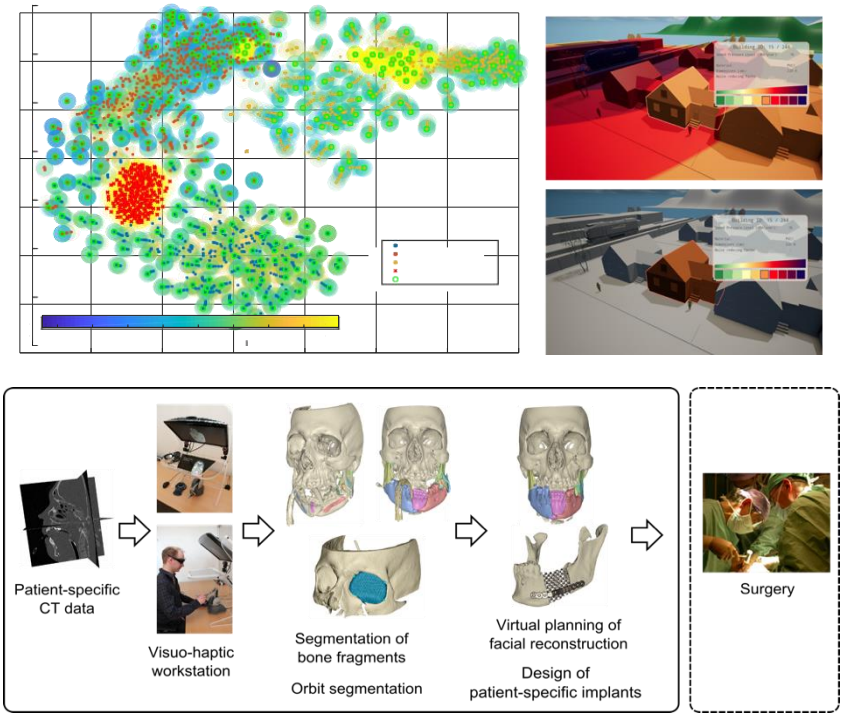

Figure 1. Examples of three types of visualizations: a) Visualization of the weight space of a neural network. Each point represents a single training run. The colors under the points represent the classification test error of each point. From Eilertsen et al. Unpublished. b) Images from an urban digital twin model study where different ways of visualizing noise data were tested. c) Pipeline of a virtual surgery planning system built with interactive visualization techniques.

Our definition of the term “visualization” includes all stages of data analysis in the *visualization pipeline*. Statistics, machine learning and other tools are a part of the InfraVis arsenal. Data-driven analysis produces results which, through methodical design, have visual representations. These visual representations, when interactive, are visualizations that exploit the extraordinary ability of the human brain to detect, classify, and relate patterns and anomalies visually.

Science Strategy

Analysis of data is an increasingly important part of research workflows in academia, industry, and government. Data is collected through experiments, simulations, sensors, modelling, surveys, and other means. Scientific progress hinges on the understanding of this data. Scientists in all domains increasingly face challenges when analyzing their data. The challenges include the sheer size, high dimensionality, noise level, and the complexity of the data. Tackling these data challenges is typically not within the expertise of the domain scientists. Rather, it requires expert knowledge in data analysis and visualization. InfraVis is primarily a human infrastructure aiming to provide data analysis and visualization expertise to every scientist in Sweden needing this support. The support entails expertise in:

- data collection and curation,
- statistical data analysis,
- machine learning (ML) and artificial intelligence (AI),
- visualization, and
- interactive, collaborative analysis.

In InfraVis, visualization competencies at Swedish universities are pooled together and expanded with new InfraVis experts. The added value of joining the separate specialized units is an opportunity to: a) effectively and efficiently share resources and support knowledge transfer across the entire Swedish research community; b) further develop and use data visualization as a research tool on a national level; c) single point of contact to accumulate visualization knowledge and software. InfraVis offers one shared point of entry for access to the coordinated ensemble of competencies and technologies to develop and facilitate new projects. Researchers requiring complex visualizations thus have access to specialized visualization expertise, software, and hardware via the InfraVis experts.

Research Fields and User Groups

Since visualization is a universal research tool, InfraVis does not cater to specific pre-determined scientific questions. Rather, it aims at supporting emerging scientific questions from researchers in all domains. In addition to research areas that already make use of visualization and are in need of continued support, InfraVis will identify new areas where the potential impact of introducing visualization is high. A central part of InfraVis involves the continuous outreach activities to identify and invite new areas and users.

The entry point for domain researchers will be the InfraVis website where they get access to three levels of support: 1) a helpdesk (chosen system: TOPdesk) is provided for processing user support; 2) mid-level support includes increasingly sophisticated assistance by InfraVis experts who may interact with the user's data and concrete analytical tasks; and 3) in-depth support where InfraVis experts are deeply engaged over a long period (months) in all aspects of the visual data analysis process, including potentially tailoring visualization tools to the user. The overall process of user support is described in detail below in the section "Module 4".

Relationship to and Interaction with Other Research Infrastructures

InfraVis is a research infrastructure with high complementarity with other Swedish research infrastructures. The focus on visualization and application-oriented user support differs from other infrastructures that provide technology or data. InfraVis will enhance research by utilizing data from various research infrastructures. This is particularly beneficial in addressing complex research questions that often span multiple disciplines, facilitating the integration of different fields and datasets. InfraVis plans to leverage technical developments in computational power, network bandwidth, and storage capacity from other infrastructures and, in turn, provide scientific value through the development and application of visual analytical tools. InfraVis thus constitutes the bridge between researchers and visualization expertise. There is an increasing need and potential for visualization as a research method given the data emerging everywhere, but in particular from other research infrastructures, including: European Spallation Source (ESS)-ERIC, MAX IV laboratory, SciLifeLab, Onsala Space Observatory, National Bioinformatics Infrastructure Sweden (NBIS), Relations, Work and Health across the life-course – A Research Data Infrastructure (REWHARD), Swedish Biodiversity Data Infrastructures (SBDI), HumInfra, Swedish National Infrastructure for Digital Archaeology (Swedigarch), and the Consortium of European Social Science Data Archives (CESSDA-ERIC). We also see the need for continued collaboration on data management with the Swedish National Data Service (SND) and the National Academic Infrastructure for Supercomputing in Sweden (NAISS) former Swedish National Infrastructure for Computing (SNIC). Another strategic goal for InfraVis is to continue to develop and provide support to users of MAX IV and ESS.

Other large programs and initiatives of relevance for InfraVis include e.g., Data Driven Life Science (DDLS), Treesearch, National research program within migration and integration, and Research for transformative and sustainable spatial planning.

There is no other national or international visualization infrastructure that is open to researchers from all domains. InfraVis is therefore in a unique position to prepare the ground for similar research infrastructures not only in Sweden but also in other countries.

Competence Accumulation and Open Science

InfraVis will contribute in the long-term to competence accumulation nationally by building and leveraging the resources at our nodes. The InfraVis experts, the developed methods, the domain-specific tailored tools, and engineered software will together form a rich collection for users of visualization in the future. InfraVis fully subscribes to the Swedish Research Council (Vetenskapsrådet) guidelines for open access to research data[1], and more generally, the principles of Open Science[2]. Some restrictions may apply because of sensitive data, ethical considerations (see appendix “Ethical Considerations”), or Swedish legislation.

[1] https://www.vr.se/analys/rapporter/vara-rapporter/2015-12-10-oppen-tillgang-open-access-till-forskningsdata.html

[2] https://creativecommons.org/about/program-areas/open-science/

Societal Benefit and Innovation

InfraVis has the potential to create added value far beyond the immediate effect of fostering scientific discovery. The use of visualization technology places the human in the loop of a data-centric workflow. Raising the level of visualization knowledge in Sweden must be seen as a critical factor in ensuring Sweden's competitiveness in the post-digitalized society and will let us take a leading role in the ongoing autonomy and intelligence revolution.

