



Industry-Academia Challenges and Pathways

Suggestions for the Digital Patient Roadmap

A Frangi & V Stroetmann

w/ inputs from D Kalra, V Diaz, M Viceconti,
P Lawford, C Umesi

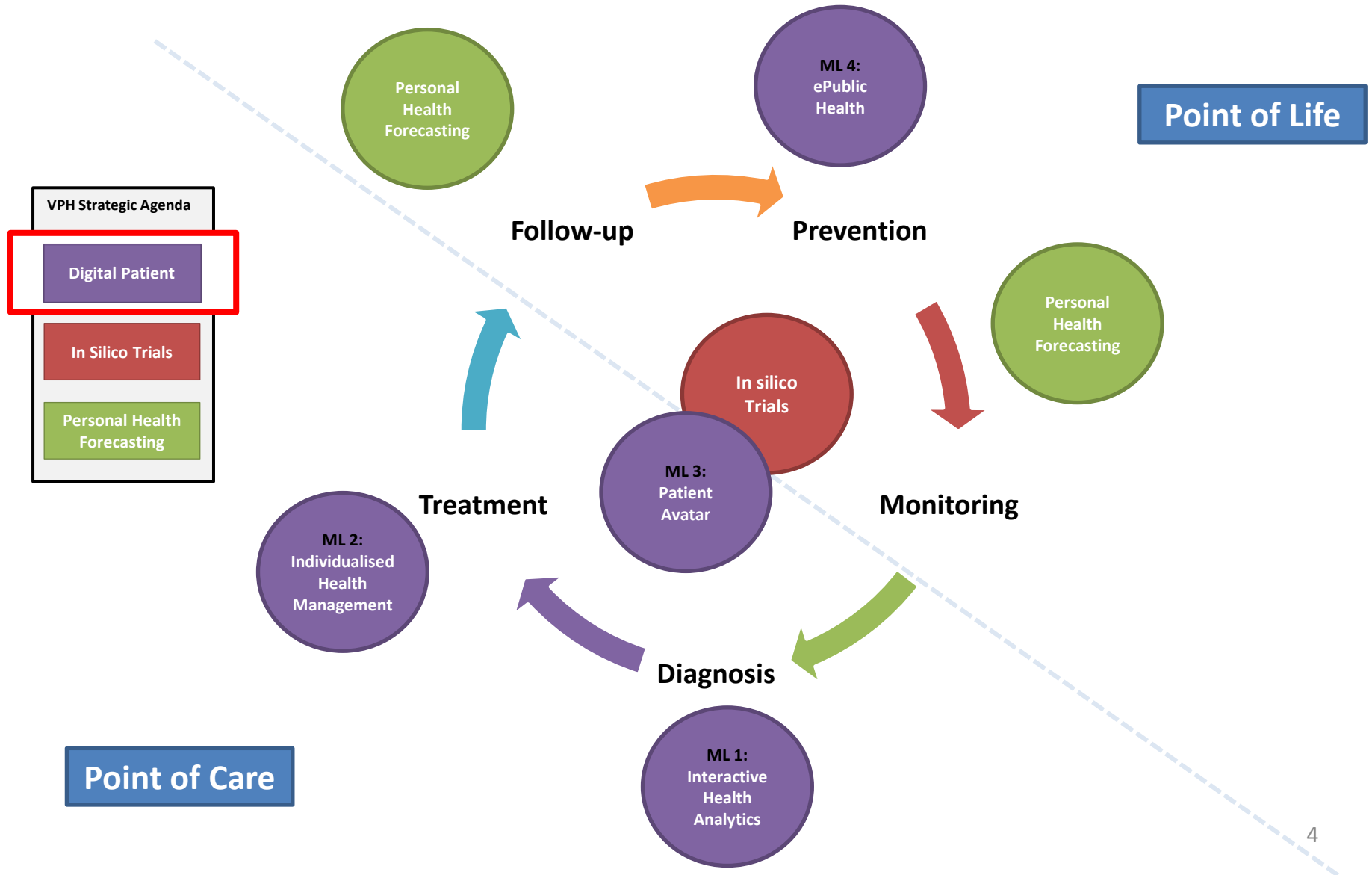
The Digital Patient

- The Digital Patient (DP) initiative will develop new ways of combining and exploiting the rich information about a patient in a highly visual, coherent and meaningful way. It will enable new clinical information to be generated by the blending and fusing of existing data and will lead to the creation of a powerful “patient avatar” capable of supporting the medical professional by producing the new clinical knowledge from the integration of patient-specific and population-specific information.
- The use of simulations of the progression, treatment, and outcome of a disease will support diagnosis, prognosis, and choice of treatment; will help develop evidence-based explanations in complex clinical cases thus improving self-understanding, doctor-patient communication, and consensus-reaching within multi-specialist teams; carry out intervention/treatment planning.
