ARM
ADVANCED ROBOTICS
FOR MANUFACTURING

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ASME INTRODUCTORY METING

ARNOLD KRAVITZ, ARM CTO

ARM

ARM Nature, Mission, and Method

Nature

- Public-private partnership

Mission;

- Increase U.S. global manufacturing competitiveness

Method:

- Develop a strategy based on investing in the most urgent and important Key enabling technologies for Robotic Manufacturing

ARM

Invest about $21 M /yr on 21 projects to advance the art of robotic manufacturing

MANUFACTURING USA INSTITUTES

The Digital Manufacturing Institute
Digital Manufacturing & Design
Chicago, IL

REMADE INSTITUTE
Sustainable Manufacturing
Rochester, NY

AIM photonics
Integrated Photonics
Albany, NY
Rochester, NY

biofabusa
Regenerative Manufacturing
Manchester, NH

affoa
Advanced Fibers and Textiles
Cambridge, MA

NEXTFLEX
Flexible Hybrid Electronics
San Jose, CA

CLEAN ENERGY SMART MANUFACTURING INNOVATION INSTITUTE
Smart Sensors and Digital Process Control
Los Angeles, CA

RAPID Transforming Process Industries
Modular Chemical Process Intensification
New York, NY

NIMBL
Bio-pharmaceutical Manufacturing
Newark, DE

lift
Lightweight Metals
Detroit, MI

America Makes
Additive Manufacturing
Youngstown, OH
El Paso, TX

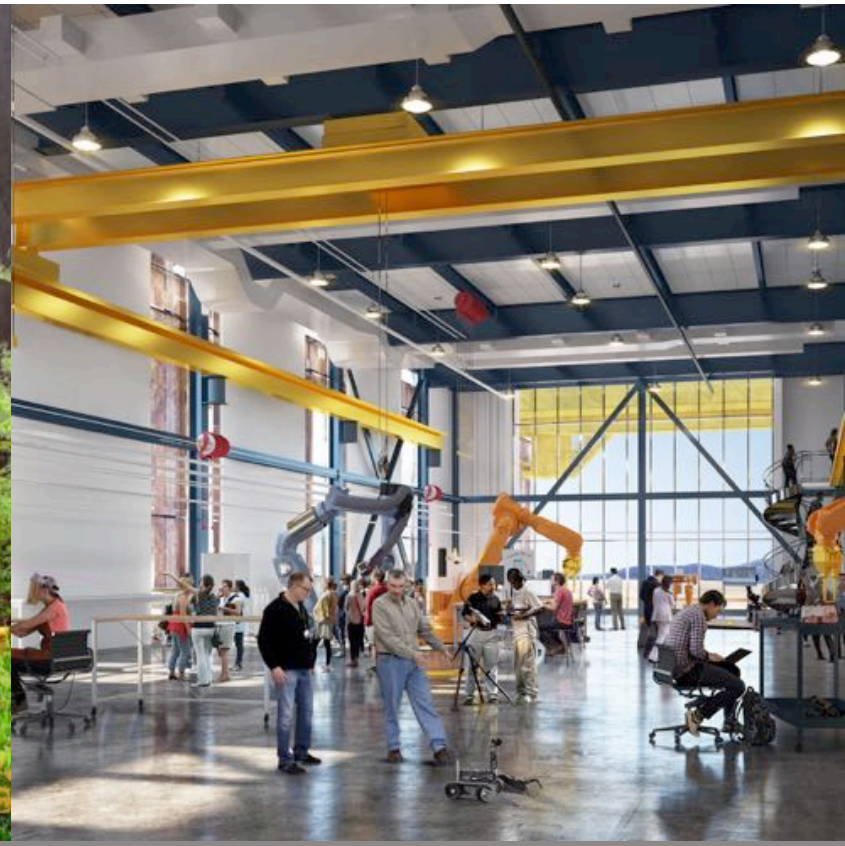
THE COMPOSITES iacmi INSTITUTE
Advanced Composites
Knoxville, TN
Detroit, MI

ARM Advanced Robotics
Pittsburgh, PA

PowerAmerica
Wide Bandgap Semiconductors
Raleigh, NC

ARM

ARM Formation

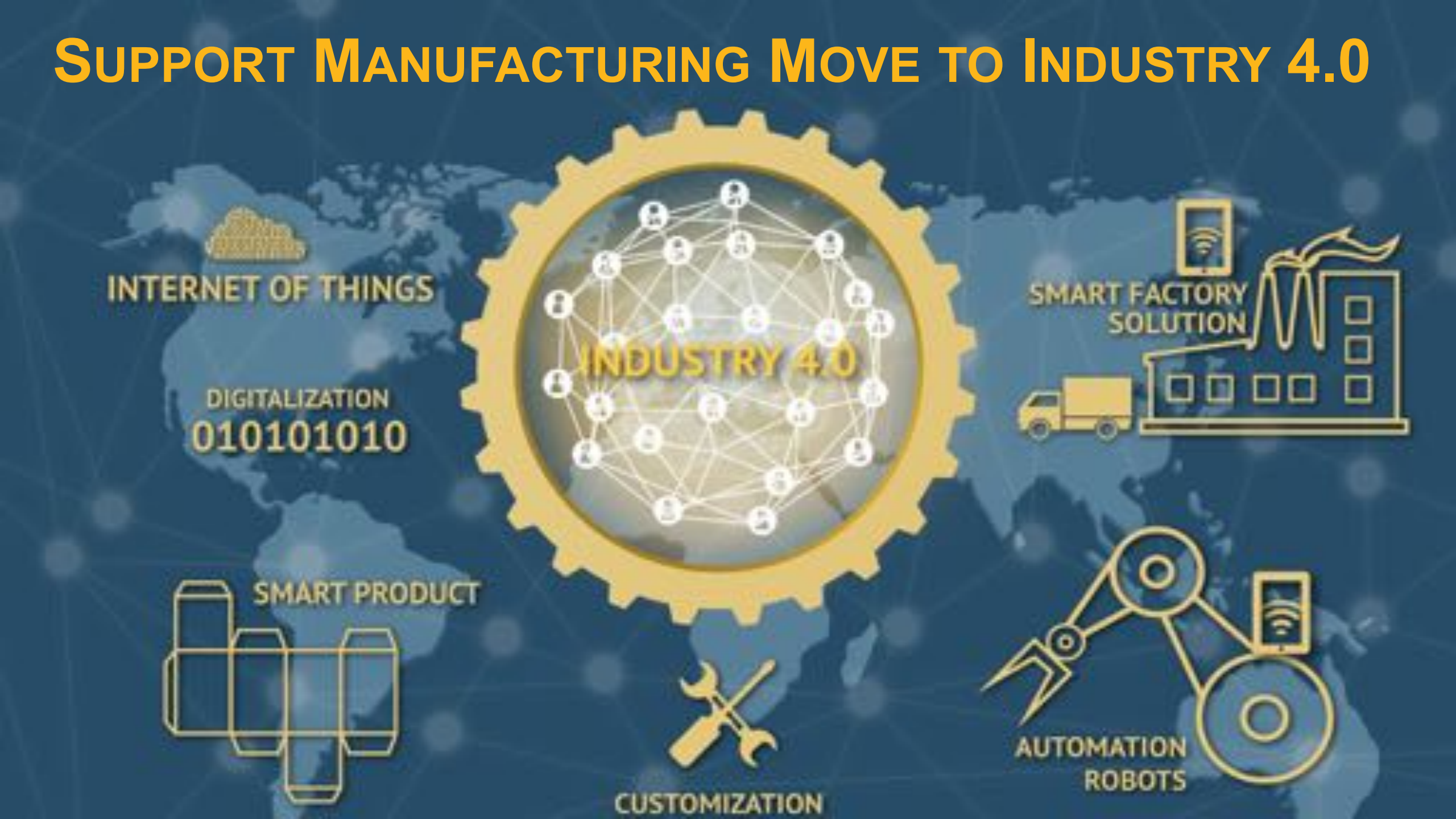


Established: Jan 13, 2017 by Carnegie Mellon University (now separate entity)

