Workshop 1: MAR Development

European Robotics Forum

12th March 2014 Rovereto

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Introduction

- Operation of Topic Groups
- MAR Development Cycle
- Next Steps in MAR Development
- Editing the MAR for Call 2
- Validating and understanding Ability Levels
- Identifying Step Changes
- TRL Levels

ERF Workshops

ERF Workshops

- Today: 16:00 to 18:30 here.
- All Topic Groups working on MAR input.
  - Detailed review of Step Changes
  - Detailed review of Ability Levels
  - Creating cross links in the MAR.
  - The use of TRL levels.
- Friday: 08:30 to 10:30 Here.
  - Strategic Review
  - Non-Technical input to the MAR

Operation of Topic Groups

Proposed Topic Groups Terms of Reference

- Draft comments for Board of Directors (13th Feb)✔
- Presented to TG Coordinators (17th Feb)✔
- TG-TAB reviewed (Feb)✔
- Final document to be approved by euRobotics Board of Directors. (14th March)

Topic Groups: Terms of Reference

- Topic Group Function:
  - Each Topic Group (TG) represents a sub-section of the European robotics community.
  - Topic Groups must be able to trace their impact in terms of sections in the SRA and MAR.
- TG Membership:
  - Topic Groups are open to euRobotics aisbl members and non-members.

Managing Topic Groups:

- Each Topic Group should nominate two persons who are the primary contact point, Topic Group Coordinator (TGC) and Topic Group Deputy (TGD). The Topic Group Coordinator (TGC) must come from an organization that is a member of euRobotics aisbl.
- A Topic Groups Technical Activities Board (TG TAB) will oversee the operation of the Topic Groups. It will:
  - Provide an annual overview of the operation of individual groups for presentation at the General Assembly.
  - Annually recommend the continuance of each Topic Group to the General Assembly.
  - Recommend the creation of new Topic Groups for approval at the General Assembly.
- The Topic Groups Technical Activities Board (TG TAB) will consist of members of the Board of Directors. External members can be nominated by the euRobotics board of directors.

What euRobotics aisbl Board of Directors expects from a Topic Group:

- Each TG should:
  - provide input to each MAR Cycle.
  - be able to identify parts of the MAR that they have impacted on.
  - collect and communicate PPP KPI data relevant to the sector that they represent.
  - collectively be aware of any advances in the state of the art in their area and communicate changes during the MAR Cycle to ensure that the MAR is timely and relevant.
  - identify synergies and overlaps to other TGs and report those to the TG TAB.
  - contribute to identifying gaps in the MAR and propose ways to overcome such gaps

Expectations…

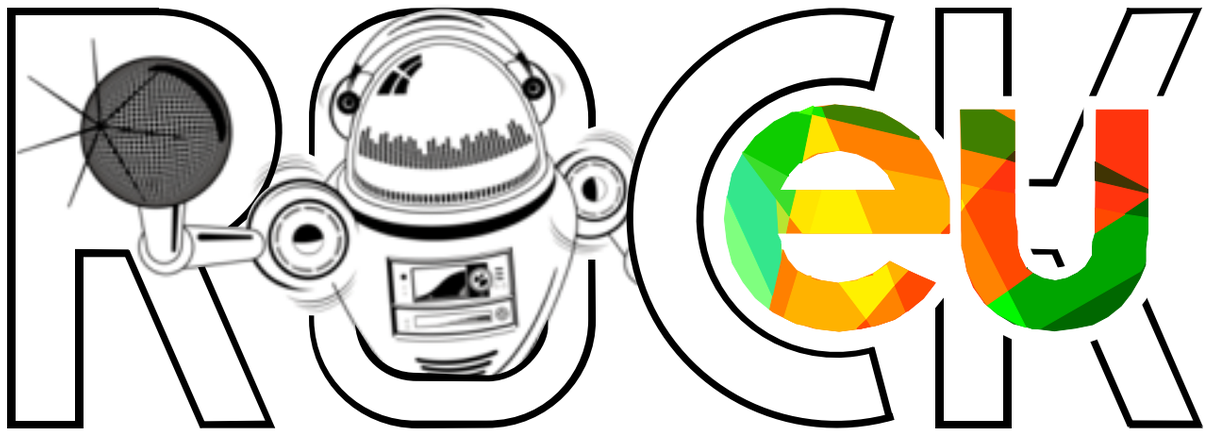
- Topic Groups Coordinators (TGC) must be active in the running of the group, organise TG activities such as workshops and represent the TG during the MAR Cycle.
- Each TG contact point should maintain a mailing list for the TG members.
- Each TG should actively seek new members and external input into the MAR Cycle

What euRobotics aisbl provides to Topic Groups:

- Each TG will be allocated an euRobotics aisbl director who can mentor and convey information to and from the TG.
- euRobotics aisbl will organise at least two workshops per MAR cycle open to TG members. One to review the outcome of a funding cycle and one to overview material prior to the MAR release, plus any others on an as needed basis.
- euRobotics aisbl will provide access to a Wiki dedicated to each TG, the content and membership of this wiki is the responsibility of the TGC and TGD.

- **New Topic Groups:**
  - A proposed new TG must gain the agreement of the TG TAB that they do not fall within an existing TG and that their formation will enhance the MAR Cycle.