Increased use of visualization provides unprecedented opportunities for science communication. It facilitates the accessibility and comprehensibility of open data and open research Initiatives such as the Wallenberg Immersive Science Communication Domes (WISDOME[3]) build upon a new paradigm in learning how to use them.

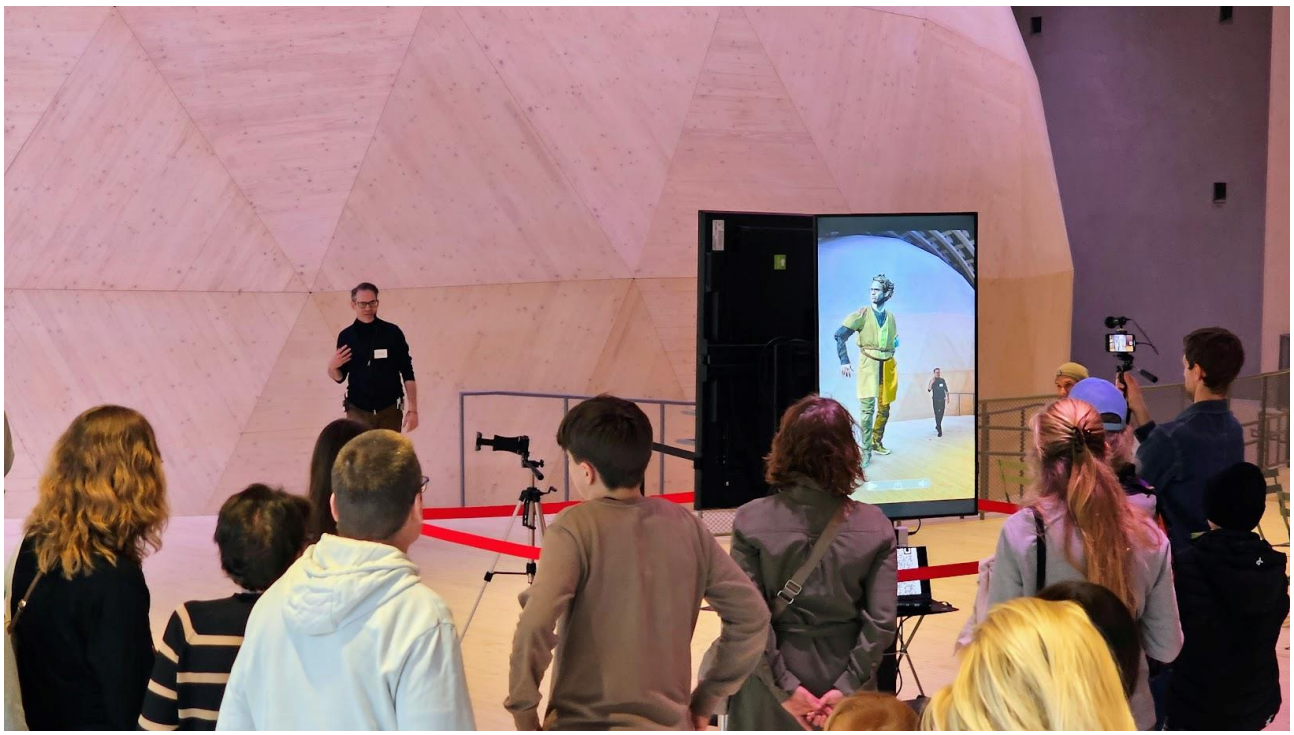

Figure 2. InfraVis supporting the FORMAS project Homo Colossus, visualizing our energy consumption, on its vernissage at the new Wisdome at Tekniska Museet, Stockholm.

Citizen participation is another aspect where a more direct access to visualization expertise can lead to a more transparent society. Swedish municipalities are facing huge challenges when dealing with transport and spatial planning. Issues of sustainability, accessibility, integration, and attractiveness must be balanced with economy and other constraints in complex planning processes that also need to consider the public opinion. Visualization is already facilitating this work, but much more can be done and InfraVis is the natural catalyst.

Forensics is another field likely to profit from InfraVis. In the recently started network ForArk, the Swedish National Forensic Centre (NFC) is investigating digital methods and tools for forensics in collaboration with Swedish archaeology researchers. Visualization, and by

[3] https://kaw.wallenberg.org/en/research/wisdome-gateway-fascinating-hidden-world

extension InfraVis, can play a pivotal role in this initiative.

InfraVis will have an impact on society outside of academia through visualization research support services to industry and government. InfraVis aims to promote knowledge transfer through: 1) collaborative projects where advanced visualization technologies are applied; 2) PhD students within applied research areas who utilize advanced visualization technologies in their postdoctoral employments; and 3) undergraduate students in a wide range of areas, whose teachers are InfraVis users applying visualization in education.

InfraVis contributes to achieving the UN's global sustainability development goals (SDGs)[4] by offering tools and methods for visualizing and exploring the complex data sets relevant to the global challenges. Research on new forest materials is of high importance for the future bioeconomy and it is an example of an area where visualization of e.g., tomographic data is required. Together with initiatives such as Treesearch, InfraVis can directly contribute visualization expertise to the research and competence building needed to develop new materials from the forest.

Organization and Leadership

The InfraVis consortium consists of nine universities: Chalmers University of Technology (Chalmers), Linköping University (LiU), Linnaeus University (LNU), Lund University (LU), Mid Sweden University (MIUN), Royal Institute of Technology (KTH), Umeå University (UmU), University of Gothenburg (UGot), and Uppsala University (UU). InfraVis is located at eight geographical nodes (two universities in Gothenburg).

The Consortium Agreement (appended as annex) regulates the InfraVis partner universities' mutual commitments as well as conditions of importance for the cooperation. Chalmers, the hosting university, is responsible for the economy and for the fulfillment of the infrastructure commitments, for reporting to the Swedish Research Council (VR) and for the future dismantling of the infrastructure. Chalmers is also responsible for communication and information with the partner universities and for anchoring particularly important decisions among them. In addition, Chalmers will follow-up with the involved universities on the resources allocated to InfraVis and seek advice on the general handling through the Advisory Partner Committee (Partsrådet). The Advisory Partner committee is governed by the Consortium Agreement and has the following tasks:

- propose the composition of the Steering Group to the Host Organization, for formal decision by the Host Organization.
- provide views and advice to the Host Organization on matters relating to the overall financial framework of the infrastructure, including co-financing.
- provide views and advice to the Host Organization on other critical issues concerning the cooperation between the parties in the consortium.

The InfraVis leadership organization includes four bodies with distinctly different roles: 1) The Steering Group; 2) The Management Team; 3) The Scientific Advisory Board; 4) The User Forum (fig. 1). The Steering Group strategically advises the Management Team on a regular basis, takes the formal strategic decisions for InfraVis steering documents and

[4] https://sdgs.un.org/goals

operations, while the Management Team is responsible for the daily operation. The Scientific Advisory Board comprises world-leading scientists in visualization, who will advise and frame InfraVis globally. The User Forum will perform the critical function of delivering user feedback to the operations of the infrastructure.

InfraVis works with gender balance issues through several different but linked actions and has developed a Gender Equality Plan (appended as an annex).