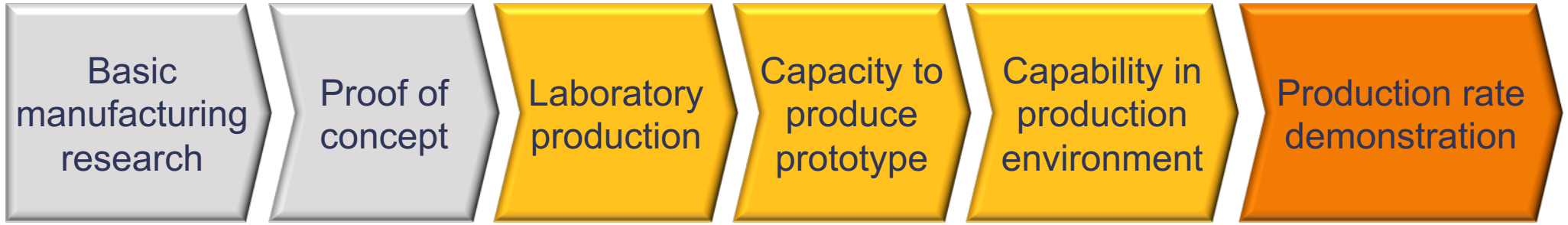
Location: Mill 19, Hazelwood Green, Pittsburgh, PA

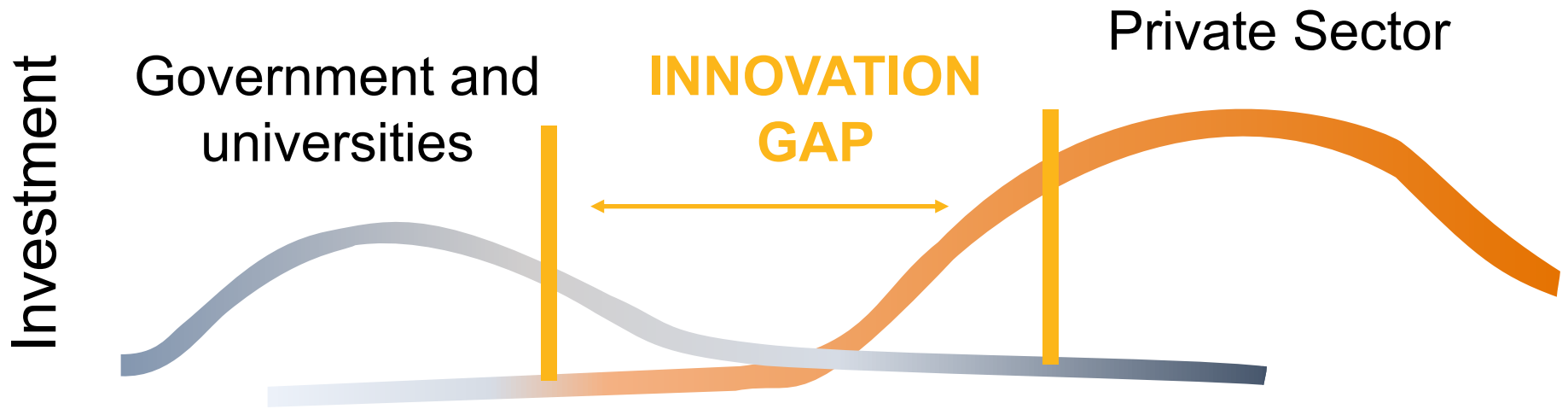
ARM

SUPPORT MANUFACTURING MOVE TO INDUSTRY 4.0



HELP BRIDGE MANUFACTURING INNOVATION GAP





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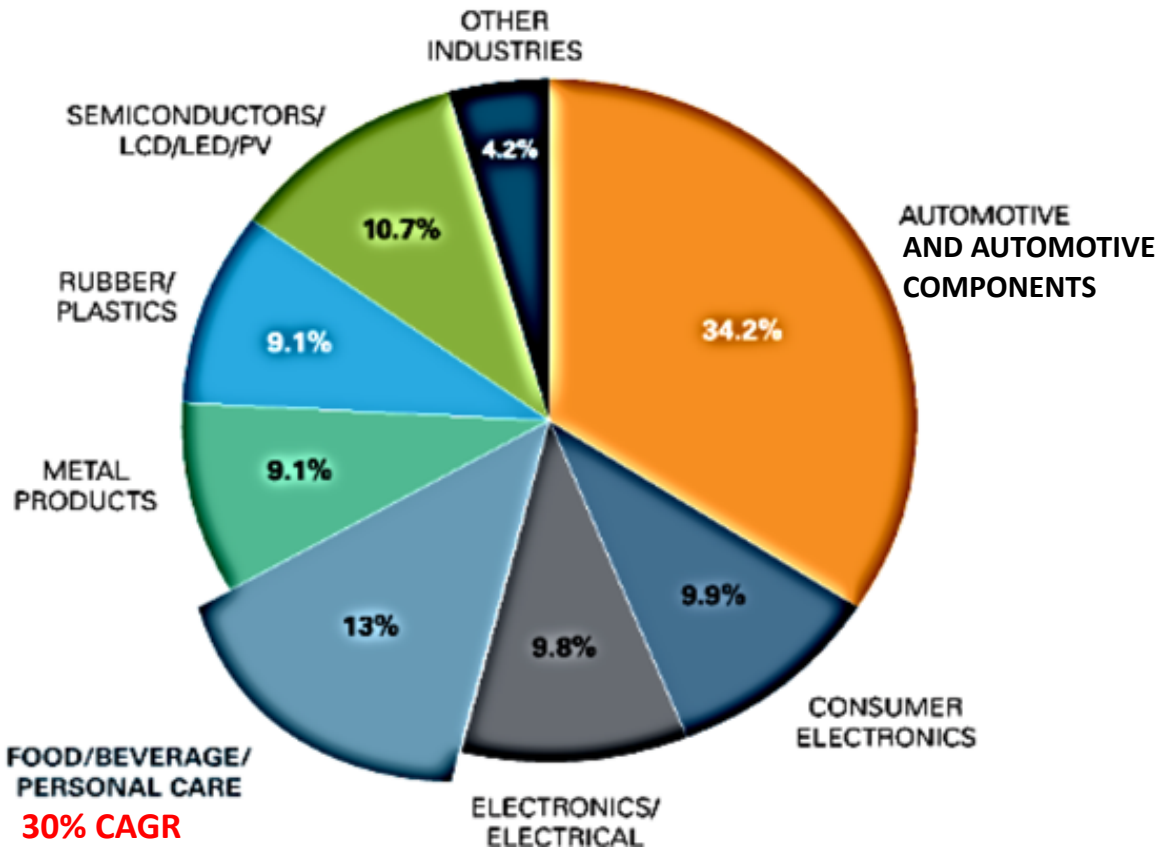
Drive Impact Across Multiple Key Sectors