RockEU and Topic Groups



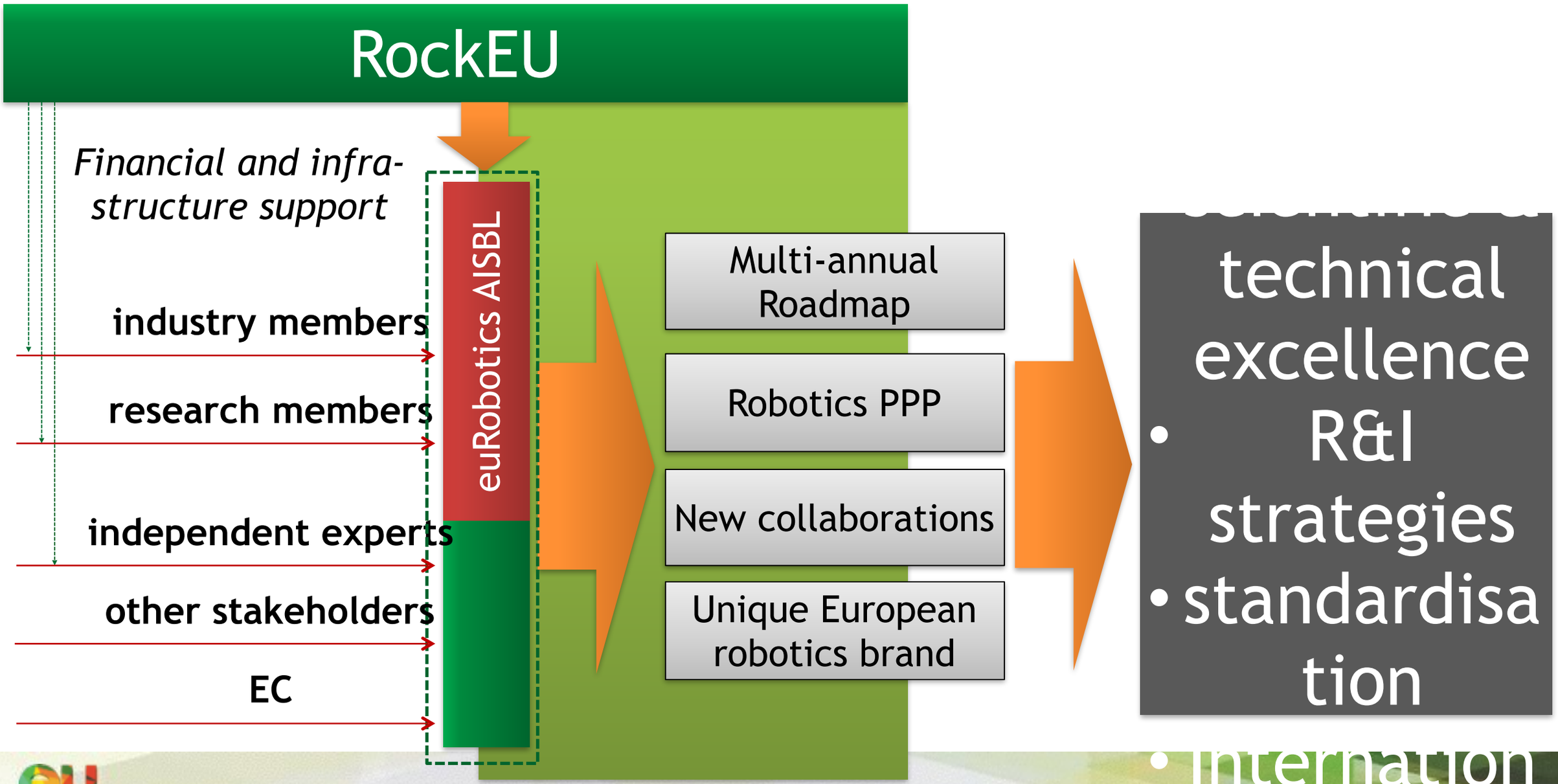
How RockEU supports euRobotics & the PPP

Robotics Coordination Action for Europe

Dr. Tim Guhl (KUKA Laboratories GmbH)

Overall project concept

RockEU brings together all stakeholders for sustainable impacts



Who can claim funding?

- RockEU partners for their tasks as described in the grant agreement
- Contributors “where the necessary contributions clearly exceed what can be expected as in-kind contributions” (quote from RockEU grant agreement)
  - This principle applies to RockEU partners and external experts alike
  - Experts do not have to be members of euRobotics AISBL
  - Directors may claim for their contributions, where these exceed what can be expected (*)
  - Only for tasks described in RockEU grant agreement
- RockEU partners can only claim from their budget (not from expert budget)

euRobotics function	Claim funding?	Prerequisite
President & Vice Presidents	***No***	
Directors	***No***	
Task Force Leaders	***Yes***	***RockEU task; exceeds in-kind contribution***
Task Force Contributors	***Yes***	***RockEU task; exceeds in-kind contribution***
Topic Group Coordinators	***Yes***	***RockEU task; exceeds in-kind contribution***
Topic Group Contributors	***Yes***	***RockEU task; exceeds in-kind contribution***

Roles

- RockEU Task Leaders
  - Decide which contributions they need to fulfil their tasks
  - Obtain these from consortium and/or experts
  - Agree expert contracts with experts (subject to budget and approval)
  - Set up subcontracts (subject to budget and approval)
- Topic Group Coordinators
  - Decide which contributions they need to fulfil their tasks
  - Obtain these from consortium and/or experts
  - Agree expenditures with RockEU Task Leader (Roadmap: D. Bisset)
- Experts
  - Can offer their services to Task Leaders or Topic Group Coordinators

Roles (cont.)

- euRobotics Secretariat (as RockEU Project Office)
  - Sets up expert contracts as instructed by RockEU Task Leaders
  - Makes payment once work is approved by RockEU Task Leader
  - Arranges meetings (e.g. consensus meetings)
- euRobotics Board of Directors (BoD)
  - Can suggest further tasks for which funding would be desirable
  - Can suggest to change tasks to adjust to new situations
- RockEU General Assembly (with EC approval if required)
  - Approves expert contracts and subcontracts suggested by RockEU Task Leaders when out of approval/budget scope
  - Decides upon BoD suggestions where budget or partner tasks are concerned
  - Re-allocates budget as required by project progress

What can be claimed?

- “where the necessary contributions clearly exceed what can be expected as in-kind contributions” such as:
  - Contributing excessively to Topic Group
  - Combining/condensing/formatting input from Topic Group Contributors for SRA / MAR
  - Preparing and running a Topic Group workshop
  - Representing Topic Group at BoD meetings / consensus workshops
- Travel Costs and / or Work Time
  - Work: €425 / day
  - Travel:
    - 2nd Class rail fares or Economy air fares
    - Accommodation up to €100 / night
    - Subsistence of €70 / day

Flow Chart Experts Contracts

*) - if VAT included: only limited possibilities to get it funded from EC
- should be handed in by 30 June 2016 at latest

Next Steps in MAR Development

Tasks for MAR Development

- Domain sections need to be synchronised with Ability Levels and Technology Step Changes
  - Need to be able to see their needs reflected in Ability Levels
- Technology sections need to identify and characterise Step Changes.
  - And refine the definition
- Need to identify any missing material.
  - Edit from TG input may have lost critical content.
- Need to identify gaps in coverage.
- Need to sharpen content and revise anything that is unclear.
- Improve cross links between sections
- Review consistency of content.

Technology sections

- Need to:
  - Identify step changes
  - and help refine Step Change definition
- Link step changes to Abilities
  - and help refine ability step definitions.
  - Identify impact on Ability Parameters
  - Identify links to other technologies
  - Impact “to” and “from”

Domain Sections

- Need to:
  - Align requirements to ability levels
    - and help refine level descriptions
    - Identify relationship to ability parameters
  - Sharpen technical statements

