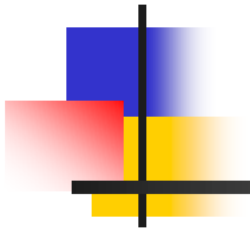

International Standardization Activities for Robots

2012. 12. 11

Seungbin Moon
Convener of ISO TC 184/SC 2/WG 8(Service robots)
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International Organizations For Standardization on Robots

- **ISO : International Organization for Standardization**
  - Membership:157 Nations
  - www.iso.org

- **IEC : International Electrotechnical Commission**
  - Membership: 68 Nations
  - www.iec.ch

- **OMG : Object Management Group**
  - robotics.omg.org

- **ASTM :American Society for Testing and Materials**
  - http://www.astm.org/

- **IEEE : Institute of Electrical-Electronic Engineers**
  - www.ieee.org

IEC Activities

- **IEC SC 59F (Floor treatment appliances) established WG 5 (Methods of measuring the performance of household cleaning robots)**
  - **IEC 60312-3 Ed. 1.0/NP 2009: Methods of measuring the performance of household cleaning robots**

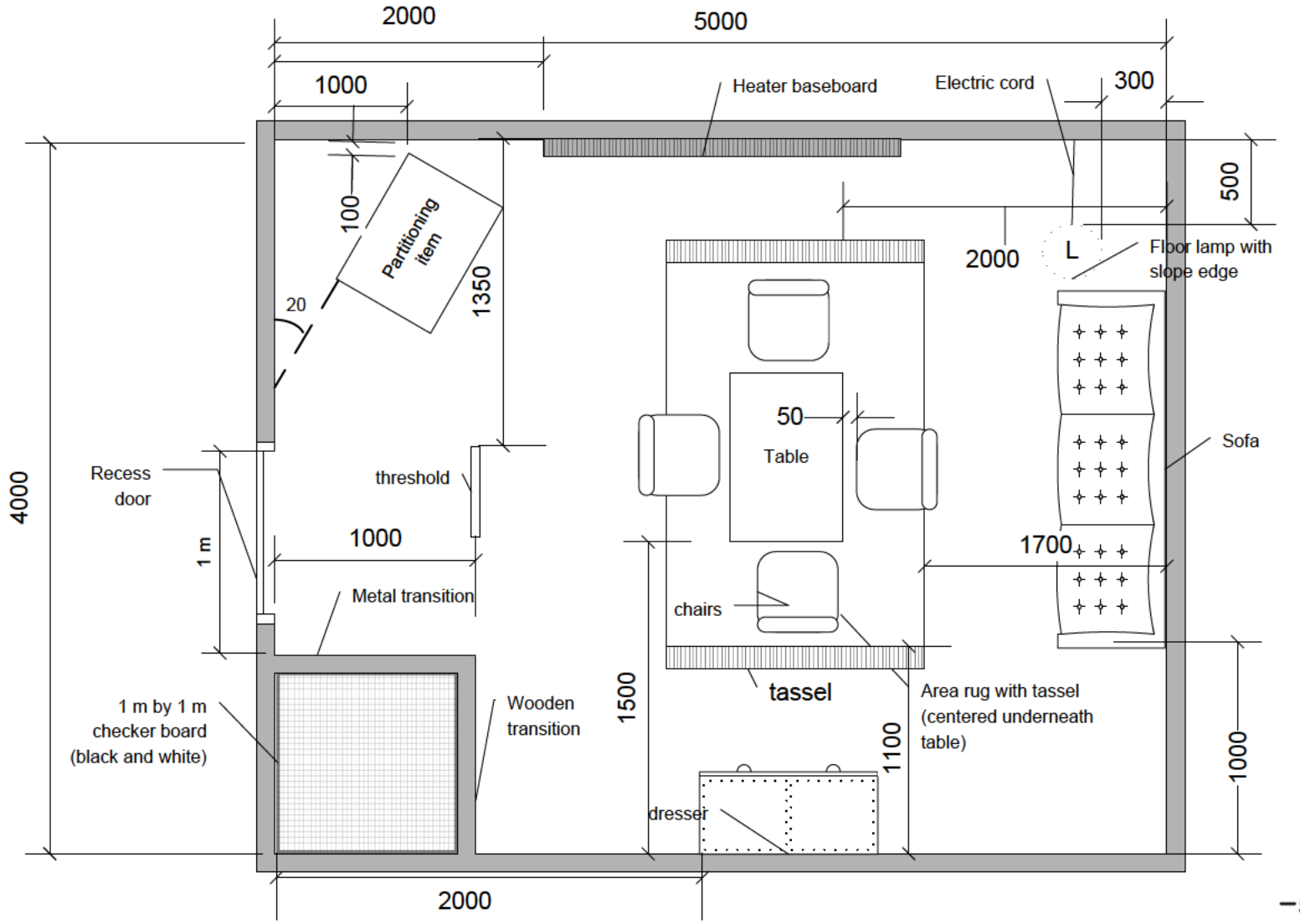
- **IEC TC 61(Safety of household and similar electrical appliances) developed a standard which covers safety aspect on vacuum cleaning robot**
  - **IEC 60335-2-2 Ed6.0:2009 Household and similar electrical appliances - Safety - Part 2-2: Particular requirements for vacuum cleaners and water-suction cleaning appliances**