ROBOTIC MANUFACTURING MARKET SEGMENT REV AND CAGR

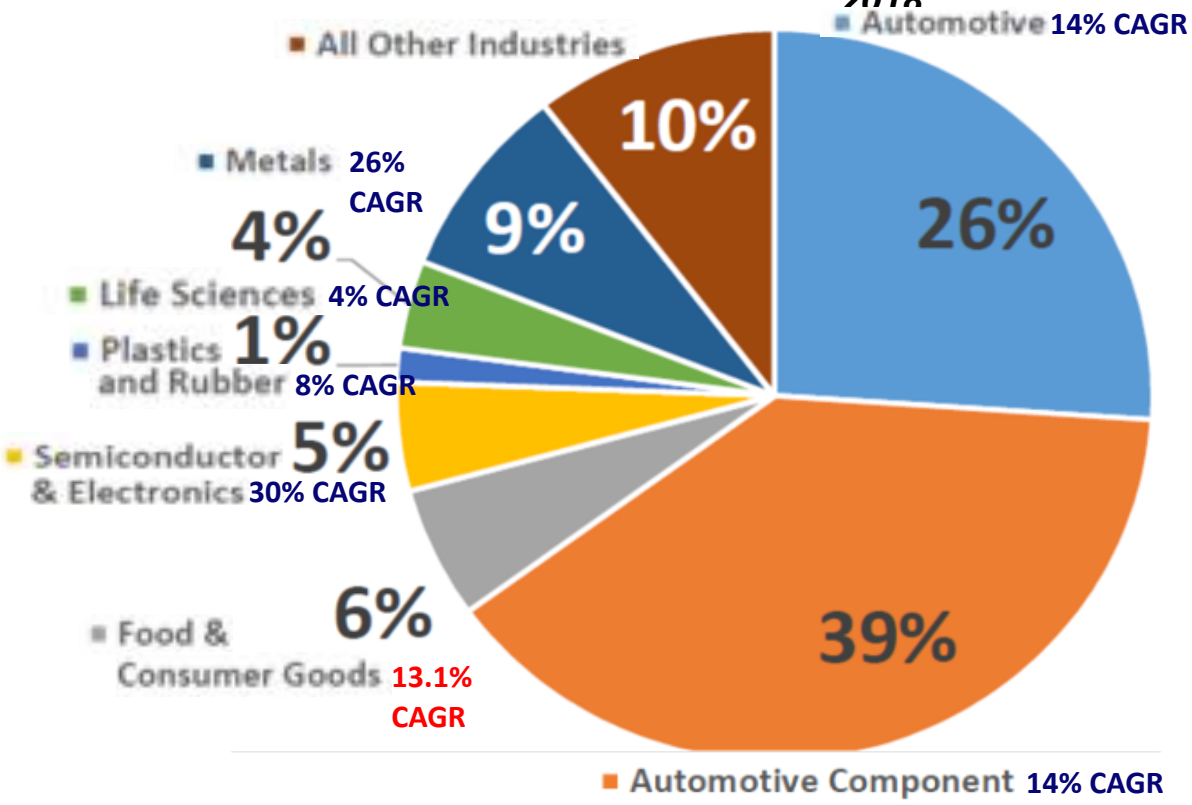
America

Source: HIS market



Global

Source: RIA and PR world robotics 2018



US vs Global Market Differences: Automotive (34% vs 65%), Semi conductor & electronics (31% vs 5%,) Food (13% vs 6%)

- *US sales- Auto (34%), Semi Conductor and Electronics (31%), Food Processing (13%)*
- *US CAGR– Food Processing (30%),Semi Conductor (30%)Metals 26% Auto 14%*

ARM

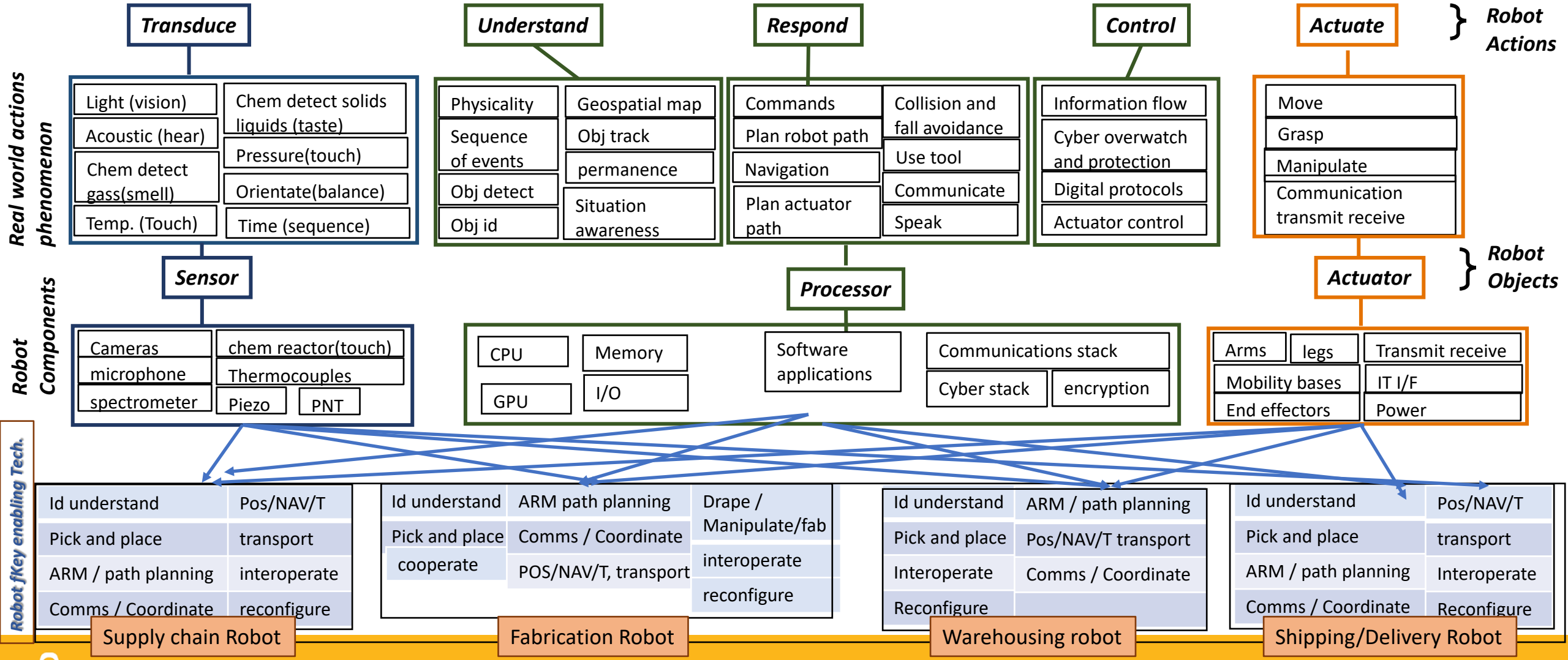
Strategic thrusts

1. *Assert leadership in advanced robotics manufacturing thru achievement*
2. *Lower the technical, operational, economic and regulatory barriers hindering companies from adopting robotics technologies*
3. *Deploy workers in a way that is cost-competitive with low-wage workers abroad*
4. *Aid in the creation sustenance and societal understanding of the value of manufacturing jobs*