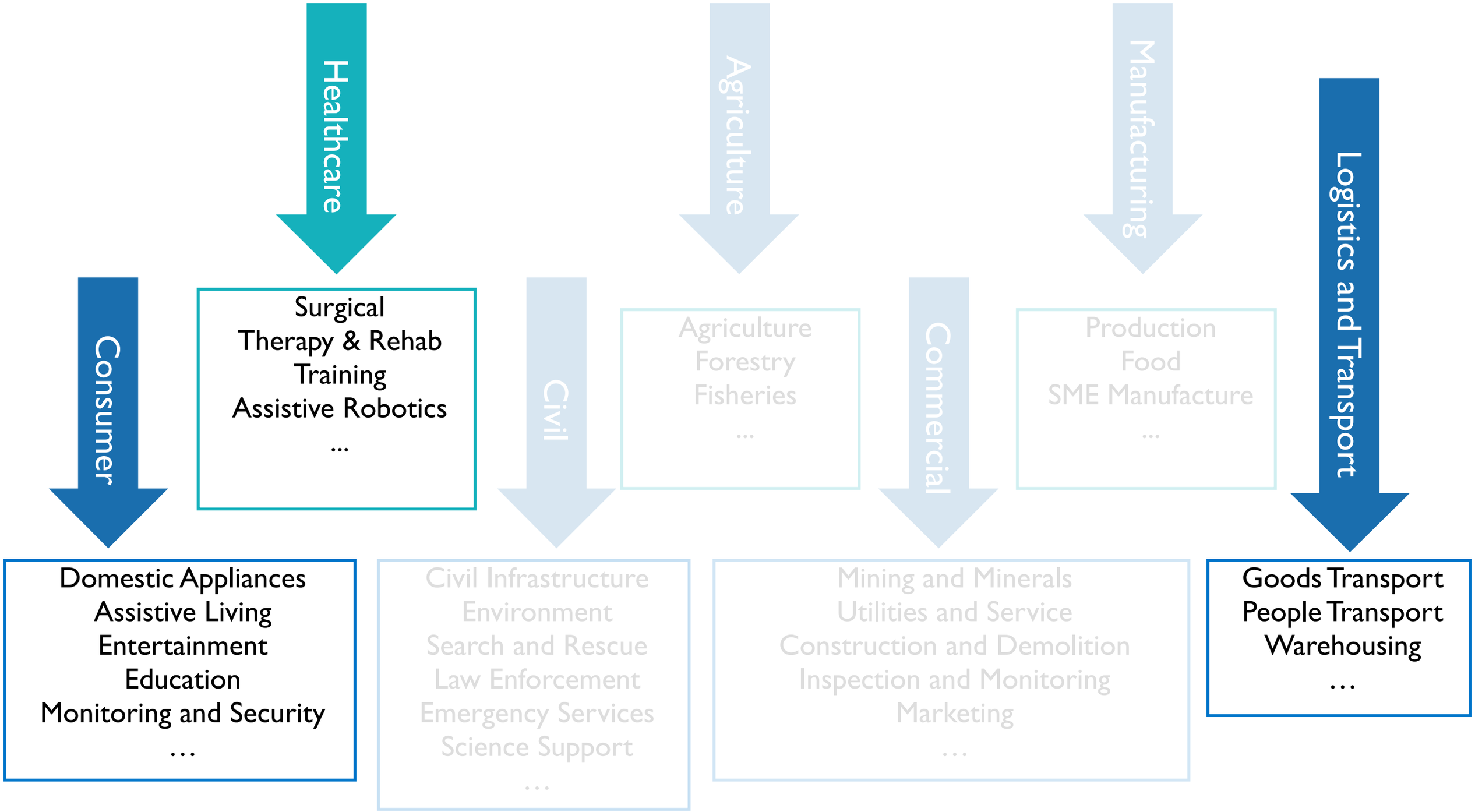
- Need to:
  - Align with technology step changes and their impact.

Robot Markets

- Are you properly represented within the Market Domains?
  - Make sure there are statements about opportunity that apply to your group
- Do the market domain Ability and Technology sections cover your requirements?
  - Can you identify Ability Levels that apply to you.

Editing the MAR for Call 2

Domains in Call 2 (ICT24)



Editing for Call 2

- Addition of missing Domains
  - Healthcare
  - Consumer
  - Logistics and Transport.
- Other domains should still update their content.
- Support for other call elements
  - PcPs in healthcare
  - Coordination Actions.
  - Call 1 vs Call 2 comparison document…

Editing Goals

- Sharpening of technical content.
- Improve cross linkage between sections.
- Identification of gaps
- Removal of unclear content.
- Topic Groups are the mechanism to do this…
  - Workshops throughout ERF should provide input.

Call 2 Development

- ERF Workshops
- Topic group submissions.
- Publication of Draft MAR
- MAR review prior to Call 2 Publication (May/June)
- Board of Directors Review (June/July)
- Publication of Call 2 MAR with opening of Call. (September)

System Ability

System Abilities

Configurability
Adaptability
Dependability

Manipulation Ability
Motion Capability
Interaction Capability

Perception Ability
Decisional Autonomy
Cognitive Ability

Domains

Requirements

System Abilities

Capability

Technologies

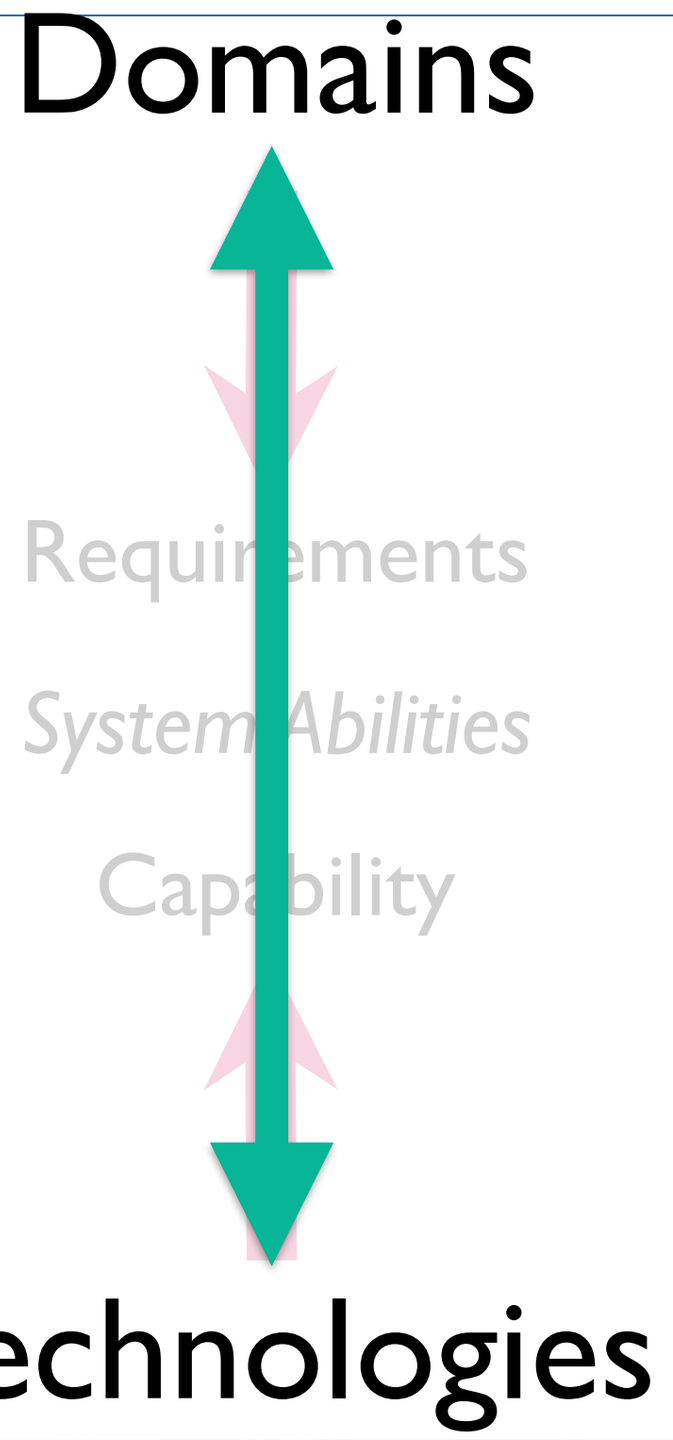
Configurability
Adaptability
Dependability