- The Discipulus project is developing, by means of a consensus process involving all key stakeholders, a detailed research roadmap for the European Research Area aimed to pursue the ambitious objective of the Digital Patient.

Rationale

- For details see: https://www.biomedtown.org/biomed_town/discipulus/reception/wiki please read & comment the clinical scenarios and DP stories, contribute to core technological challenges
- The goal of this survey is to capture the opinions of key experts from industry and the academic community around the main challenges, scientific and technology dimensions that define the research agenda for the development of the Digital Patient.
- Focus on innovative pathways addressing challenges throughout the care cycle
- Try to prescribe a time-to-realisation (TTR) and whether the main drivers should be industrial or academic actors
- List all scientific and technologic dimensions which need to be addressed.

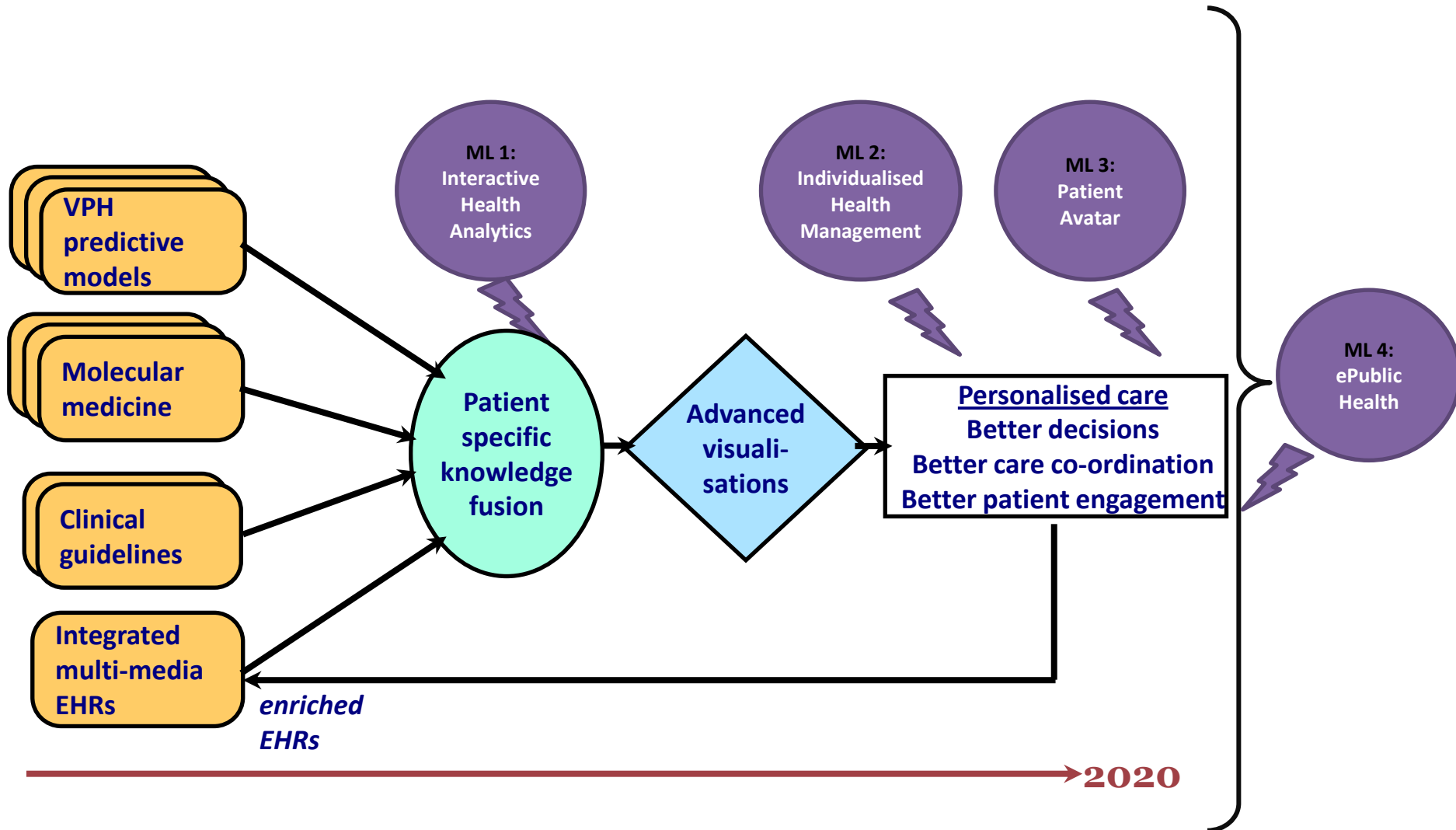
The wider VPH context with its Challenges across the Care Cycle