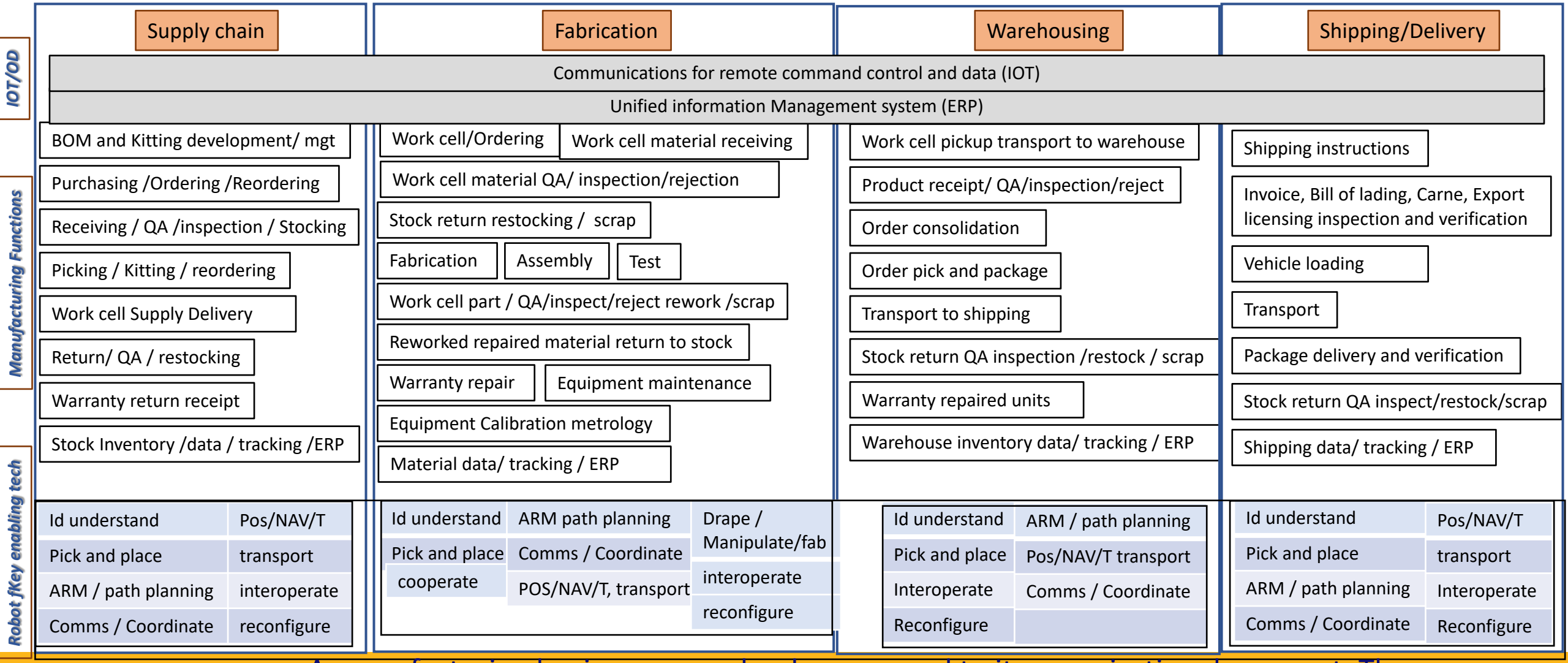
Tactics

1. **Identify and invest** in Key Enabling **Technologies** with large market lift
2. **Educate**, train and develop a **workforce** to use the robotic technology
3. **Nurture** and sustain a robotic manufacturing infrastructure and **ecosystem**

DEFINITION OF A ROBOT.



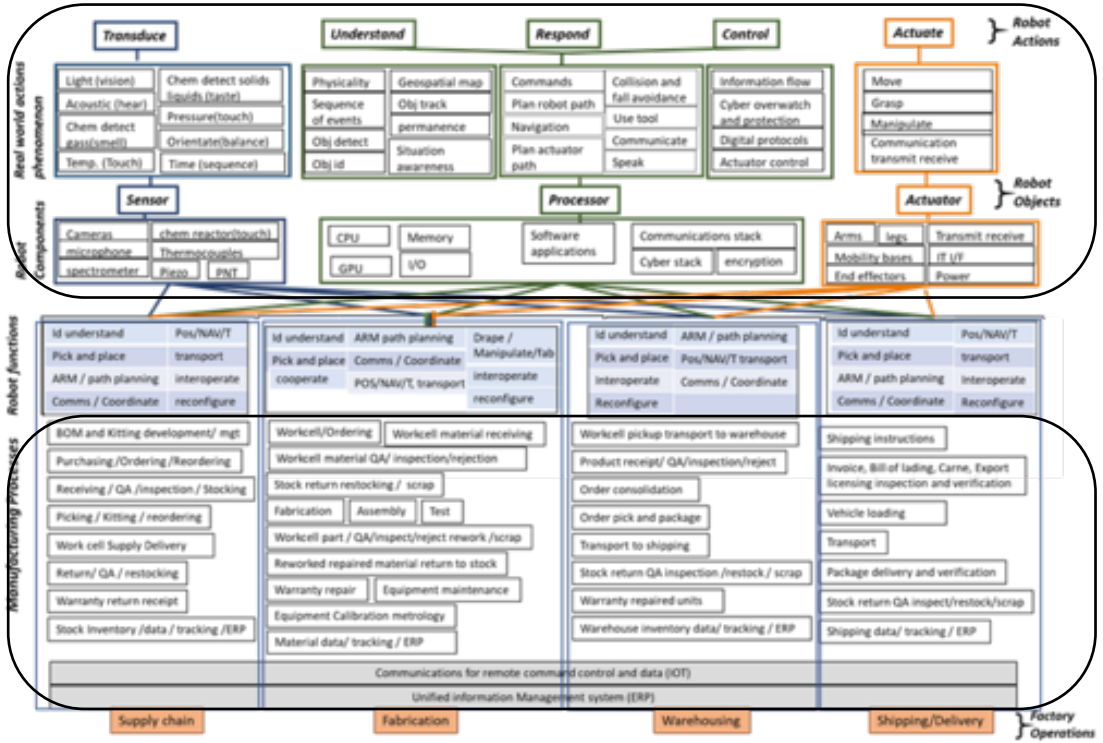
DEFINITION OF A MANUFACTURING ORGANIZATION



A manufacturing businesses can be decomposed to its organizational segment. The key processes for each segment are identified, and the key functions and enabling technology can then be deduced

DERIVATION OF 4 KEY TECHNICAL FOCUS AREAS THAT ENABLE THE GROWTH IN FOR ROBOTIC MANUFACTURING

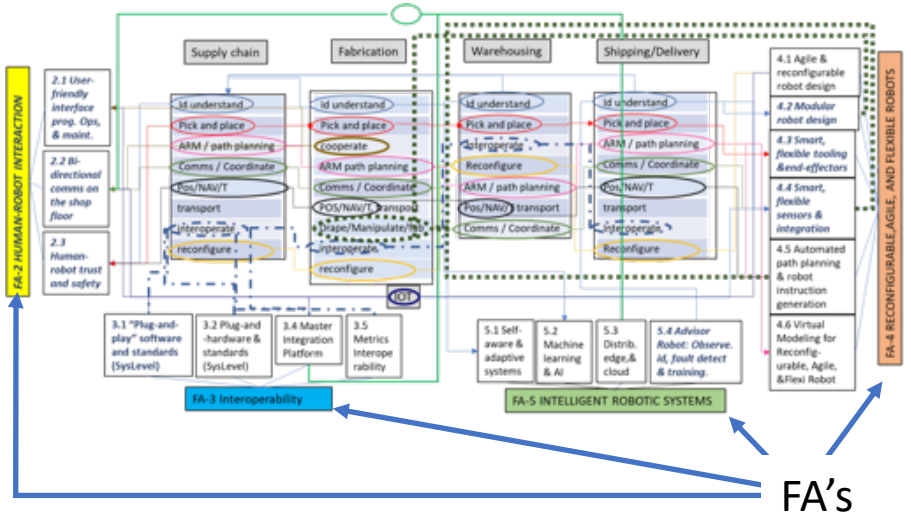
Functional and Physical decomposition of a manufacturing environment to a manufacturing robot



Functional and Physical decomposition of a manufacturing business to a manufacturing robot