Manipulation Ability
Motion Ability
Interaction Ability

Perception Ability
Decisional Autonomy
Cognitive Ability

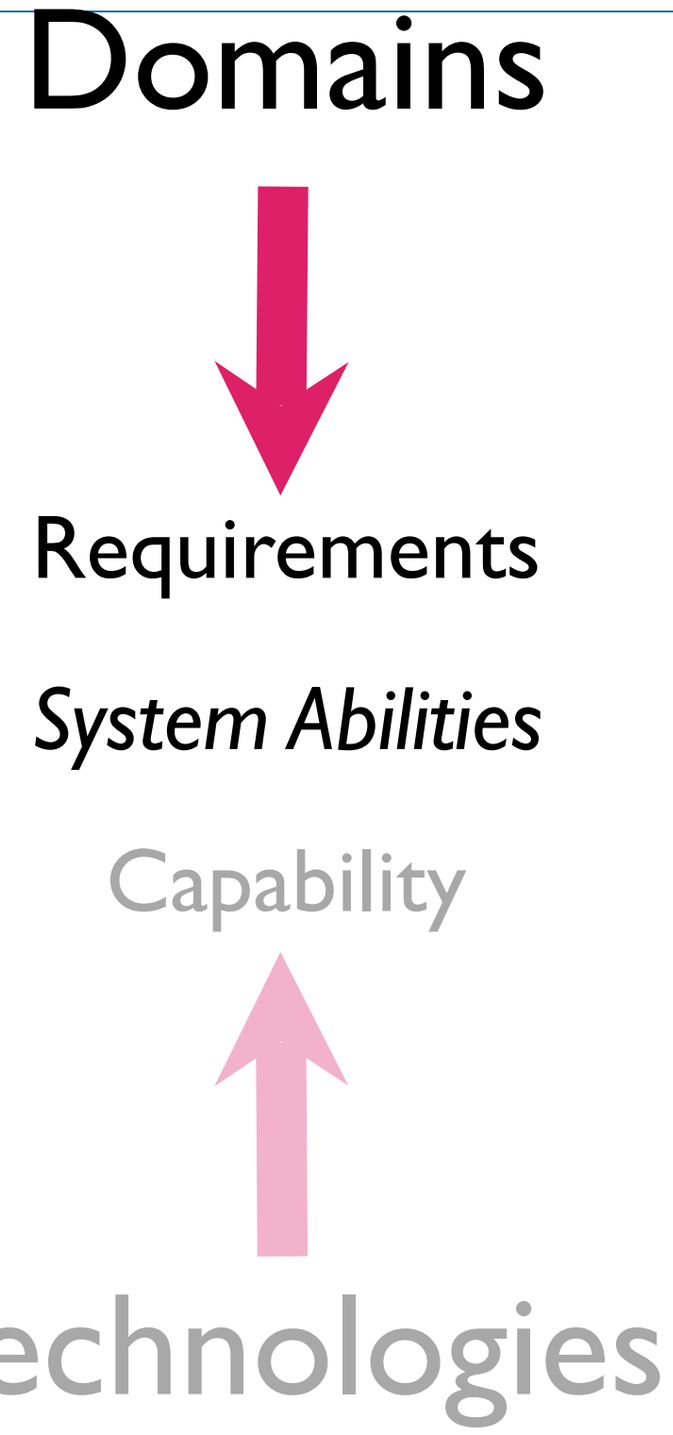
Purpose of the MAR

- The MAR scopes R&D&I activity within the PPP.
- H2020 is closer to market and roadmap driven.
- Therefore:
  - Need to be able to find “paths” linking technologies to applications.
    - to identify the impact of R&D&I actions.
  - Without defining the individual applications
  - their solutions.
  - or their implementations.



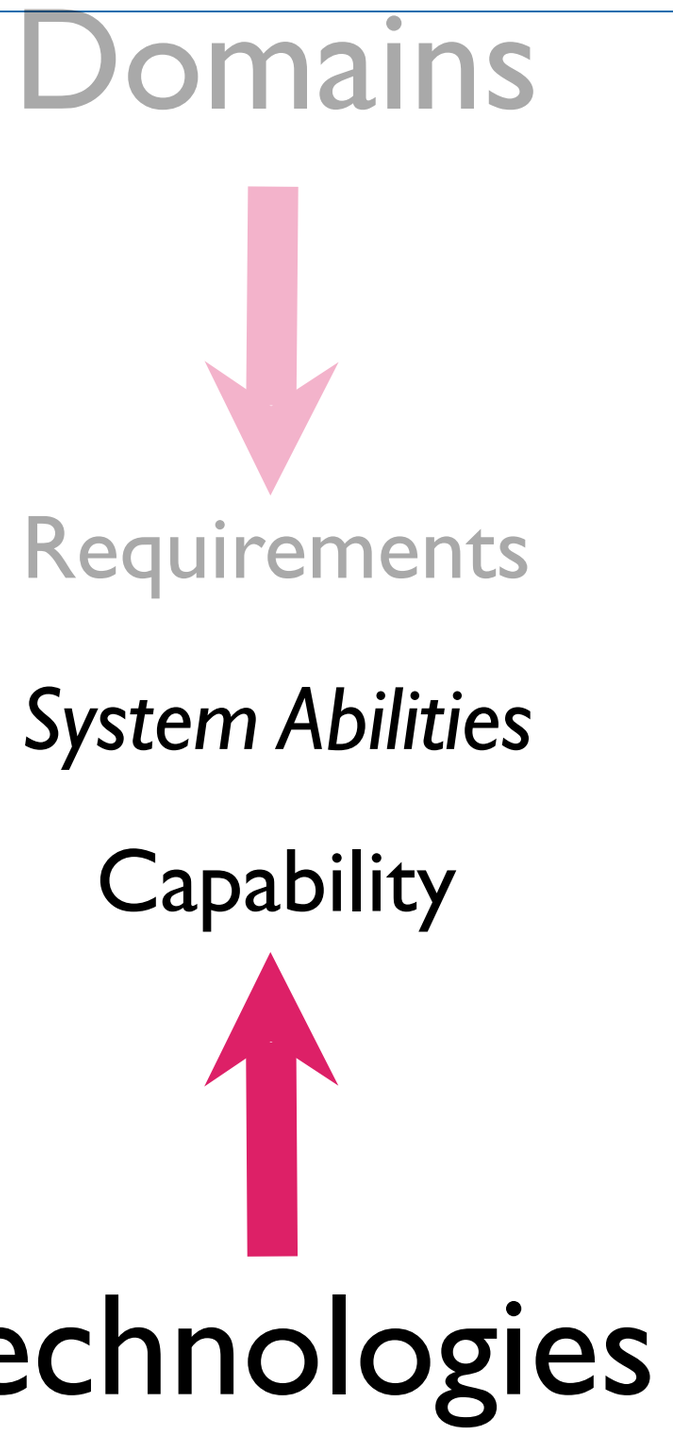
From a Market Domain Perspective (Top down)

- Technical step changes enable applications and markets.
  - BUT, it is difficult to identify exactly which technologies will enable an application.
    - Different combinations may work equally well
    - Or the key technology may not yet exist.
- It is easier to identify the relationship between application requirement and System Ability.
  - Makes specification “technology independent”
  - Allows for future novel and disruptive technical steps.