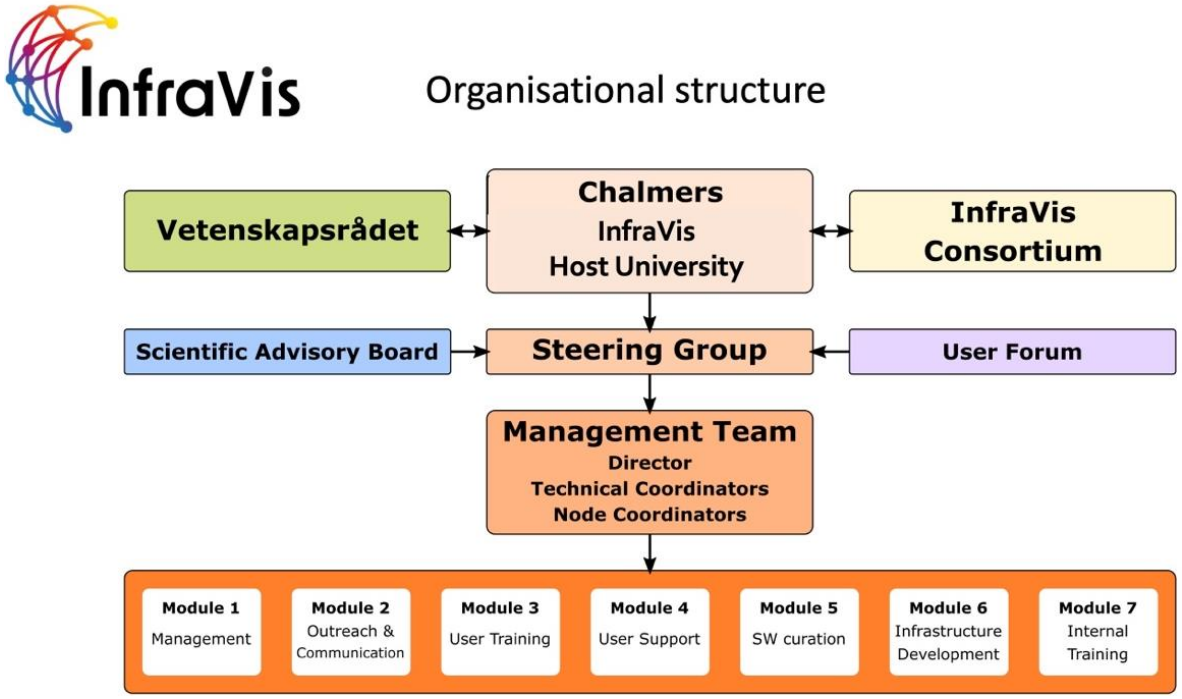

Figure 3. InfraVis organization. The Steering Group, the Management team, the Scientific Advisory Board, and the User Forum are essential components of the InfraVis organization. The Advisory Partner Committee (partsrådet) meets at least once per year for consultation between all participating parties.

Operation

InfraVis consists of seven modules, each addressing a specific task or need. InfraVis meets its users through the operations layer, rests upon its service pillars, and is organized through the management layer. Figure 2 illustrates the functional relationships between the InfraVis modules. Module 1 concerns the overall management and leadership of InfraVis. Modules 2–4 concern the operations of InfraVis which interact directly with the users. Module 2 focuses on the recruitment of new users. Module 3 undertakes user training. Module 4 provides user support on three levels: 1) helpdesk for short questions; 2) mid-level support requiring the assistance of experts; and 3) in-depth support, involving the tailoring of software. These operational modules are supported by the service pillars of Modules 5-7. Module 5 provides software curation and documentation. Module 6 engages in development projects to improve the infrastructure. Lastly, Module 7 evaluates the performance of InfraVis and supplies quality assurance through internal training.

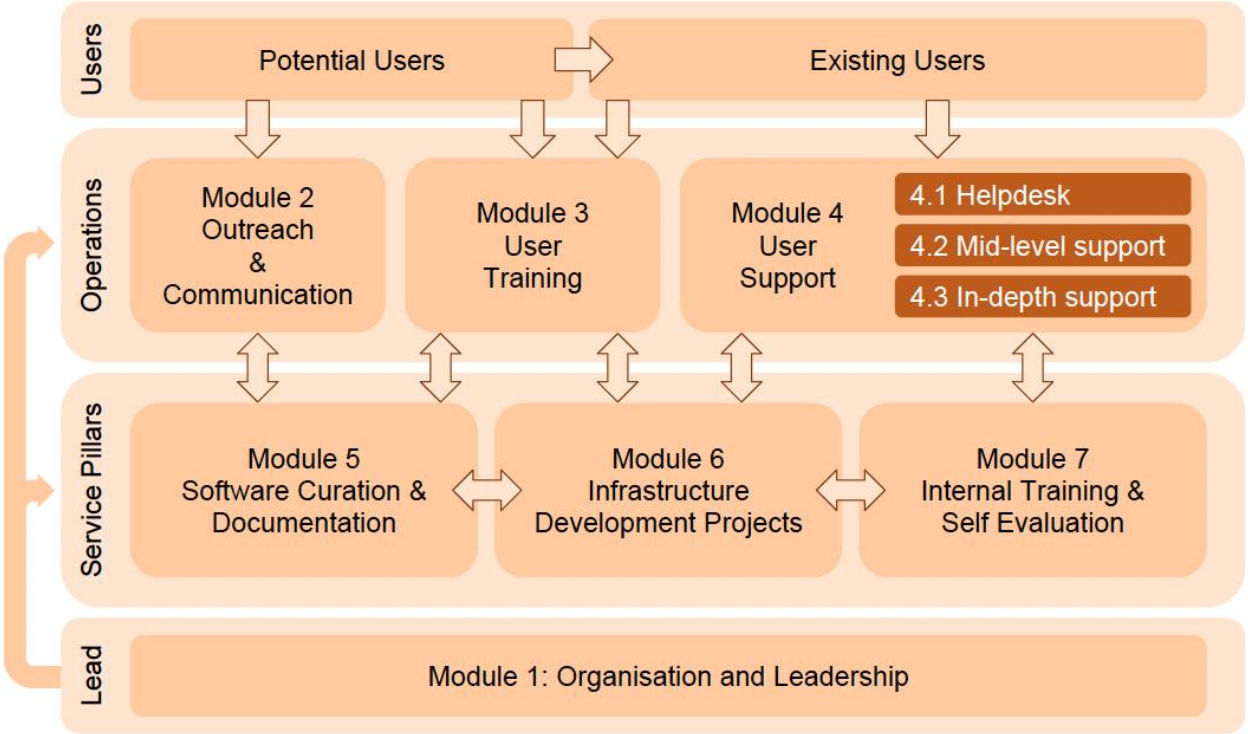

Figure 4. Overview of the seven modules of InfraVis.

Time Plan

The InfraVis Time Plan is defined through the infrastructure's internal schedule of Milestones and Deliverables and refined by its quarterly Gantt chart (see appendix Gantt chart 2024). These target events are aligned with the Steering Group meeting agenda at the InfraVis Days in spring and autumn, respectively. In November, the Steering Group meets the Management Team to evaluate the budget for the upcoming period. In May, they meet to discuss the strategy for the upcoming year. The Management Team is responsible for overseeing the execution of operations towards Milestones and Deliverables.

InfraVis will start preparations for its continuation in conjunction with the half-time evaluation in Q3, Year 3, i.e. 2024. Given that InfraVis will be the first infrastructure of its kind, nationally and internationally, we aim to establish it over its first five years and take InfraVis to new heights in the subsequent phase. The continuation will benefit from our gained expertise, observed user demands and experiences, and close monitoring of emerging science and technology.