Key Functionality

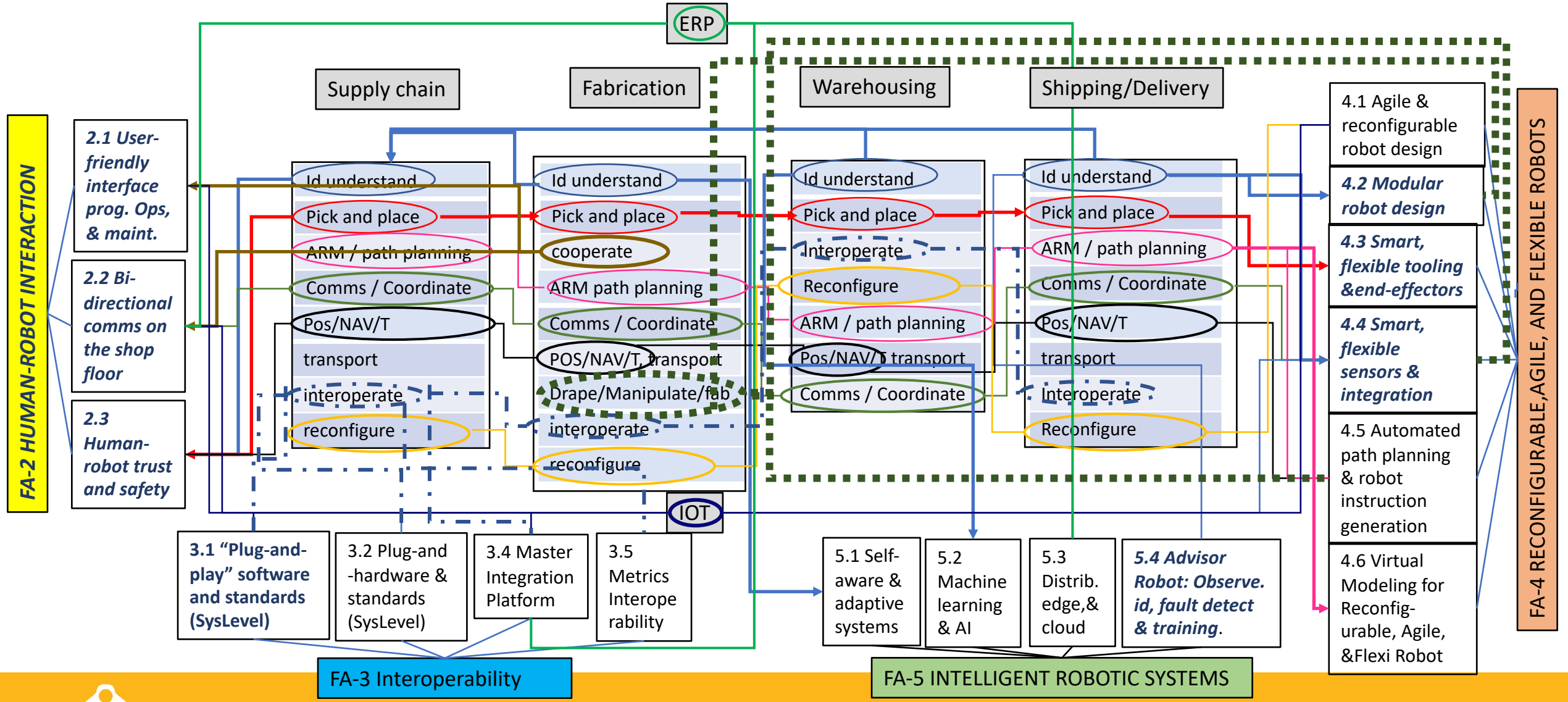
Key functionality is mapped to 17 Key Enabling Technologies (KETs)



17 KETs are grouped to form 4 strategic technical Focus Areas FA's.

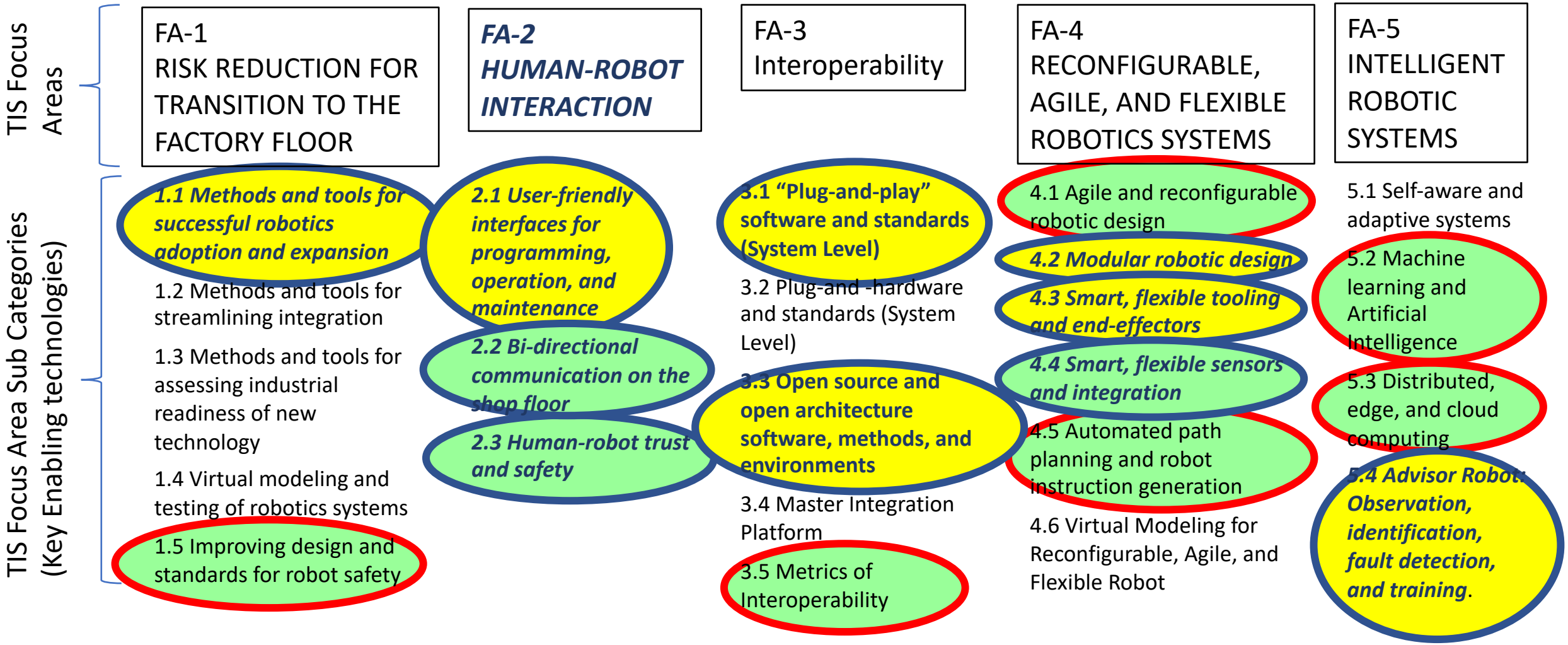
Four technical focus areas combine with a 5th, "risk reduction of factory robotic adoption", form ARMS technical Investment strategy

HOW ARM MAPPED MANUFACTURING ROBOT FUNCTIONS TO KEY ENABLING TECHNOLOGIES ALIGNED WITH THEIR STRATEGY



- *Key functionality is mapped to 17 Key Enabling Technologies (KETs)*
- *17 KETs are grouped to form 4 strategic technical Focus Areas FA's.*

ARM INVESTMENT STRATEGIES FOCUSED ON DEVELOPING TECH IN THE MOST URGENT AND IMPORTANT AREAS AS IDENTIFIED BY A BROAD INDUSTRY SURVEY