From a technology perspective (Bottom Up)

- It can be difficult to see how a technical Step Change impacts on a market.
  - It may impact on many markets, unequally.
  - It may enable a market that doesn't yet exist or it may create a disruption (chaotic step) that is difficult to predict.
- By connecting technologies to System Abilities (both levels and parameters) it is possible to see:
  - the impact of a step change
  - in a domain independent way



System Abilities

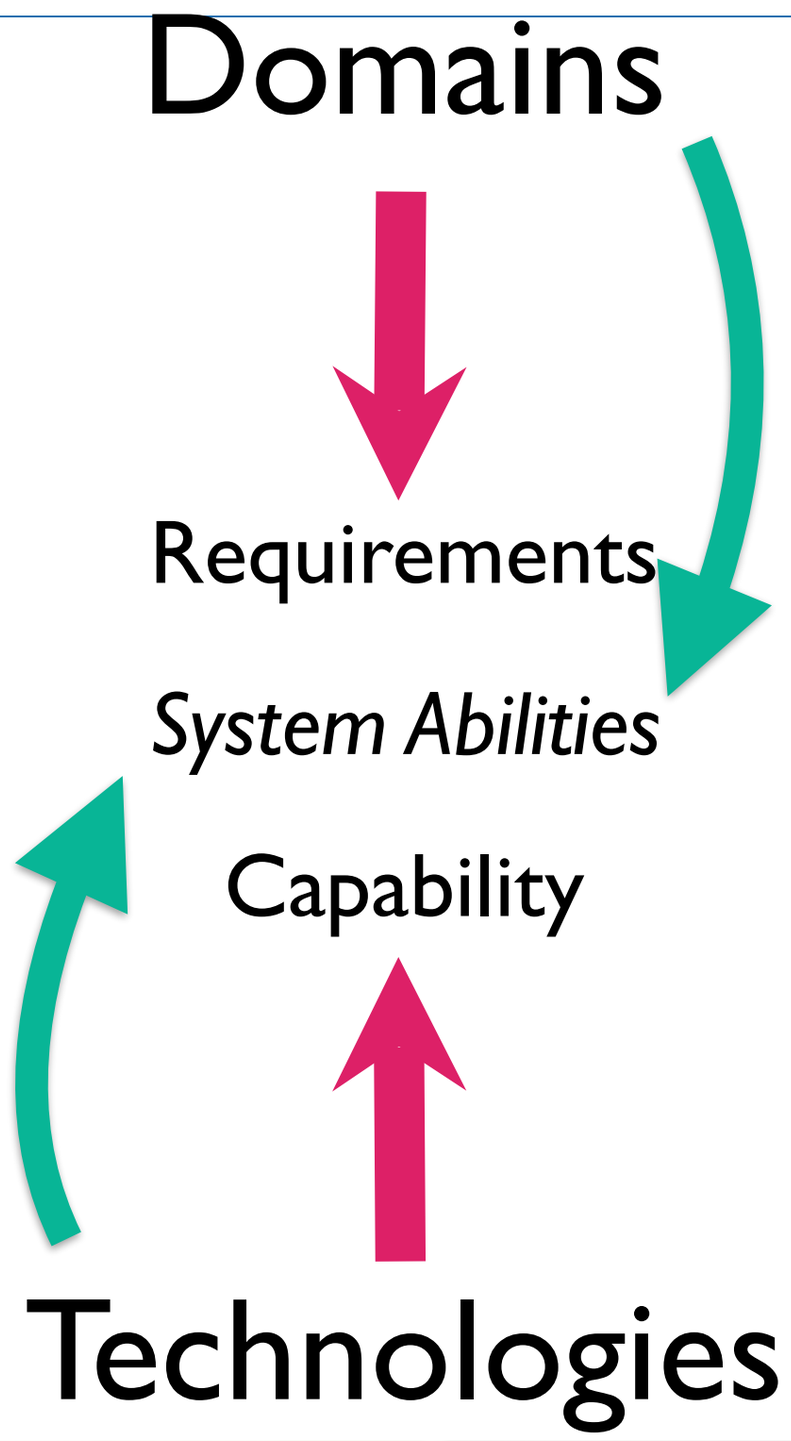
Configurability
Adaptability
Dependability

Manipulation Ability
Motion Capability
Interaction Capability

Perception Ability
Decisional Autonomy
Cognitive Ability

System Abilities

- A domain and technology independent way to characterise requirements and capability using the same terminology.
- By creating links between
  - application requirements and ability levels
  - technologies and ability levels
- Creates a rich set of links between Domains and Technologies
  - Without the need to define individual applications or implementations.



System Ability Levels

System Ability Levels

- Each Ability is divided into “Ability Components”
- Ability Components have “Ability Levels”
- Ability Components can have “Ability Parameters”

Validating System Ability Levels

- Ability levels are new
- They are detailed in the MAR.
  - Derived from Domain expectations of system performance.
  - Each level provides **successive** increments in system ability.
- Levels mostly subsume the previous abilities.

System Ability Components

Configurability:	Mechatronic Configuration
Adaptability:	Adaptability
Dependability:	Failure Dependability
	Functional Dependability
	Environment Dependability
	Interaction Dependability

Motion and Interaction Abilities

Manipulation Ability:	Manipulation Ability
Motion Capability:	Motion Capability
Interaction Capability:	Human Robot Interaction Robot Robot Interaction Human Robot Interaction Safety

Action and Awareness Abilities

Perception Ability:	Perception Ability
	Tracking Ability
	Recognition Ability
	Scene perception
	Location perception
Decisional Autonomy:	Decisional Autonomy
Cognitive Ability:	Action Ability
	Interpretive Ability
	Envisioning Ability
	Learning Ability
	Reasoning Ability

Perception Ability

- Divided into five components:
  - Perception ability
  - Tracking ability
  - Recognition ability
  - Scene perception
  - Location perception
- And five Parameters:
  - Object orientation
  - Object composition
  - Scale and range
  - Object types
  - Environment

Tracking Ability

Level 0 - No tracking

Some robots will be able to carry out their tasks without any tracking ability.

Level 1 - Tracked Feature Perception

Features detected in the sense data are tracked over time. The tracking of features is used to build internal models of the environment. The tracking of markers in the environment is equivalent to tracking derived features.