- **IEC TC 116(Safety of hand-held motor-operated electric tools) is developing a standard on safety requirements related to lawn mowing robots**
  - **IEC 60335-2-107 Ed. 1.0/CDV stage: Household and similar electrical appliances - Safety - Part 2-107: Particular requirements for robotic battery powered electrical lawnmowers**

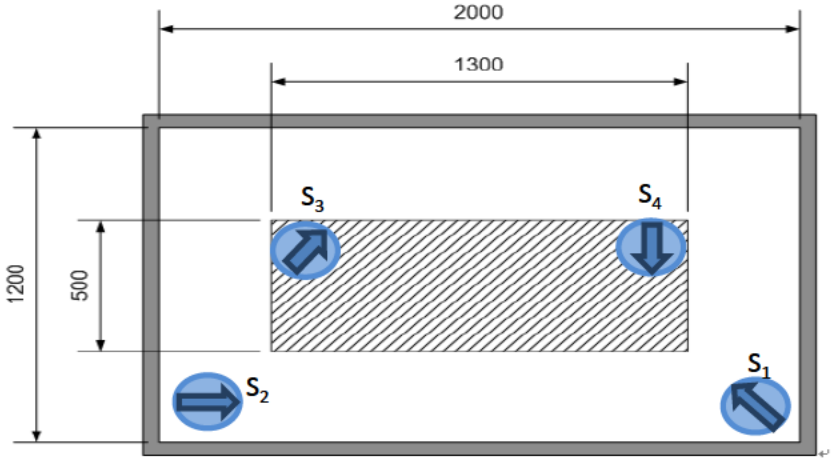
IEC SC 59F/WG 5

- **TC 59 (performance of household and similar electrical appliances)**
  - **SC 59F(Floor treatment appliances)**
    - **WG 5 (Methods of measuring the performance of household cleaning robots)**
    - **Convenor: Sungsoo Rhim, Kyung Hee Univ, Korea**
    - **Started from May, 2009**
    - **Members: Electolux, iRobot, Philips, Kaercher, Samsung, LG, Yujin Robot, Dyson, TEK, etc.**
    - **Issues**
      - **Mobility - coverage rate in a standardized area**
      - **Dust removal - Dust collection in a standardized area**
      - **Noise, Battery power, ….**

IEC SC 59F/WG 5 – Navigation



Dust removal - Box test



OMG Activities

- **Robotics DTF(Domain Task Force)**
  - To foster the integration of robotics system from modular components through the adoption of OMG standards.
  - Co-chairmen: Tetsuo Kotoku(AIST, Japan), Young-Jo Cho(ETRI, Korea), and Laurent Rioux(Thales)
  - robotics.omg.org

- **Technical Working Groups**
  - Infrastructure WG
    - Robotic Technology Component (RTC) Specification
    - Software modularization and integration at middleware level
  - Robotics Functional Service WG
    - Robotic Localization Service(RLS)
    - robot interaction service (RoIS)
  - Robotic Devices and Data Profile WG
    - Programmer API: Typical device abstract interface and hierarchies
    - Hardware-level resources: Define resource profiles