		2022				2023				2024				2025				2026			
Mod.	**Modules, Activities & Deliverables**	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1	**Organisation and Leadership**	**2022**				**2023**				**2024**				**2025**				**2026**			
1.1	Daily operation management	X	X	X	X	X	X	X	X	X											
1.2	Kick-off meeting	X																			
1.3	Recruitment process overview	X	X																		
1.4	Protocols and processes	X	X																		
1.6	Start-up and recruit members to the User Forum	X	X																		
1.7	InfraVis Days: Mars/April & September			X			X		X												
1.7.1	User Forum Mars/April						X		X												
1.7.2	Scientific Advisory Board (SAB)						X														
1.8	Steering Group meetings	X	X	X	X	X	X		X												
1.9	Half-way evaluation																				
1.10	Plan for next step - the direction after Year 5																				
2	**Outreach and Communication**	**2022**				**2023**				**2024**				**2025**				**2026**			
2.1	Website and social media	X	X	X	X	X	X	X	X	X											
2.2	Newsletter		X		X		X		X												
2.3	Information material (printed and digital)		X		X																
2.4	Outreach activities	X	X	X	X	X	X	X	X	X											
2.5	Open house			X		X															
3	**User Training**	**2022**				**2023**				**2024**				**2025**				**2026**			
3.1	Definition of event types and target groups	X	X	X	X			X													
3.2	Pedagogical design of training events		X	X																	
3.3	Pilot studies of training events		X	X																	
3.4	Execution of training events							X													
3.5	Evaluation and analysis																				
4	**User Support**	**2022**				**2023**				**2024**				**2025**				**2026**			
4.1	Set-up helpdesk, support operations				X	X	X	X	X	X											
4.2	Protocols for mid-level			X	X	X	X	X	X												
4.3	Protocols for in-depth support			X	X	X	X	X	X												
4.4	Evaluation protocols and analysis						X	X													
4.5	Execute User support			X	X	X	X	X	X	X											
5	**Software Curation and documentation**	**2022**				**2023**				**2024**				**2025**				**2026**			
5.1	Survey of existing platforms, state-of-the-art					X	X	X	X												
5.2	Define and produce documentation templates						X	X													
5.3	Define, setup and maintain repository						X	X	X	X											
6	**Infrastructure development to improve services**	**2022**				**2023**				**2024**				**2025**				**2026**			
6.1	Needs elicitation from other infrastructures	X	X					X	X												
6.2	Monitor needs from User Support				X	X	X	X													
6.3	Pre-studies for development			X	X			X	X												
6.4	Defined projects execution					X	X	X		X											
7	**Int. training & evaluation - knowledge sharing**	**2022**				**2023**				**2024**				**2025**				**2026**			
7.1	Survey internal training needs						X	X													
7.2	Define continuous evaluation methodology						X	X													
7.3	Pedagogical design of internal training events		X	X																	
7.4	Execution of training events		X	X		X	X	X	X	X											
7.5	Evaluation and analysis							X													

InfraVis Milestones (M) & Deliverables (D)

2022			2023		2024		2025		2026	
March (0) Startup	**June (1)** 6-month M&D	**December (2)** 12-month M&D	**June (3)** 18-month M&D	**December (4)** 24-month M&D	**June (5)** 30-month M&D	**December (6)** 36-month M&D	**June (7)** 42-month M&D	**December (8)** 48-month M&D	**June (9)** 54-month M&D	**December (10)** 60-month M&D
M0.1. Pre-kickoff meeting KTH Nov 9 2021	**M1.1.** Definition of recruitment process	**M2.1.** All internal & most external recruitment	**M3.1.** Pilot studies completed	**M4.1.** Optimized full TOPDesk operation	**M5.1.** User group mapping	**M6.1.** Full evaluation of 2- ops	**M7.1.** Follow-up on user call 2024	**D8.1.** User Call 2025	**M9.1** Follow-up on user call 2025	**D10.1.** User Call 2026
M0.2. Kickoff at Gothenburg March 23	**M1.2.** Development of operations and	**M2.2.** All currently needed HW & SW	**M3.2.** Proposed adjustments	**M4.2.** Optimized InfraVis protocols	**M5.2.** Define development project with at	**M6.2.** Start up development project with at	**D7.1.** Send application 2027 and onwards	**D8.2.** Steering Committee meetings (at least	**D9.1.** Report to VR	**D10.2.** Steering Committee meetings (at least
D0.1. Steering Committee meeting - Jan	**D1.1.** Pilot project plan to develop	**M2.3.** All protocol definitions outlined	**D3.3.** Protocols for interfacing with	**D4.1.** Pilot study report	**M5.3.** Follow-up on user call 2023	**M6.3.** Preparation for continuation and	**D7.2.** Report to VR	**D8.3.** Infravis Days TBA	**D9.2.** Steering Committee meetings (at least	**D10.3.** Infravis Days TBA
D0.2.. Steering Committee meeting – Feb	**D1.2.** InfraVis Plan for Gender Equality	**M2.4.** Full operation TOPDesk Nov7	**D3.4.** Report to VR	**D4.2.** InfraVis adjustments proposal	**D5.1.** Report to VR	**M6.4.** Present plan and strategy for application	**D7.3.** Steering Committee meetings (at least	**D8.4.** InfraVis internal/external Newsletter	**D9.3.** Infravis Days TBA	**D10.4.** InfraVis internal/external Newsletter
D0.3 Steering Committee meeting - Mar	**D1.3.** Steering Committee meeting - April	**D2.1.** User training workshops and	**D3.5.** Scientific Advisory Board assembled	**D4.3.** Validated protocols document	**D5.2.** Steering Committee meetings (at least	**D6.1.** User Call 2024	**D7.4.4** Infravis Days TBA		**D9.4.** InfraVis internal/external Newsletter	
	D1.4. Steering Committee meeting – May	**D2.2.** InfraVis Communication Strategy	**D3.6.** InfraVis Data Management Plan	**D4.4.** Steering Committee meetings	**D5.3.** Infravis Days Umeå	**D6.2.** Steering Committee meetings (at least	**D7.5.** InfraVis internal/external Newsletter			
	D1.5. Steering Committee meeting - June	**D2.3.** Steering Committee meeting - Sep	**D3.7.** Steering Committee meeting – Jan		**D5.4.** InfraVis internal/external Newsletter	**D6.3.** Infravis Days Lund				
		D2.4. Steering Committee meeting - Oct	**D3.8.** Steering Committee meeting - Mar			**D6.4.** InfraVis internal/external Newsletter				
		D2.5. Steering Committee meeting - Nov	**D3.9.** Steering Committee meeting - April							
			D3.10. Steering Committee meeting - June							

Figure 5. Updated Gantt diagram, and Milestones & Deliverables for 2022-2026 (focus 2022-2023).

Data Management and Need for Supporting e-Infrastructure

InfraVis has developed a data management policy. The general principle for InfraVis Data Management Plan (DMP) is that the responsibility of handling the data lies with the user of the infrastructure, the Principal Investigator (PI) of the project that is hiring the services of InfraVis. It is the responsibility of the PI to ensure that all issues concerning confidentiality and ethical approvals are handled before anyone from InfraVis handles the data. For instance, if the data handling protocol requires specific ethical certifications, the PI must provide the resources for the InfraVis personnel involved to get the required certifications. In particular, InfraVis Application Experts (IAEs), the personnel who directly handle data, must have all necessary certifications. Infravis does not have hardware, software or human infrastructure to manage data storage, distribution, and audit trails, to name a few requirements of data handling. However, we will encourage the user to apply for NAISS[5]/Swestore resources whenever possible and practical. The PI then grants the IAE access to the data repository. For level-3 projects, the PI supported by IAE has the option of applying for data handling resources such as NAISS-SENS[6] and Swestore[7].