Level 2 - Static Object tracking

It is possible to track a detected object. The detected location of the object can be maintained with a reliability and accuracy that is compatible with the task.

Level 3 - Dynamic object tracking

It is possible to identify an object and track it using sense data. As the object moves the system is able to disambiguate the motion of the robot from the motion of the object.

Level 4 - Flexible object tracking

It is possible to identify a flexible or deformable object and track it.

Level 5 - Animate objects

It is possible to identify and track an animate object and extract the pose of the object.

Object Recognition Levels

- **Level 0 - No Recognition**
- The robot system does not need to detect or recognise objects in the environment in order to carry out its task.
- **Level 1 - Feature detection**
- Sense data is gathered from a region of the environment such that the data has a spatial component and can be mapped to a model of that region. The richness of the sense data is such that it is possible to apply a feature detection process to create a set or sets of features that persist.
- **Level 2 - Object detection**
- Multiple persistent features can be grouped to build models of distinct objects allowing objects to be differentiated from each other and from the environment.
- **Level 3 - Object recognition - single instance**
- Object models created from sense data can be matched to specific known instances of an object with a reliability that is appropriate to the task.
- **Level 4 - Object Recognition - one of many.**
- Object models created from sense data can be matched to one of a number of specific known objects with a reliability that is appropriate to the task.

- **Level 5 - Parameterised object recognition.**
- Object models created from sense data can be matched to a number of known, parameterised object types. The settings for the parameters (e.g. size ratio, curvature, joint position etc) can be deduced from the sensed object model. Note that in conjunction with single instance recognition ability this implies the ability to recognise a known (possibly learned) instance of a generic object, for example a particular brand of canned drink based on the generic recognition of a drinks can shape.
- **Level 6 - Context based recognition**
- The system is able to use its knowledge of context or location to improve its ability to recognise objects by reducing ambiguities through expectations based on location or context.
- **Level 7 - Novelty Recognition**
- The system is able to recognise novelty in a known object, or parameterised object type. For example a known mug where the handle is missing or broken.
- **Level 8 - Unknown object categorisation (Rigid)**
- The system is able to assess an unknown rigid object based on sense data and deduce properties that are relevant to the task.

- **Level 9 - Object property detection**
- It is possible to use sense data and the derived object model to deduce the properties of an object. For example analysis of the sense data may provide surface texture information, knowledge about deformability, or the content of an object.
- **Level 10 - Flexible object detection**
- The system is able to detect the shape and form of objects that are deformable and generate parameterised models of flexible objects. This includes articulated objects and objects with flexible and rigid components.
- **Level 11 - Flexible object classification**
- The system is able to classify flexible objects by their properties and parameters. It is able to recognise specific known objects relevant to the task with an appropriate level of reliability.
- **Level 12 - Animate Objects**
- The system is able to detect animate objects and provide a classification appropriate to the task.
- **Level 13 - Pose estimation**
- The system is able to estimate the pose of an animate object within the environment.

Recognition parameters

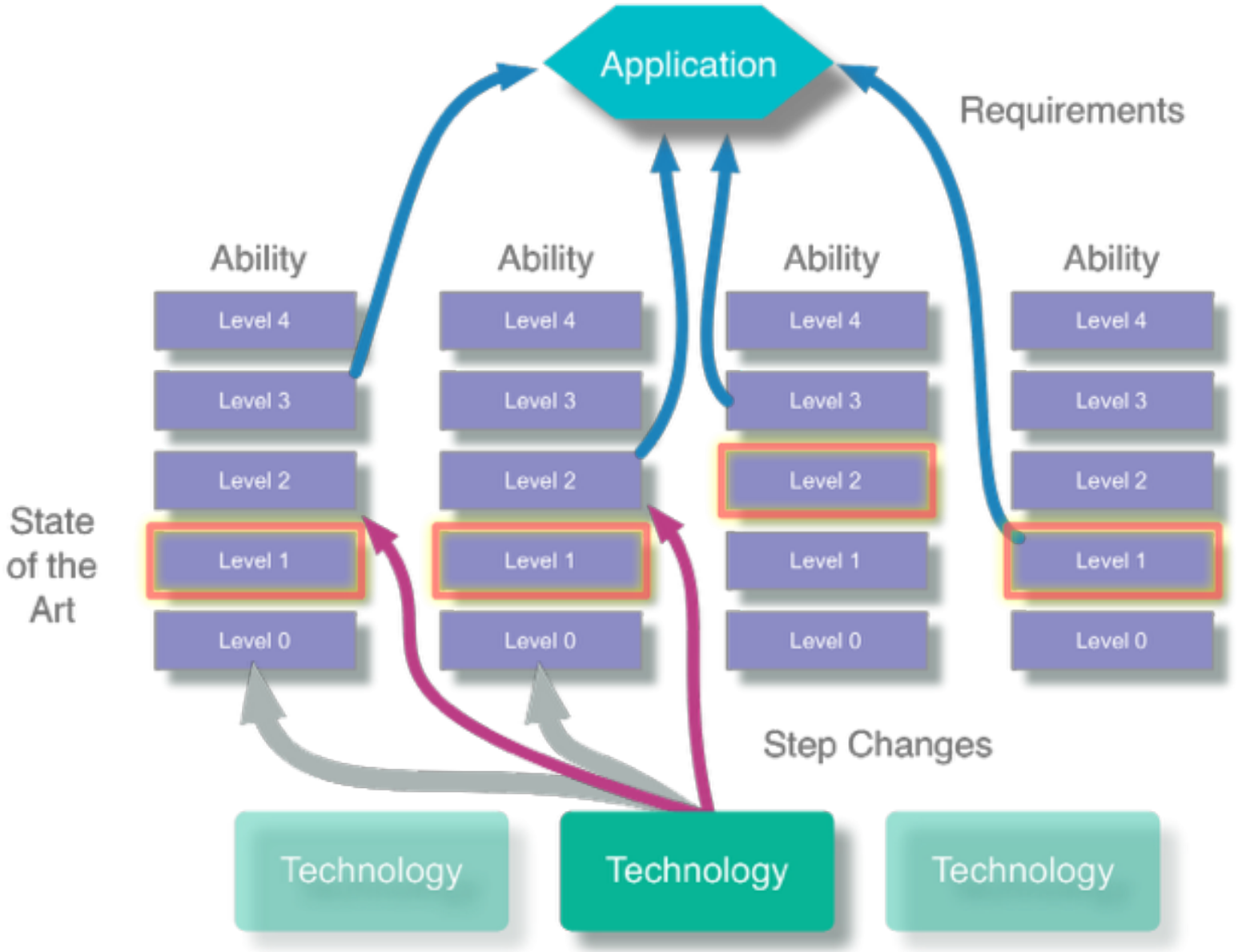
- *Object orientation:* Some tasks may only present objects within a limited range of orientations, in other tasks there may be considerable variability in orientation. The difficulty of recognising objects increases with the number of presented orientations.
- *Object composition:* Object surface variation, texture, reflectivity, transparency, patterning etc. All affect the difficult of performing object recognition. Reflections and patterns are an integral part of everyday objects and can present significant difficulty.
- *Scale and range:* Some objects may be visible within a single field of view larger objects may require a sequence of views to enable recognition. The identification of scale and range in relation to sense data is also a key component in recognition performance.
- *Object types:* Recognition ability will depend on the number of different object types that must be disambiguated and the sensitivity of the recognition process to similarities between the objects.
- *Environment:* Nearly all sensors are affected by environmental factors, either directly (e.g. the use of vision systems in bright sunlight) or indirectly (e.g. the sound of rain hitting a window in acoustic recognition).