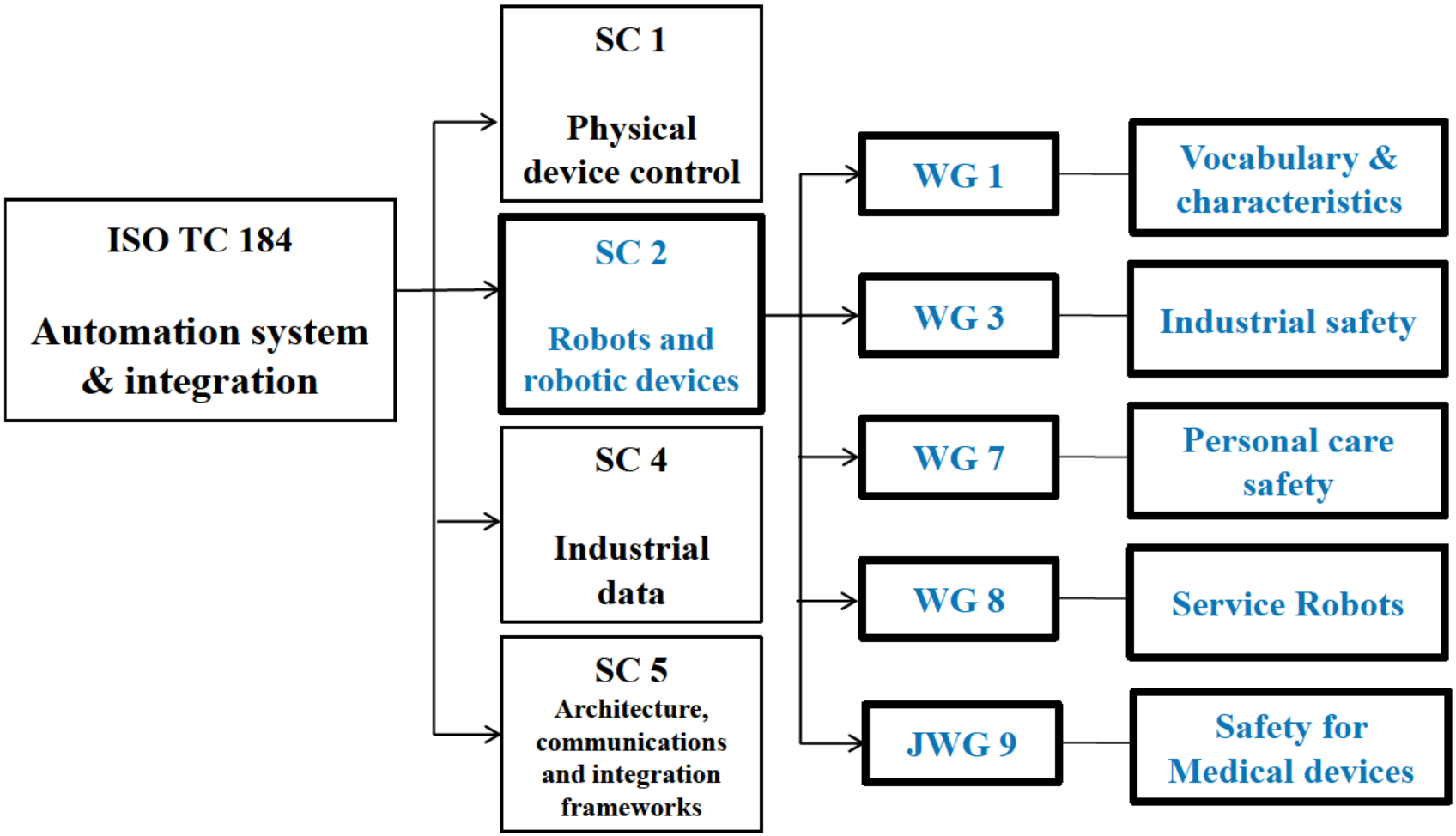
ASTM Activities

- **E54(Homeland Security Applications)**
  - **Subcommittee E54.08(Operational Equipment)**
  - **http://www.astm.org/COMMIT/SUBCOMMIT/E5408.htm**
  - **E2521-07a: Standard Terminology for Urban Search and Rescue Robotic Operations**
  - **E2566-08 : Standard Test Method for Determining Visual Acuity and Field of View of On-Board Video Systems for Teleoperation of Robots for Urban Search and Rescue Application.**
  - **E2592-07: Standard Practice for Evaluating Cache Packaged Weight and Volume of Robots for Urban Search and Rescue**
  - **Under development for navigation and communication performances, etc.**
- **F38 (Unmanned aircraft systems)**
- **F41 (Unmanned maritime vehicles)**

IEEE RAS(Robotics & Automation Society)