InfraVis nodes will encourage PIs to use their local University DMPs, typically provided by their libraries. For instance, KTH's DMP is handled by the library through online and consultation services, including the tool DMP online. Of particular concern are possible conflicts of interest (COIs) between InfraVis personnel and data owners, partly due to the research value of unpublished data. For example, if an IAE is working with multiple users from similar areas, the research data or methods must not be shared between users without explicit consent from them. InfraVis must proactively identify and address COIs between support personnel and users through thorough and transparent agreements and protocols. For the full DMP, see appendix.

The e-infrastructure needs will be modest for InfraVis and are difficult to estimate today. Nevertheless, we foresee the need of NAISS resources, especially with regards to storage and remote visualization resources. InfraVis users will partially overlap with NAISS users. InfraVis' user-base will, however, be larger than this overlap as InfraVis attracts users who today have not come into contact with High Performance Computing (HPC). InfraVis will facilitate users to get access to resources at NAISS. InfraVis plans for a development project together with NAISS (Module 6). This is especially important as the data generated by instruments and simulations are rapidly growing and visualization can often only be done close to the generated data. Remote visualization services will also bridge visualization and HPC, enabling the use of visualization tools directly by HPC/AIML users.

[5] https://www.naiss.se/ previously https://www.snic.se/

[6] https://www.snic.se/allocations/snic-sens/

[7] https://www.snic.se/resources/swestore/

Part II: Strategic & Operational plan for Modules

Part I of this document has been adapted from the InfraVis application submitted in 2021 to the Swedish Research Council. Part II consists of the Operational plan for 2024.

The InfraVis modules

Here, we provide the overall information for and strategy on each of the modules in InfraVis and describe its operational objectives for 2024.

Module 1: Organization and Leadership

The Management Team (MT) is responsible for the coordination of activities across all consortium partners. They coordinate activities within the modules and are responsible for all central InfraVis administration, disbursement of funds, budgeting, economic follow-ups, administrative documentation, half-way evaluation, and auditing. Chalmers staff and its financial officers provide administrative support and the material for budgetary decisions, monitor the finances, handle the distribution of funds from InfraVis to the respective universities, and distribute invoices regarding user fees where applicable. The node coordinators (NCs) are part of Module 1 and active in the development of the activities in the Modules. The NC meeting is an important arena for sharing information between the MT and the nodes. During the autumn of 2023 the weekly NC meetings started to be alternately led by the NCs.

Module 1 evaluates the scientific impact of the support given by InfraVis throughout the runtime of the infrastructure. Its impact can be measured in several ways, e.g., by contributed support to scientific publications (bibliometrics), how InfraVis is used by researchers and if it cross-fertilizes ideas and innovation (scientometrics), or how it is perceived in print media and large-scale online social media (sociometrics).

The operation of a distributed infrastructure with nine consortium members and eight nodes is a challenge. Nevertheless, the geographical distribution and the breadth of expertise included are key reasons for establishing InfraVis. In 2023, the efficacy of consolidating access to all InfraVis nodes and services through a single point of contact, the helpdesk, became evident. This approach facilitates cross node collaboration and helps balance the workload. To continue the development of InfraVis towards its full potential, a number of operational goals are set to guarantee a seamless sharing of expertise and transparency of communication between the eight InfraVis nodes.

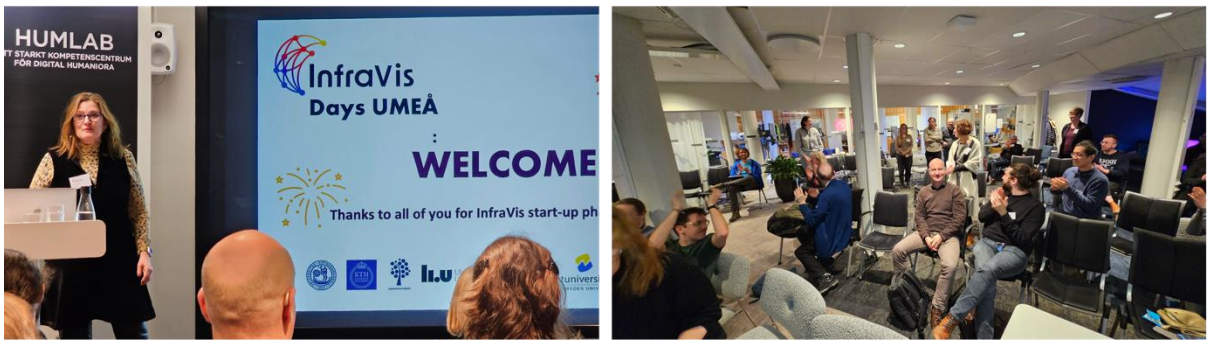

Figure 6. Summary of the start-up years at InfraVis Days. Photos CC-BY 4.0 by Mario Romero.

Module 1: Operational plan 2024

The work in individual modules started to be more prominent during 2023. The responsibilities have shifted from collective chairing to more individual for some of the modules. Further development of the module working model will be done during 2024.

Throughout 2023, Module 1 has served as the primary hub for coordinating InfraVis activities, hosting two MT meetings and one NC meeting each week. In addition, we've conducted separate meetings, which also involved IAEs, to address various types of activities. Module 2, outreach and communication, started to conduct weekly module meetings 2023 and will continue to do so. In 2024, a similar model with more individual responsibilities for chairing additional modules will be established and more frequent module meetings will be set up. Each module will be led by a technical coordinator, the vice director, or an NC with strong engagement for a particular module. During Q1 2024, a prioritized activity for M1 is the 2023 annual report (to be submitted to the Swedish Research Council, deadline March 30). All NCs will have reported activities and finances by the end of February. Steering Group meetings are planned to oversee, support and take necessary decisions. During Q2, M1 will prioritize to govern preparations for our second user call scheduled after summer. The first user support call was very successful with 47 applications; however, we learned the lesson that we need to add a dialogue phase with applicants before closing the call. During Q2 we will also start the work with the application for renewed funding from the Swedish Research Council, which during Q3-Q4 will be a major focus for InfraVis M1. Beside these activities that span over a long period of time, M1 will govern the implementations of the following central activities:

- Establishment of the InfraVis User Forum at InfraVis Days Umeå 2024.
- InfraVis days November 2024 Lund, including User Forum and Scientific Advisory Board (SAB)meeting.
- Organize at least 4 Steering committee meetings.
- Govern and develop cohesive internal and external processes.
- Develop Module responsibilities.
- Develop the technical coordination of M4.
- Improve the resource allocation process.
- Improve the user support call process including to develop transparent evaluation criteria for prioritizing support requests and execute one call per year.
- Develop the User Fee model(s) Facilitate the development of InfraVis Faculty and introduce to users and InfraVis researchers.
- Competence development for the IAEs.
- Initiate implementation of offering support to industry, which should come with a full-cost model (Module 4).

Figure 7. SAB meeting at InfraVis Days at KTH, October 2023. Photo CC-BY 4.0 Mario Romero.

Module 2: Outreach and Communication

Figure 8. InfraVis outreach and communication. Visualization Studio Open House and workshops 2023. Photos CC-BY 4.0 Mario Romero.

The visualization community within Sweden is already large. However, there are many researchers from various domains not employing visualization to its potential. Consequently, an important function of InfraVis is to allow researchers to maximize their scientific impact through visualization. As part of Module 2, InfraVis reaches out to researchers in three ways: 1) through the InfraVis website; 2) through a series of coordinated events; and 3) through social media, including LinkedIn, Instagram and the production of scientific videos for YouTube. The InfraVis website provides essential information about the infrastructure activities including user training, resources and expertise, user support activities and examples of supported projects. For more information, see the InfraVis Communication Strategy and Communication Plan.