Domains and Ability Levels

- Identify the sets of levels needed in an application.
  - Robot vacuum cleaner needs
    - *Perception Tracking Ability-Level 1 – Tracked feature perception*
    - *Location Perception at Level x*
    - *Motion Capability at Level y*
    - *…*
  - Cloth handling robot needs Level 4
    - *Perception Tracking Ability-Level 4 – Flexible object tracking*
    - *…*

Domains and Ability Levels (cont.)

- Applications can now be aligned to:
  - Multiple ability levels
  - Ability parameters.
- When compared to the “state of the art” Levels
  - Gives an indication of feasibility.

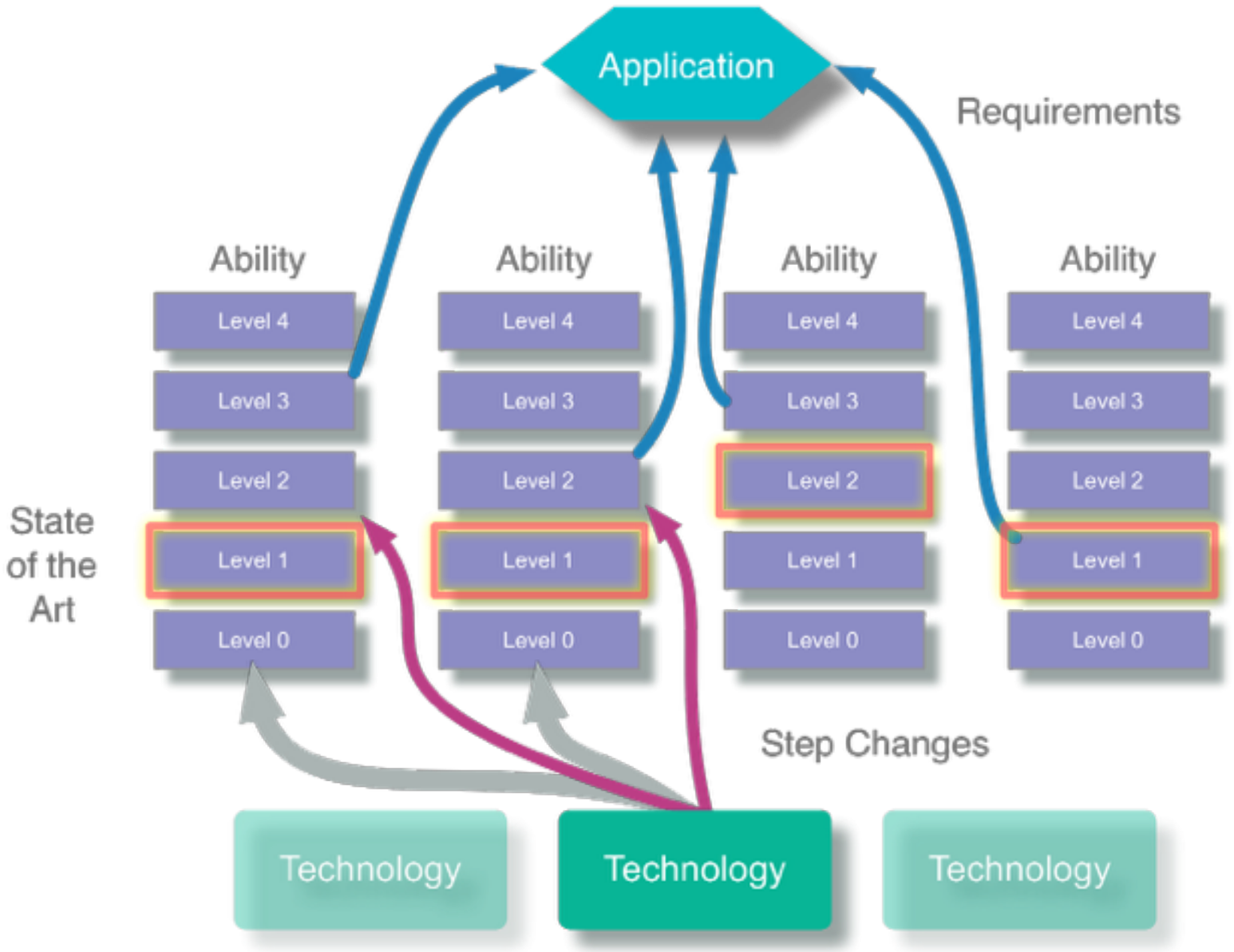

Application
Requirements
Ability
Ability
Ability
Ability
Level 4
Level 3
Level 2
Level 1
Level 0
State of the Art
Step Changes
Technology
Technology
Technology

TASK: Validating Ability Levels

TASK: Validating Ability Levels

- One “Team” per ability level
  - Focus on abilities you understand.
- Level descriptions should be technology independent and application/domain independent.
- Take the Ability Level Descriptions
  - Work through the levels.
    - Are there any missing levels?
    - Are they in an acceptable order of progression?
    - Do the descriptions make sense?
    - Are the level names consistent and acceptable.
  - Read through the parameters.
    - Are there any missing parameters?
    - Do the parameter descriptions make sense?

Domains and Ability Levels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- Need to align Domain sections with Ability Sections

Domain Requirement	***Ability Levels***
Machines aware of each other's status.	Robot Robot Interaction: Level 2 Communication of Task Status

- Requirements should be application and technology independent.

- Sometimes the scope of the Ability Levels needs to be wider:

Domain Requirement	***Ability Levels***
Ability to identify boundaries, crop condition, objects including animate objects in fields, distinguish plant types and pests.	Perception Ability: Level 5-7 combined with Object Recognition Level 7: Novelty Recognition and Scene Perception: Level 4-5.

- Sometimes the Requirements will need to be split.

TASK: Refining Ability Links

- Domain Topic groups and Robot Market Groups should review their Ability mappings
- First make sure that requirements are independent of technologies.
- Add any new generic future requirements that are typical of your domain.
- Identify the Ability Levels and Parameters that characterise the requirement.