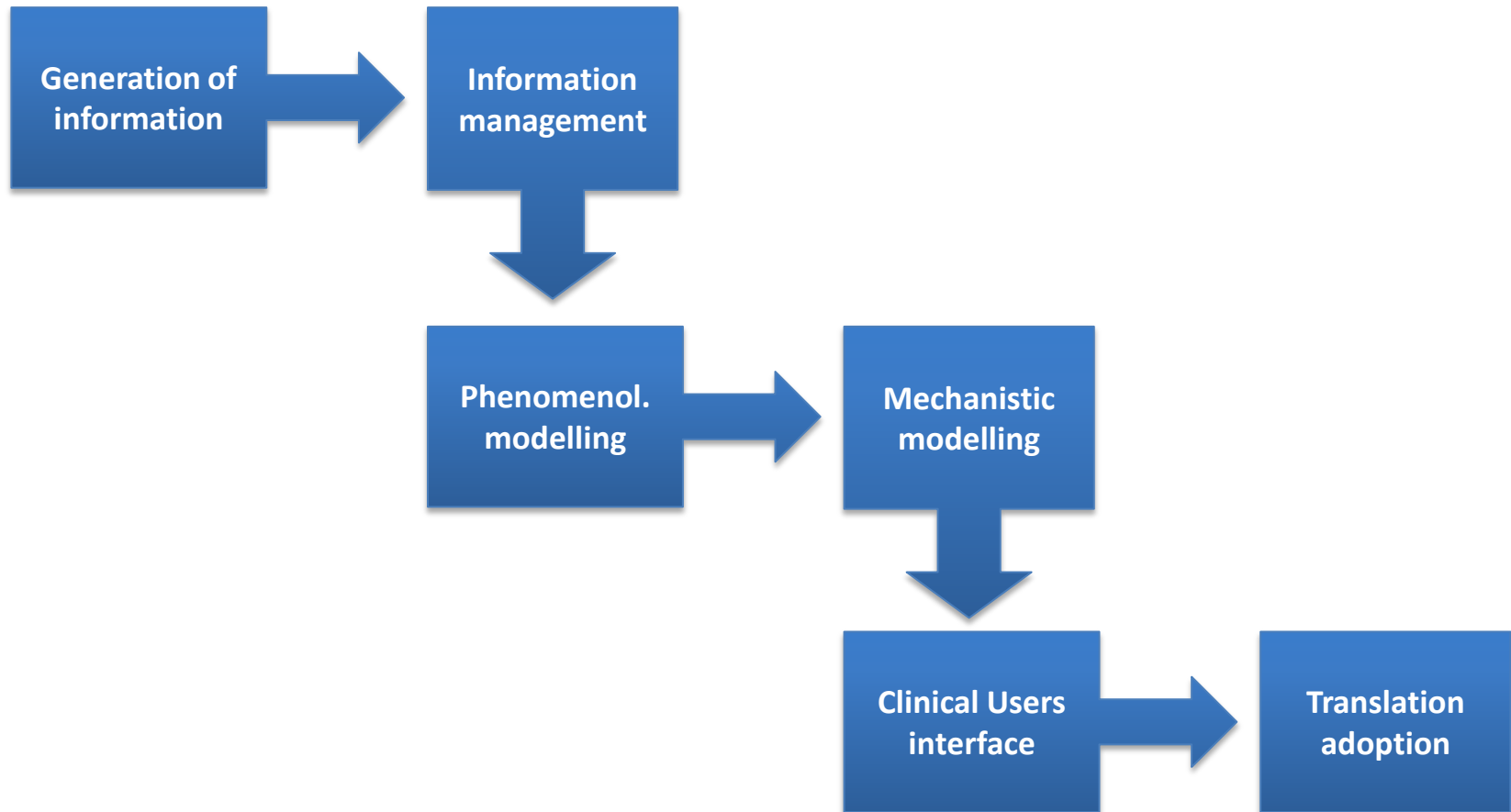
Pathways for the Digital Patient

DP Maturity level	Pathway to?	Other initiatives	TTP?	TTM?	Technological Drivers / Enablers		
					Academia	Industry	Government
ML 1: Interactive Health Analytics	By extending interoperable EHRs with visual and haptic means for exploration and interaction, we shall enable new ways for patients and clinicians to explore and exploit healthcare information, enhance patient counselling with visualising predictions and uncertainty, and integrated diagnostic and therapeutic decision making	Medical Informatics, Biomedical Informatics, Information Visualisation	5y	10y	Primary	Secondary	Primary / Regulatory, secondary use of EHRs
ML 2: Individualised Health Management	By seamless integration of multimodal imaging and sensing, computational information processing, and computational physiological modelling, we shall be able to deliver patient specific diagnosis, prognosis, interventional planning and guidance at the point-of-care that optimise both the Quality of Life and the Quality of Experience	Personal Health Systems, Customised Medical Devices, Physiome Modelling	5y	10y	Primary	Primary	Secondary