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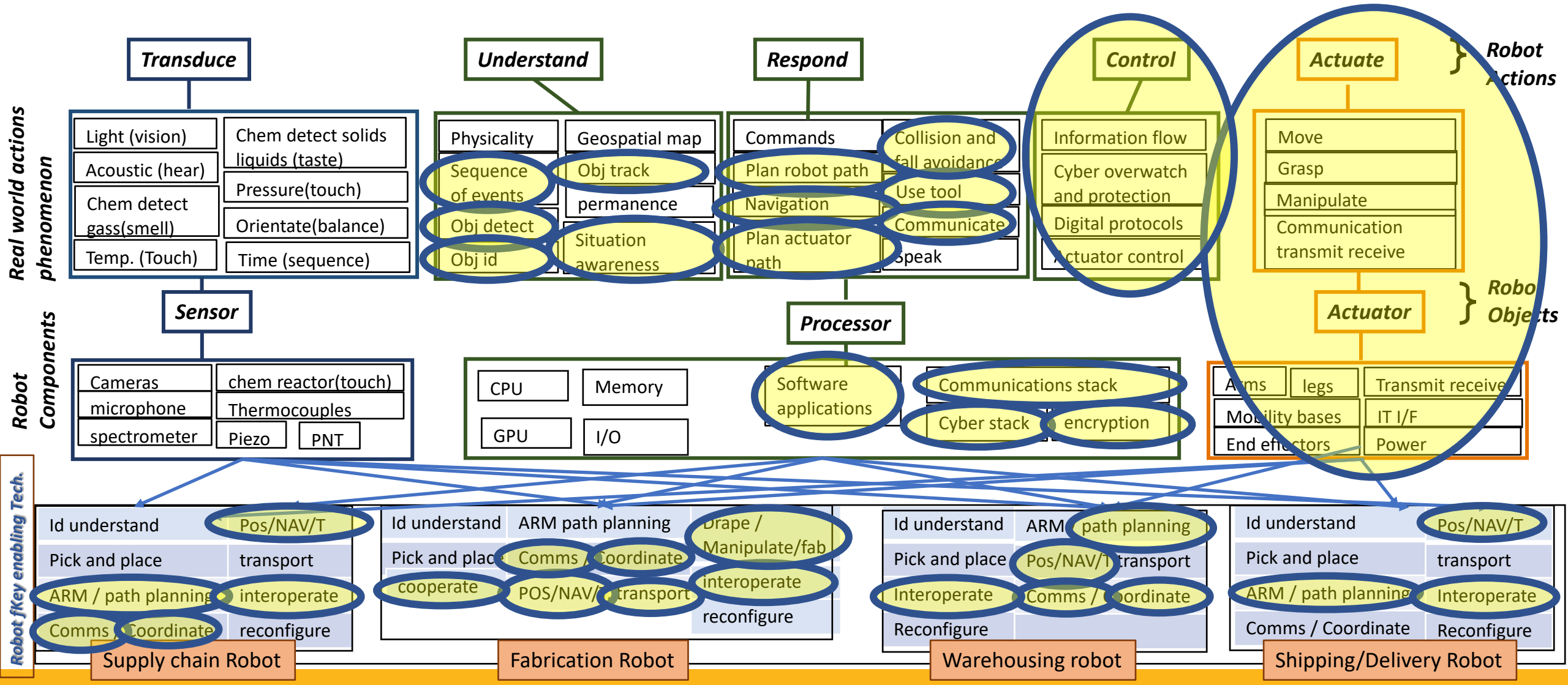
Most urgent and important Investment areas for robotic manufacturing

Current Call opportunities for Investment in controls technology for robotic manufacturing

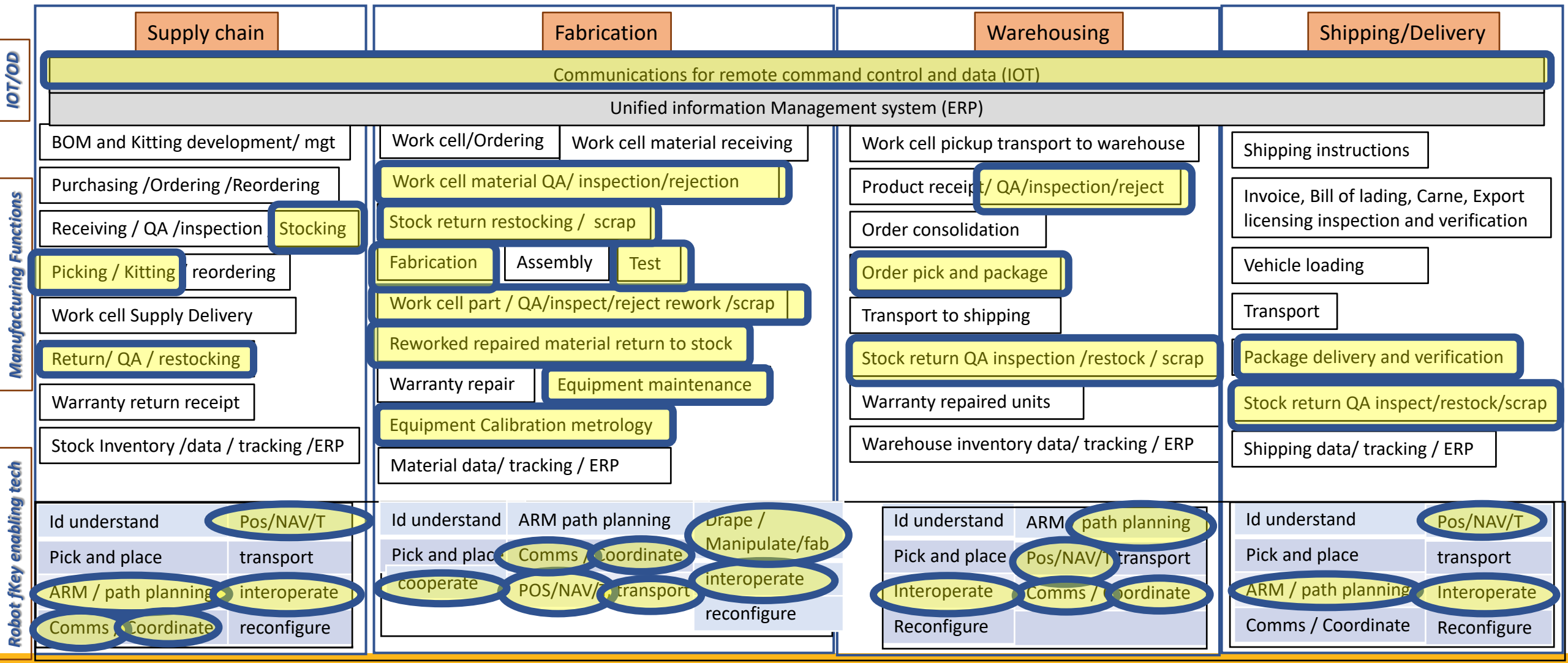
Investment in controls technology for robotic manufacturing that is aligned with strategy

Taxonomic analysis of Control elements used in manufacturing operations from supply thru fab to delivery



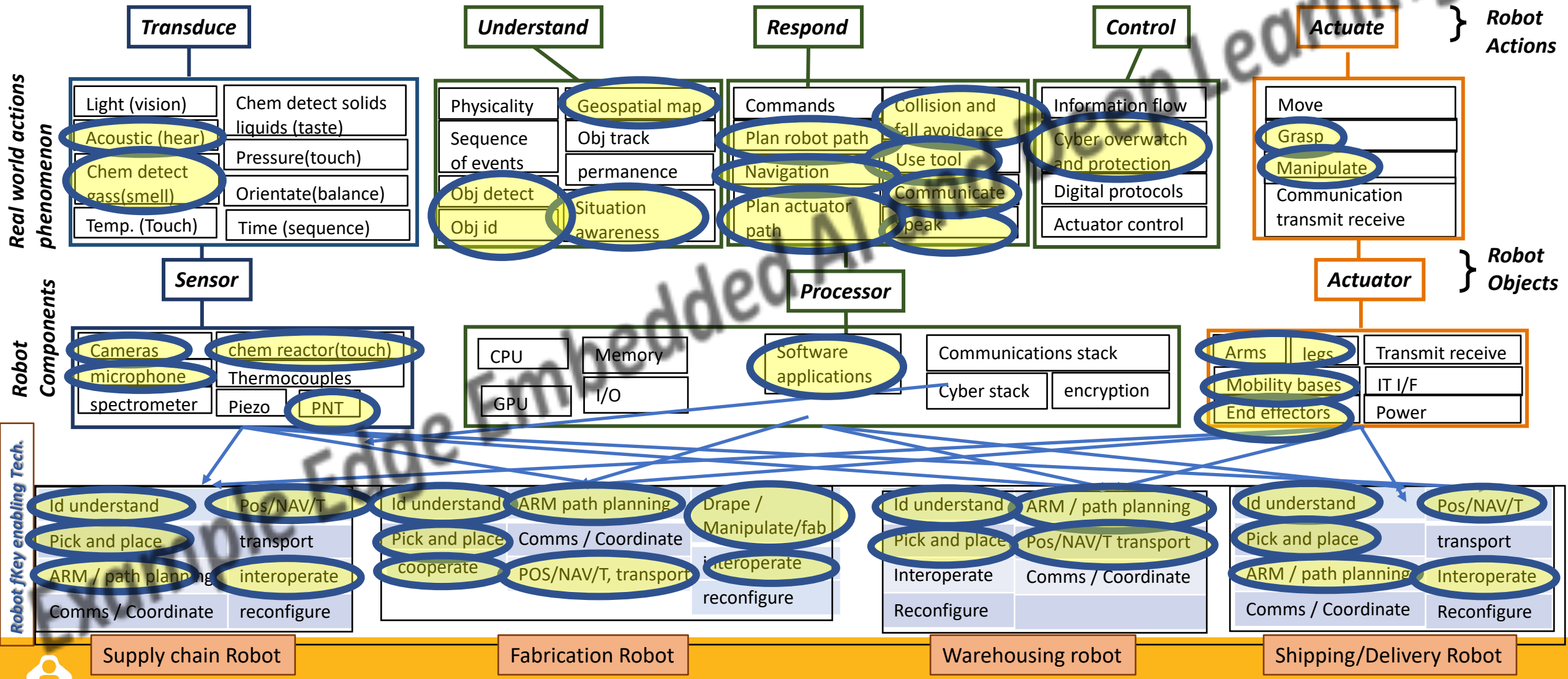
Controls technology broadly penetrates the taxonomy

Taxonomical analysis of a robotic manufacturing organization to identify the controls element and interfaces via the plants IT.