InfraVis organizes events tailored to researchers from specific domains and other infrastructures to meet their unique requirements. During these events, researchers have the chance to explore the potential of visualization for their data by engaging in discussions with InfraVis experts and experiencing hands-on demonstrations. Through these interactions, users gain insight into how visualization techniques can

advance their research and facilitate effective communication of their findings. Outreach events will be arranged at all nodes.

Module 2: Operational plan 2024

The operation plan for Module 2, Communication, for 2024, includes the following action items:

- Open house meetings to inspire researchers to apply for InfraVis support and to include the need for InfraVis resources in their research applications.
- Arrange outreach and communication activities.
- M2 weekly meetings.
- Ensure a consistent and frequent internal information flow.
- Internal newsletter for InfraVis colleagues.
- InfraVis National Newsletter (with event updates).
- Consistent presence on social media: plan content at least one month ahead. Informed by insights generated through social media analysis, with consideration of the various InfraVis target groups.
- Participation in InfraVis activities will, to the largest extent possible, be followed by individual follow-up contact.
- Web site posts and development:
    - Complement the skills table with a “user request-table”.
    - Display experiences from and expertise in supported scientific domains.
    - Communicate InfraVis participation at events arranged by, e.g., other infrastructures and scientific communities.

For more details and information on communication and outreach activities, see the InfraVis Communication Strategy[8].

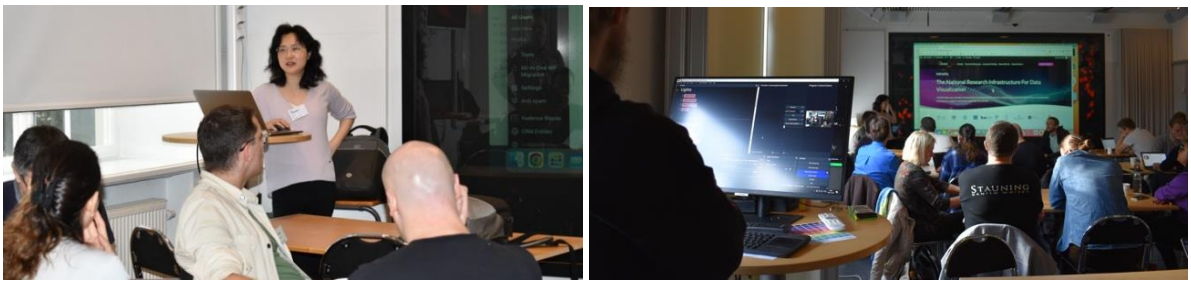

Figure 9. Website workshop at InfraVis Days KTH, October 2023. Photos CC-BY 4.0 Mario Romero.

Module 3: User Training

Advanced training is a key factor to ensure Sweden’s scientific competitiveness in the ongoing transformation of today’s science into research with increasingly complex and large-scale data. The InfraVis Module 3: User Training will spread knowledge via workshops, tutorials as well as courses, and in the long-term, through the creation of a national mentoring program. InfraVis’ user training and education offers important knowledge transfer in the use of visualization resources. The aim is to give every user increased know-how of the challenges and possibilities with visualization of their

[8] InfraVis_Communication_Strategy_Approved_20221027.pdf

respective data.

InfraVis has the mission to provide state-of-the art visualization courses to scientists within Sweden from any disciplinary domain. The people behind the InfraVis initiative already contribute with courses at all InfraVis sites, which will form the basis of some of the courses offered also within InfraVis. New courses and tutorials will be tailored to meet researcher interests as expressed directly by researchers as well as through the InfraVis User Forum, following a bottom-up approach for course requests. They will be designed to address the most significant demand within specific subject areas and proficiency levels.

The default mode of user training is on-site. The training will normally be given at a node of InfraVis but can be located elsewhere if needed. Having on-site training will give the participants the opportunity to interact with the InfraVis staff as well as participants from both within the InfraVis nodes and other universities. In addition, InfraVis will provide opportunities for remote participation in some of the user training events, e.g., data clinics, hackathons and workshops.

Available training events will be announced at the InfraVis website and spread via other outreach activities given in Module 2.

Module 3: Operational plan 2024

The operation plan for Module 3, User Training, for 2024, includes the following action items:

- Include user training as a standing item on the NC meeting agenda.
- Define event types and target groups aiming for diversity in both these aspects.
- Tailoring user training to align with the specific needs identified through user support projects (M7 activity).
- Arrange training events together with M6 for Research Infrastructure co-events.

Figure 10. Data clinics and user training. Photos CC-BY 4.0 by Mario Romero.

Module 4: User Support

The primary advantage of InfraVis lies in its ability to unite Sweden's top visualization competence hubs, guaranteeing that every academic user requiring visualization support can connect with specialists tailored to their unique challenges. Moreover, there is potential for these users to collaborate with experts on their research endeavors. The interface to the users is thus the core of the daily InfraVis operations. It is recognized that user needs exist at varying levels of complexity depending on the

problem at hand and this complexity can change over time as a project specification evolves. Furthermore, the potential threshold created by the diversity and high number of existing visualization applications (commercially available solutions, open-source initiatives, and research prototypes) require the support of users from IAEs.

The InfraVis user support is organized into three levels (helpdesk, mid-level and in-depth) to meet user demands and expectations, and to manage the varying complexity of incoming requests. This organization reflects the expertise needed to effectively handle the requests and the process of matching them with the resources available at InfraVis. InfraVis staff involved in user support are expected to operate across several levels.

InfraVis TOPdesk is the first point of contact with InfraVis support, which is at the multifunctional website that provides information about the three support levels. The user can contact InfraVis via an automated form on the website that links to TOPdesk. A typical support scenario starts with a user submitting a request via the InfraVis website. The request ends up in TOPdesk - the helpdesk administration system used by the InfraVis support staff. The request can be referred to the mid-level (L2) if required or escalated further to the level when in-depth support (L3) is needed. Users need to apply and be approved for L3 projects.

For in-depth support, significant resources may be required as a project may entail tailoring existing software solutions or even researching and implementing new approaches and methods specific to the problem at hand.

By necessity, the definition of an in-depth support project will have to involve visualization experts. Users may have limited knowledge and experience of visualization techniques and possibilities. InfraVis opens an annual call for project proposals and engages users in an iterative process in which InfraVis experts and users jointly define and develop what visualization support the project requires. The benefit of such a process includes that technical relevance is assured already at the in-depth project definition stage. The result of the process is a project specification that accounts for scientific novelty, potential of application, novelty of visualization challenges, technical feasibility, previous contact with InfraVis experts, and the scientific track record of the applicant.

The activities of ongoing projects are closely monitored by management to ensure efficient utilization of the resources and that efforts are appropriately distributed at the appropriate level between nodes. An important aspect of the in-depth support is the feedback of results and solutions into the general pool of knowledge curated by InfraVis, thus ensuring the wider community benefits from efforts spent on applications and method development (Modules 4 and 5).

User Access to Visualization Laboratories and Resources

Significant and complimentary state-of-the-art visualization hardware resources exist in affiliated visualization laboratories and e-infrastructures of the InfraVis nodes. Jointly, InfraVis covers the full range of equipment from high-end workstations to personal Virtual Reality equipment, such as HMDs, and large-scale immersive Virtual Reality environments and dome theaters. Additionally, novel interaction devices based on multi-sensory input are available at several sites. Managing access to these environments is an integrated activity of InfraVis at all levels of user support.

We define four main levels of access to the facilities:

- Physical access to the laboratories.
- Remote access to the laboratory facility resources.
- Online collaborative access to the laboratory facilities and personal support.
- Access to equipment and computers, in-place, remote, or borrowed.

This is planned as a potential development project in Module 6.

Access to the helpdesk (TOPdesk), mid-level support (up to a week) and user training will be free of charge. InfraVis had applied user fees for in-depth support for two projects 2023 and learned that we need to develop different models for different needs of support.