ML 3: Patient Avatar	A patient avatar is a sophisticated representation of the integrated data, information and knowledge about a patient, using state of the art visualisation techniques. It will enable new clinical information and knowledge to be generated by the blending and fusing of existing data, information and prior knowledge. This knowledge will be queried, instantiated, intervened upon	Medical Informatics, Biomedical Informatics, Physiome Modelling	8y	12y	Primary	Primary	Tertiary
ML 4: ePublic Health	An interface to a virtual population of patient avatars, modelled using VPH models, and statistically spanning characteristics representative of true populations or those resulting from specific public health interventions, we will be able to understand some consequences of public health policies	Medical Informatics, Biomedical Informatics,	10y	15y	Primary	Secondary	Primary

Pathways to Challenges across the Care Cycle



The Digital Patient workflow



DP workflow: 6 Scientific and Technologic dimensions (part 1)

- **ST 1: Generation of Information**
 - Imaging
 - Sensing
 - Point of life, point of care
 - Biochemistry
 - Molecular biology
 - Anamnesis
- **ST 2: Biomedical Information Management**
 - EHR
 - Big data
 - Interoperability
 - Terminology
 - Data mining
 - Health analytics
 - Multimodal information
 - Knowledge management
- **ST 3: Phenomenological modelling**
 - Exploratory analyses
 - Statistical methods
 - Bioinformatics
 - ANN, Machine learning

DP workflow: 6 Scientific and Technologic dimensions (part 2)