Step Changes

Domains

Applications

Requirements

Step Change

System Abilities

System

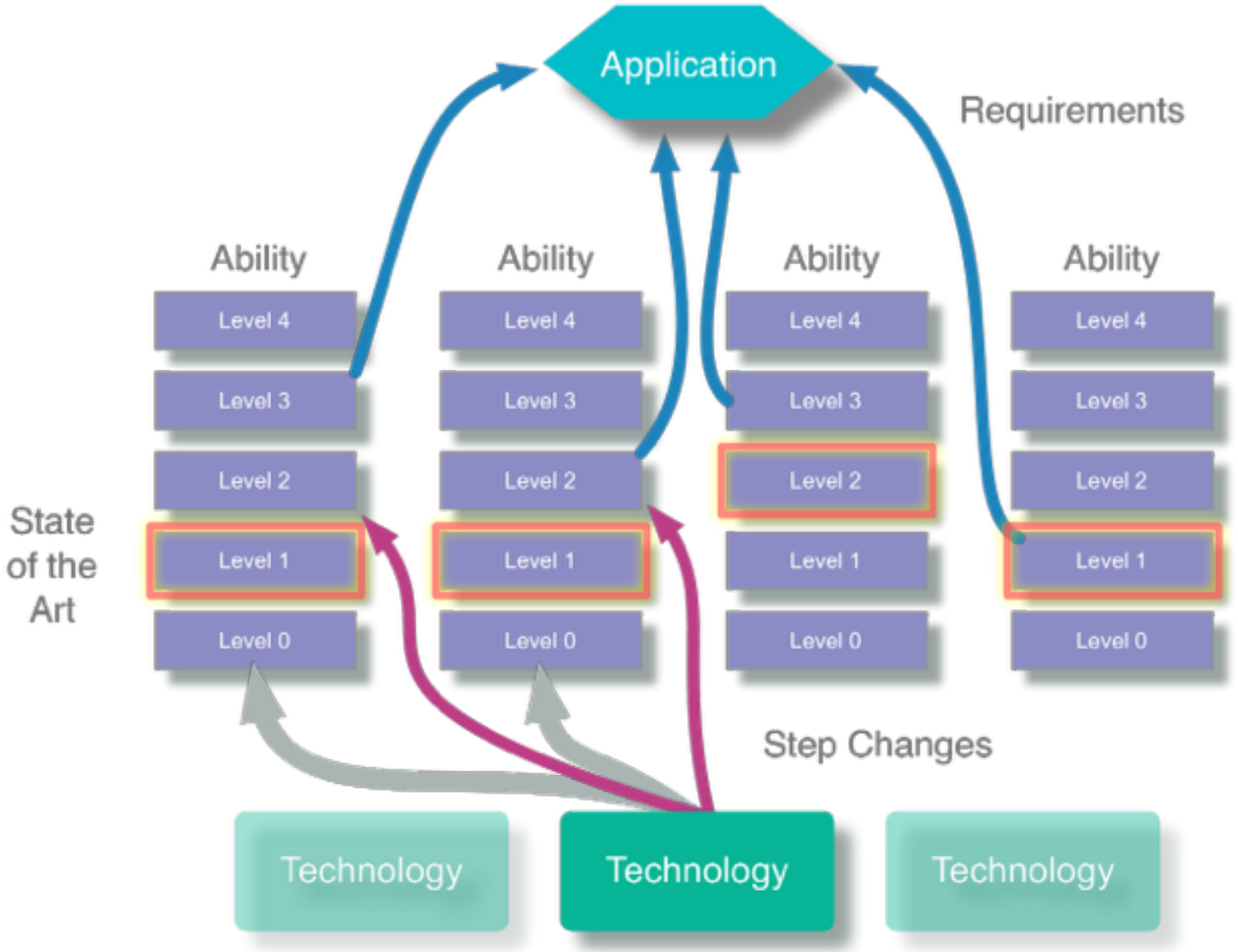
Technologies

What is a Step Change?

- It is important to define what a “Step Change” is.
- It is **not** incremental improvement.
- A “Step Change” is a significant improvement.
- It enables new market opportunities.

Proposed Step Change Definition

- A Step Change is:
- An multiplicative improvement. (x2 x5 x10)
  - cost reduction
  - parameter improvement
  - reduction in resource requirement
- Or categorical step in capability.
  - Moving from procedural to declarative controller
  - Specification developed by reasoning rather than hand construction
  - From rigid robots to joint compliant robots to segment compliant robots
  - Multi-scale integration of perception and control of base, arm, hand, finger systems.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Domains

Applications

Requirements

Step Change

System Abilities

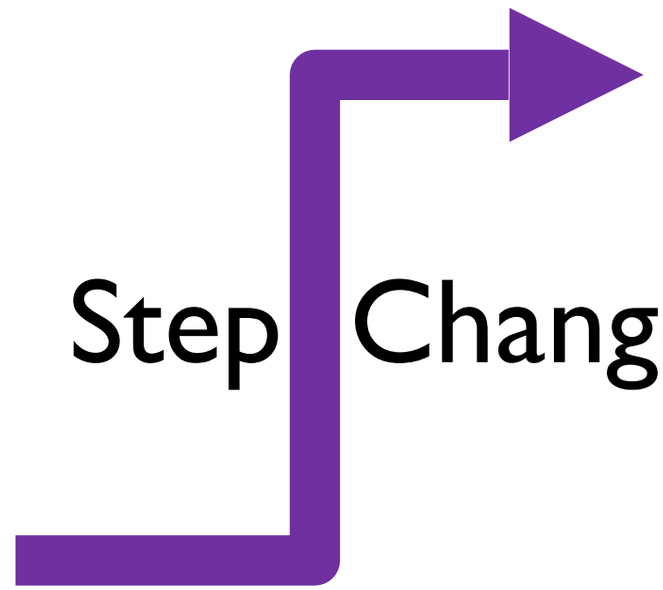
System

Technologies

What type of Step is it?

What is the end point?

What is the starting point?
(Evidence?)



How difficult is the Step?

Technologies

How big is the Step?
(Metrics?)

What are the technical dependencies?

What is the impact on System Ability?

What is the current progress?

Step Change

What is the impact on other Technologies?

Technologies

Step Change Impact

- Answering these questions
  - Characterises Technical Steps
- Builds links between Technologies
- Highlights the impact of Technologies on Abilities
- Helps identify R&D&I activity Impact
  - Establish linkage between Technology and Domains.
  - Sets focus for R&D&I activity.
  - Helps develop priorities.

Step Changes and R&D&I Actions

- It is suggested that:
  - A small proposal should solve one step change.
  - A large project several smaller steps or one challenging step.

Or

  - At least one TRL increment from the state of the art.

- Gives clear guide line.
  - Terms need to be clearly defined.
- Opportunity to make future call texts focus on large steps as an exception.

TASK: Step Changes

- Technology TGs per Technology Cluster.
- Identify metrics that might make Step Changes
- Identify categorical steps
- Identify and describe Step Changes.
  - Characterise the Steps by the following questions…

Step Change Questions

- What type of step is it?
- What is the starting point?
  - Metric? State of the Art evidence?
- What is the end point?
- How big is the step?
- How difficult is the step?
- What are technical dependencies?
- Where does the step impact on System Abilities?
- What is the impact on other Technologies?
- What is the current progress?

Domain Independent
Implementation Independent
Technique Independent