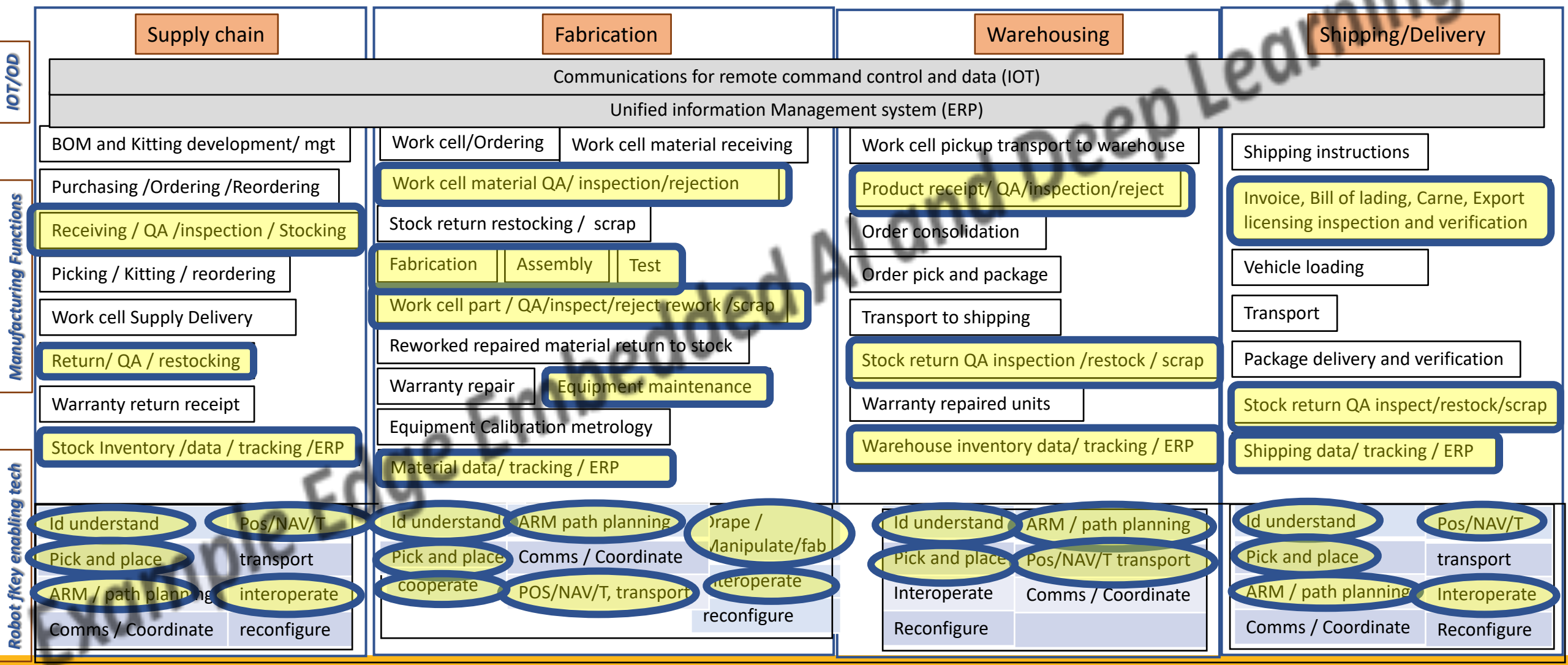
IT – down loads from servers (drawings, documentation, g-files, etc) Remote monitoring equip. Internal WAN

Taxonomic analysis of Robots used in various Manufacturing operations from supply thru fab to delivery



Edge / embedded AI and deep learning applies to numerous elements of manufacturing robots

TAXONOMICAL ANALYSIS OF A ROBOTIC MANUFACTURING ORGANIZATION IS USED TO IDENTIFY OPPORTUNITIES FOR APPLYING AI AND DEEP LEARNING



1) Mgt reports, (Gemba, PM)
2) QA inspection,
3) User, maintenance, and repair training
4) Edge vision and motion control.

USING PROJECT CALLS TO DRIVE GROWTH

Call for Proposals issued 3 times/year; Technology(2) and EWD(1) teams

Simple process:

Proposal Submission

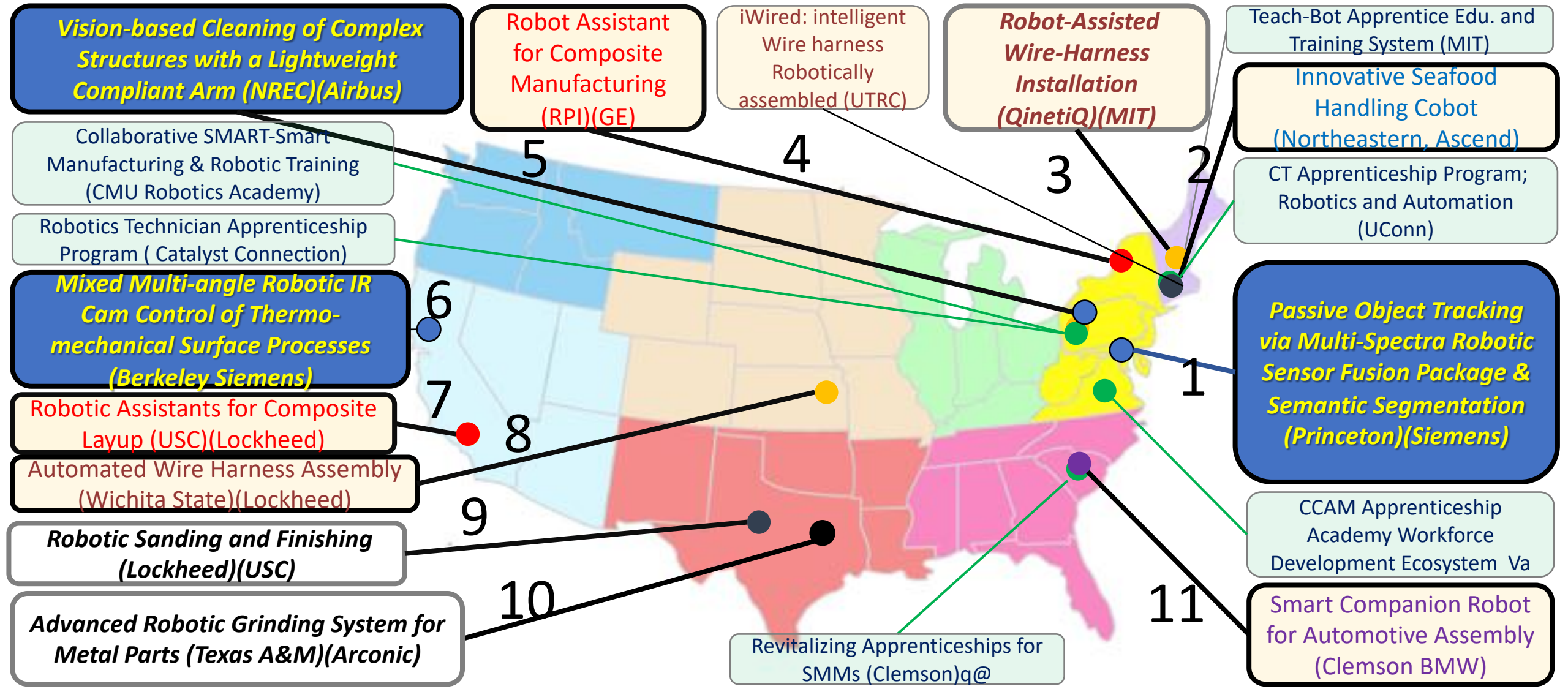
Peer Review and Selection

Must be a member to lead or participate in a project

Project topics address challenges as defined by member consortium and industry need