- **ST 4: Mechanistic modelling**
 - Computational biochemistry
 - Pathways modelling
 - Cell networks
 - Physiological modelling
 - Multiscale modelling
 - Applied math, Computational sciences
- **ST 5: Clinical user interface**
 - Scientific visualisation
 - Information visualisation
 - Multiscale visualisation
 - Virtual and immersive reality
 - Human-machine interface
- **ST 6: Translation**
 - Pre-clinical validation
 - Clinical assessment
 - Regulatory affairs
 - Impact analysis
 - Health technology assessment
 - Business modelling
 - Adoption, clinical guidelines, EBM
 - Training and retraining

Questions to all Academic and Industrial Experts (part 1)

- **Do you agree with the current set of maturity levels (ML) /challenges and pathways?**
 - Do you have additional ones? If yes, please, provide a name, a description of the pathway and a reason why these are not yet covered in any of the existing MLs!
 - Do you think that any of the proposed MLs needs redefinition in terms of its title (they should be simple, short and visionary) or in terms of the actual implied content? If yes, please do so!
- **Please rank these MLs and pathways based on the impact you think they could have on improving healthcare and wellbeing of EU citizens!**
- **Could you state, for each ML, your estimated “time to realisation”, i.e. the time by which, with the current level of resources provided to the VPH community (e.g. € 40m/years), we could technically deliver the vision behind it?**
 - This will have a list of all MLs and a drop-down menu enabling setting a TTP (e.g. 2, 4, 6, 8, 10, 15, 20, >20 years)
- **Which should be, in your opinion, the key Primary drivers for realisation of each ML and those that could have Secondary, Tertiary or No Role?**
 - Primary are those that in the position to lead the change, Secondary are those that need to be closely involved but are not expected to lead, Tertiary are those that have to provide inputs but are not in a position to lead the change or contribute with core technology. The type of involvement expected may hint towards the type of funding mechanisms we will have to suggest in the roadmap (e.g. if Industry is Primary, PPPs might be more appropriate than conventional EU projects, if major research needs still to be carried out, EU Projects might be the way, etc.)
 - This will have a list of all challenges and 4 drop-down menus under headings of Academia, Industry, Government, Others where for each of them we could indicate: Primary, Secondary, Tertiary, No Role Foreseen

Questions to all Academic and Industrial Experts (part 2)

- **Why do you think industry could benefit from the implementation of the DP roadmap?**
 - This will have a list of potential benefits as well as with a drop-down menu next to each so that the individual can rank the importance for industry of each of those benefits. Additionally there will be a free text box for not covered items. The scale for importance will be from 1-10. The proposed benefits are:
 1. Stay informed and engage in consultations on the DP as a long-term vision for transforming healthcare without clearly affecting our product roadmap in the next 3-10 years,
 2. Access public funding in the DP with immediate strategic value in accelerating time to market (<3 years) of our current product roadmap
 3. Access public funding in the DP with immediate strategic value in having proof-of-concepts of new products to enter our roadmap in 3-5 years
 4. Fund proof-of-concept of products that my company could not tackle individually and require partnerships to have impact in our roadmap in 3-5 years
 5. Fund feasibility/exploratory R&D in the DP within our company with impact in our roadmap in 5-10 years and where private investments are still too risky/scarce
 6. Fund multi-partner feasibility/exploratory R&D of products in partnership with other stakeholders and impact in our roadmap in 5-10 years
 7. Seek specific academic expertise in areas of critical and immediate interest for industry where my company would be ready to do investments
 8. Other, please specify

Questions to all Academic and Industrial Experts (part 3)

- **Do you agree with the current list of 6 scientific and technologic dimensions (S&T)? If not, please propose and describe additional dimensions.**
- **Please complete the bullet list for each S&T dimension if there is the necessity!**
- **In your opinion, which technologies will be critical for realising the DP vision in the next 10 years?**
- **Which research areas have not received sufficient scientific attention and are critical for the implementation of the DP vision?**
- **Could you explain how such research areas will impact on the DP and how they should be supported over the next 5 years?**

- **Please provide information about your affiliation**
 - Type of industry (EHR system vendor, devices, application/tools for ?? vendor, pharma..)
 - Type of academic/ research institution
 - Main focus
 - Company size
 - Department
 - ...