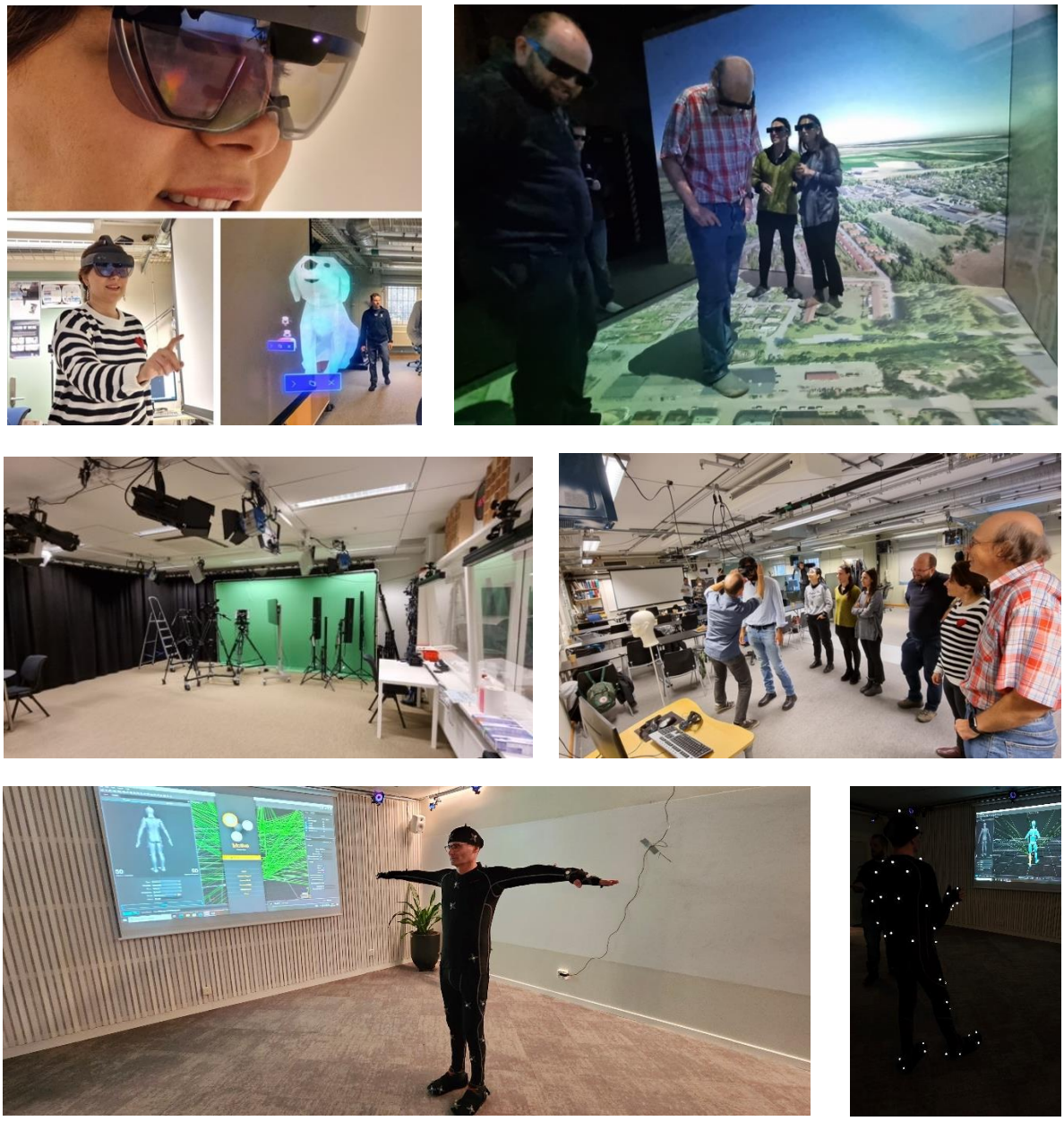

Figure 11. Facilities used by InfraVis. Photos CC-BY 4.0 by Mario Romero.

Module 4: Operational plan 2024

M4 will work with the second user call for in-depth projects during 2024, from April to October. The user support requests for in-depth support require that InfraVis experts are deeply engaged in all aspects of the visual data analysis process, including potentially tailoring visualization tools with the user. Our plan is to develop our user fee model for in-depth support. InfraVis' in-depth projects will be flexible in their extent of time and volume. Moreover, we will develop a full-cost model for non-academic user groups.

The main work for module 4 will be to develop and implement support procedures on all levels:

- Continue work according to plan on the L3 projects from call 2023.
- Provide L1-L3 user support.
- Provide helpdesk service.
- Host regular open house meetings before and under the 2nd user call announcement.
- Work with processes related to the User Call (dialogues, agreements).
- Test one full-cost user support project outside academia.

Module 5: Software Curation and Documentation

The body of existing visualization software (tools, platforms, and libraries) is complex and constitutes a diverse set of ecosystems that has various application domains in focus. The breadth is bewildering for first time users and often the steep learning curve is preventing adoption by researchers outside the visualization community. This module will create recommendations based on best practices for different application domains along with sample configurations to get users up and running as quickly as possible. To the extent applicable, and depending on the maturity of specific software packages, the original software providers' documentation and training material will be referred to. This module will, however, include tailored documentation and provide add-ons to support necessary interfacing between software packages when required. By providing curated sets of software packages, along with examples, online user training material (from Module 3), helpdesk and in-depth support (from Module 4), this module supports the InfraVis' goal to enable scientific research in Sweden to utilize visualization to boost their research efforts and excel in scientific communication.

This module depends mostly on personnel to establish baselines of software and sample data configurations as new application domains are added to the portfolio of curated software. During the runtime of the infrastructure, more time will also be devoted to maintenance and revision of baselines as the software landscape evolves. InfraVis will also provide and maintain a limited roadmap of future baselines to enable researchers in application domains to plan ahead and minimize challenges as new software versions are recommended. Transition documentation will also be provided to minimize the impact of software upgrades.

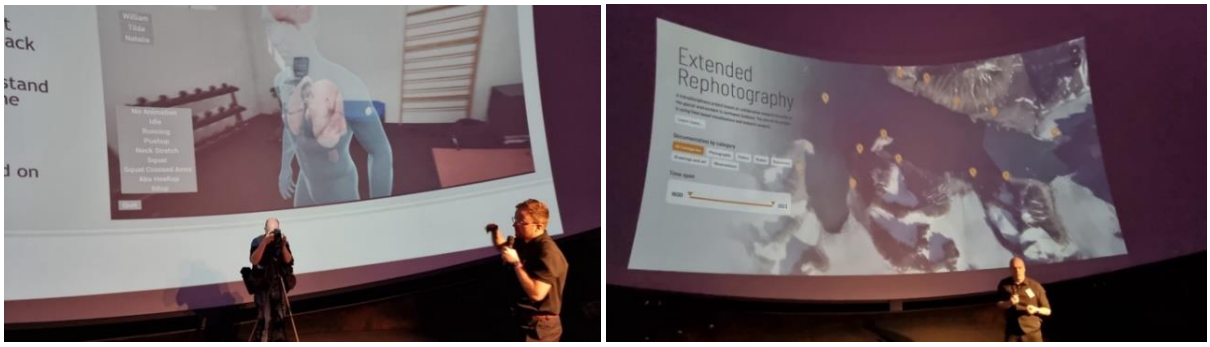

Figure 12. InfraVis Pilot projects Extended Rephotography and Digital Medical Twin presents developed software at InfraVis Days Norrköping. Photos CC-BY 4.0 Mario Romero.