1. ***ARM consortium investment to be up to $45Million / year government and consortium***
2. ***Three (3) TL/MRL 4, 5,6, and 7 calls for proposal per year***
3. ***120 days from RFP posting to award potentially 150 days to first revenue***

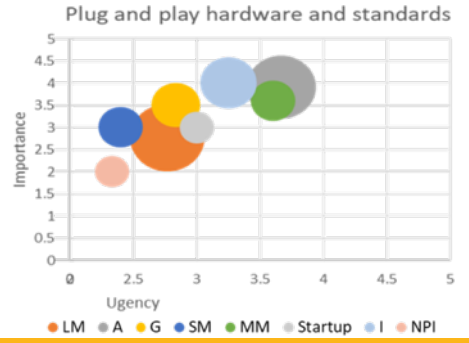
CURRENTLY SPENDING $27M TO 21 PROJECTS (11 IN CONTROLS)

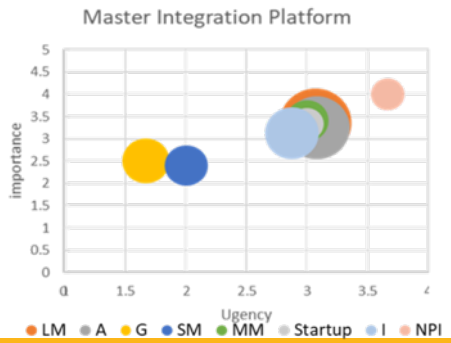


- Grinding finishing additive/subtractive manufacturing
- Draping composites/textiles; buildup, & handling
- Assembly COBOT / IOT- IT file down loads and ERP
- Food Inspection or Processing COB tied to IOT
- Edu Workforce Dev
- Edge-AI Vision Processing
- Assemble fetch COBOT (Auto, heavy Equip / IOT)

INDUSTRY WAS SURVEYED (11/2018) TO ID THE MOST URGENT AND IMPORTANT KEY ENABLING TECHNOLOGIES FOR ROBOTIC MANUFACTURING

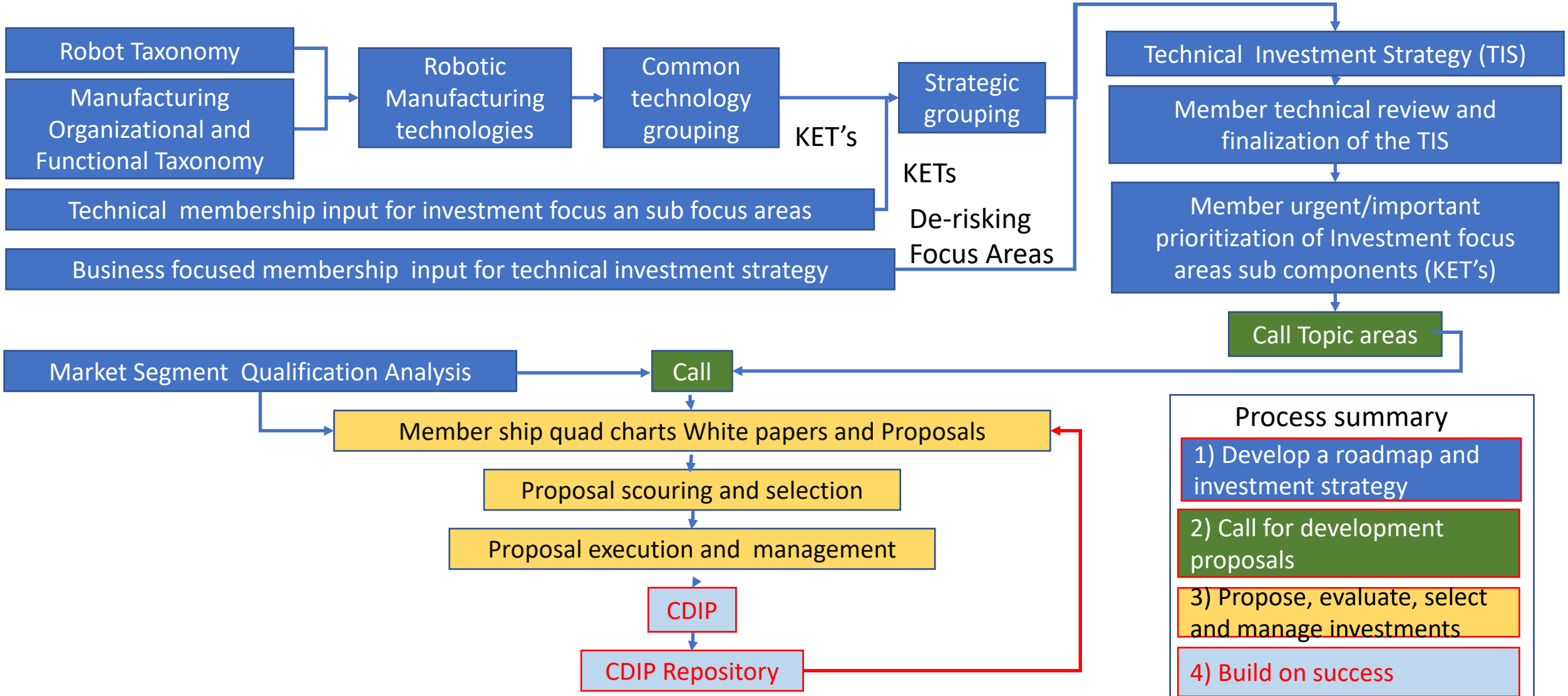
- ARM Community
  - Manufacturing organizations
    - Startups to Large Corporations
    - Aerospace to textile
    - Food processing to automotive
    - Defense and Commercial processes
  - Services organizations
    - Universities
    - Government agencies
    - Not for Profit Institutes,
- Methodology:
  - TIS was developed and defined via a broad collaborative ARM team
  - The TIS was reviewed revised and finalized by over 2/3 of the ARM community
  - The Focus Areas and Sub categories were rated by the community for urgency and importance
  - The results were analyzed
  - The highest scouring sub categories were chosen for the call





Funding the development of the most urgent and important technologies to TRL level 7.
IP brought into ARM is owned by the member. IP developed by ARM funds is shared.
IP developed to mature to TRL 9 level is owned by the developers

ARM is creating a Robotic Manufacturing innovation Market



CDIP stacking and the ARM repository allows members to forward deploy CDIP into other companies products pre launch to generate a royalty stream post launch

CALL 19-02 BIDDING IS ENCOURAGED
JOIN ARM! FORM A TEAM!

ARM-TEC-19-02 Call for Technology Projects

Tech Meeting in Pittsburgh (MEMBERS ONLY)	June 24-25, 2019
FINAL Project Call and Submission Documents Released	July 16, 2019
Project Call Webinar (MEMBERS and PUBLIC)	July 16, 2019
Submission Deadline for Proposals	**August 16, 2019 5:00 pm**
Final Selections Released, Subaward Negotiations Begin	On or about September 23, 2019
Final SOWs and Budgets Due (by invitation only)	On or about October 21, 2019

E-mail: tech-arm-19-02@arminstitute.org
Phone: 412-681-3960

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Arminstitute.org
(412) 681-3960

Arnold Kravitz
(727) 686 2702