Changes to the baselines and recommendations will sometimes impact Module 3 (User Training) as well as Module 6 (Infrastructure Development Projects). As more software is made available as a service (SaaS), InfraVis will have to include this for consideration in our recommendations.

Module 5: Operational plan 2024

The Module 5 action items for 2024 are:

- Create rigorous and formal documentation of InfraVis software development.
- Create interactive and engaging user tutorials of the visualization software employed or developed and employed in the support projects. This material is valuable for documentation, M5, education M3 and M7, and communication M2. It also provides a repository of solutions for future M4 user support tasks. The tutorials will include text, images, videos, and animated interactive models of the visualization software.
- Maintain the Inventory of skills and software packages in use.
- Update and maintain resources in InfraVis.se, including templates and tools.
- Publish recommendations based on best practices for different application domains along with sample configurations.
- Prepare a proof-of-concept webpage (wiki) that is capable of linking competences, skills, software, hardware and different data courses and areas of visualizations.
- Create a central repository (GitHub hosted by Chalmers) for software packages produced by InfraVis experts.

Module 6: Infrastructure Development Projects to Improve Services

We acknowledge the strong need to keep the InfraVis set of services at the leading edge of the rapidly developing landscape of visualization software and methods. As much of this development is taking place in the context of research efforts, projects that will bridge the gap between research prototypes and production level software and services are necessary. There are also specific technical needs that are unique to application domains and infrastructure interoperability, so tailored solutions may be needed at all levels of operations. We foresee that interoperability with other infrastructures will require specific solutions for data handling and analysis, and we envision that InfraVis will operate, in collaboration with stakeholders, a number of development projects.

InfraVis serves as a crucial complement to other research infrastructures involved in data collection or extraction. As research infrastructures such as MAX IV embark on upgrades and expansion with state-of-the-art new beamlines, the potential for groundbreaking discoveries in e.g., in-vivo imaging for life sciences and materials research is immense. However, these technological advancements necessitate complementary infrastructures for data handling, analysis and visualization to be fully leveraged. InfraVis, which can provide cutting-edge data visualization tools, may be an indispensable asset in this regard. It will enable researchers to effectively interpret and utilize the complex data generated from such new facilities, thereby ensuring that the enhanced capabilities of MAX IV, for example, are translated into tangible scientific achievements.

One of the competitive advantages of InfraVis is close proximity of operations to strong research environments. This makes it possible to conduct projects in a synergistic manner with research efforts in both the technical and application domain. This also contributes to the goal of keeping the internal InfraVis competence maintained at the international forefront as well as providing technical research challenges to researchers in a win-win scenario.

Development projects will be defined in a process curated by the technical management of InfraVis and approved by the Steering Group. It is imperative that the projects are addressing pertinent improvement of operations of InfraVis, while funding of research-oriented components of the projects will be provided by the hosting research environments.

We will explore collaboration with other Research Infrastructures to develop strategies for coordinated actions and visualization initiatives customized for specific user communities. Notably, NAISS is a significant infrastructure. As part of InfraVis's objectives, we aim to provide on-demand large-scale remote visualization capabilities to users of the NAISS e-infrastructure.

InfraVis will follow up on the dialogue that was initiated during 2023 with WISDOME. Several InfraVis nodes, including KTH, LU and LiU, are engaged in planning and developing projects together with WISDOME. The criteria used for selection of development projects will be:

- Potential to improve operations and services.
- Scope of solutions (number of research infrastructure users that will benefit).
- Technical complexity and feasibility.
- Leverage on existing solutions.
- Benefit for the research community.
- Addressing a gap and creating new pipelines leveraging the use also of other research infrastructures. Synergy with user groups and technical research groups (matching funding).

Once projects are completed, the results will when applicable be compiled into Module 5 (Software Curation) and made available to the community and branded as InfraVis software and solutions. The results will also be communicated and taught through Modules 2 and 3.

Module 6: Operational plan 2024

We need to streamline the process and documentation of mid-level and in-depth projects. A common check-in document/template as well as a common naming convention and repository of projects and results will be further developed.

Interaction with other research infrastructures is defined as an important strategy for developing InfraVis. In early 2022, a survey was circulated among various research infrastructures to gauge interest in collaboration and ascertain the potential utility of InfraVis for their needs. The survey results unequivocally demonstrated significant interest and a clear demand for InfraVis to serve as a collaborative partner for other research infrastructures. This sentiment has been further validated through meetings convened with a select group of research infrastructures.

These meetings have not only addressed the development of visualization pipelines to better serve researchers and users but have also delved into broader topics such as optimizing distributed research infrastructures, designing user fee models, sustainable financial models and outreach and communication.

Module 6 actions for 2024:

- Initiate routine module 6 meetings within InfraVis.
- Sustained engagement in dialogues with research infrastructures, ensuring representation from diverse scientific disciplines.
- Enhance and deepen dialogues with specific research infrastructures to focus on the development of user pipelines.
- Start at least one development project with another Research Infrastructure.

Module 7: Internal Training and Self-Evaluation

InfraVis is a human resource infrastructure. Its central assets are knowledge and skills. InfraVis Application Experts (IAEs) naturally become proficient in their everyday tasks. To ensure other members of the infrastructure increase their expertise over the stages of the service pipeline, knowledge sharing will be formally structured into the regular activities of IAEs. This activity ensures robustness through a level of redundancy across the nodes. Our goal is to ensure that the responsibilities of every IAE can be temporally resumed by a combination of other IAEs in case of sickness or vacation. InfraVis will work consciously with competence development with the whole group of experts, both in terms of technical and organizational development. This creates possibilities for career paths for the IAEs, and ensures the transmission of knowledge to incoming team members. To formally conduct internal training and cross node collaboration, we work with the following activities:

- Meetings for IAEs with regular intervals: IAEs meet to share and discuss methods, challenges, and techniques to allow for knowledge and best practice exchange.
- Bi-monthly workshops (train the trainer): Experts will share deep knowledge of visualization science, tools and practices on specific topics that have proven central to user support.
- Short-term staff exchanges between nodes,
- Self-Evaluation: The central aim of self-evaluation is to enhance InfraVis'

service to users. Feedback from stakeholders, encompassing users and staff, will undergo analysis and be presented to the Steering Group. We will use best-practices in project evaluation, including:

- User evaluation: InfraVis user feedback will be gathered through surveys, interviews, and usage data analysis.
- InfraVis procedure evaluations: While users can share their service experiences, they lack insight into InfraVis' internal support structure. To gain this perspective, we'll conduct staff surveys and analyze data from internal tools to evaluate infrastructure procedures.
- Postmortem analyses: Upon each user support project completion, we'll compile the experiences to create a reference library for current and future staff.

Module 7: Operational plan 2024

In 2024, internal training and sharing of experience will be prioritized. The reasons are, on the one hand, the importance of competence development to give state of the art support, and, on the other hand, that we need to facilitate possibilities to increase the level of identification among IAEs. We foresee that in 2024 with the new employments the share of IAEs with higher percentages (above 30%) will continue to increase. However, the working percentage will still have large variations. All nodes will prioritize to let IAEs attend the training events provided. Diverse kinds of planned training:

- User Call 1 experience sharing and self-evaluation (cross-node).
- User group mapping (research areas, communities…).
- Continued TOPdesk education.
- Internal Training: State-of-the-art visualization, software, and tools.
- Internal training: Ethical dimensions of visualizations.
- Seminars with visualization senior researchers (trainer-of-trainers).
- Develop a strategy for computer science related to Artificial Intelligence (AI) for visualization.
- Plan for engagement at EuroViz and/or IEEE 2025.

Figure 13. InfraVis workshops at InfraVis Days, KTH Oct 2023. Photos CC-BY 4.0 by Mario Romero.