- **IEEE RAS formed standard committee**
  - **It is chaired by Raj Madhavan, NIST, USA.**
- **It recently formed 2 Working Groups in Sep, 2011.**
  - **Robot Map Data Representation for Navigation**
    - **Chair: Wonpil Yu, ETRI, Korea**
  - **Ontologies for Robotics and Automation**
    - **Chair: Craig Schlenoff , NIST, USA**

Organization of ISO TC 184/SC 2



ISO TC 184/SC 2

- **Background - created in 1983**
  - Chairman: Tomas Angelhag of ABB, Sweden
  - Secretary: Mattias Lafvas of SIS, Sweden
  - 19 P-member countries and 6 O-member countries
  - Published 10 International Standards, 1 Technical Reports
  - 2 are under revision, and 2 new documents are being developed
  - Fields: safety, performance criteria, I/F for mechanics & software
  - www.isotc184sc2.org

- **ISO TC184/SC2 Scope Changes**
  - 1983: "Robots for Manufacturing Environment"
  - 2003: "Robots for Industrial Environment"
  - 2006: "Robots and Robotic Devices"

- **Scope**
  - Standardization in the field of automatically controlled, reprogrammable, manipulating robots and robotic devices, programmable in more than one axis which may be either fixed in place or mobile.
    - **Excluded: Toys, military applications.**

TC184/SC2 Membership

Participating countries: 19

- Secretariat: Sweden (SIS)
- Bulgaria (BDS)
- Canada (SCC)
- China (SAC)
- Czech Republic (CSNI)
- Denmark (DS)
- France (AFNOR)
- Germany (DIN)
- Hungary (MSZT)
- Italy (UNI)
- Japan (JISC)
- Korea, Republic of (KATS)
- Portugal (IPQ)
- Romania (ASRO)
- Russian Federation (GOST R)
- Spain (AENOR)
- Switzerland (SNV)
- USA (ANSI)
- United Kingdom (BSI)

Observing countries: 6

- Finland (SFS)
- Netherlands (NEN)
- Norway (SN)
- Poland (PKN)
- Serbia (ISS)
- Slovakia (SUTN)

TC184/SC2: International Standards

1. ISO 8373:2012 Robots and robotic devices -Vocabulary
2. ISO 9283:1998 Manipulating industrial robots -Performance criteria and related test methods
3. ISO 9409-1:2004 Manipulating industrial robots -Mechanical interfaces -- Part 1: Plates
4. ISO 9409-2:2002 Manipulating industrial robots -Mechanical interfaces -- Part 2: Shafts
5. ISO 9787:1999 Manipulating industrial robots -Coordinate systems and motion nomenclatures
6. ISO 9946:1999 Manipulating industrial robots -Presentation of characteristics
7. ISO 10218-1:2011 Robots and robotic devices – Safety requirements for industrial robots– Part 1: Robots
8. ISO 10218-2:2011 Robots and robotic devices – Safety requirements for industrial robots– Part 2: Robot systems and integration
9. ISO 11593:1996 Manipulating industrial robots -Automatic end effector exchange systems -- Vocabulary/presentation of characteristics
10. ISO 14539:2000 Manipulating industrial robots -Object handling with grasp-type grippers -- Vocabulary and presentation of characteristics
11. ISO/TR 13309:1995 Manipulating industrial robots -- Informative guide on test equipment and metrology methods of operation for robot performance evaluation in accordance with ISO 9283

WG 1: Vocabulary and characteristics

- **Structure**
  - Convenor: Soon-Geul Lee, Kyung Hee Univ, Korea
  - Formed in June, 2007 at Washington DC Plenary Meeting.
- **Revision ISO 8373:1994 (Vocabulary)**
  - Feb. 2010: NP is approved
  - 2012: IS(International Standard) is published
- **Revision ISO 9787:1999(Coordinate system)**
  - NWIP: 2011
  - Revision to include mobile platform coordinate system
- **Developing vocabulary for mobile robots**
  - New standards on mobile robots(wheeled robots, legged robots)
- **ISO concept database**
  - http://cdb.iso.org

ISO 8373: Vocabulary – New terms

- **ROBOT-OLD Definition:**
  - **robot/manipulating industrial robot: automatically controlled, reprogrammable , multipurpose manipulator programmable in three or more axes (4.3) which may be either fixed in place or mobile for use in industrial automation applications**
    - **NOTE The robot includes**
    - **- the manipulator (including actuators);**
    - **- the control system (hardware and software).**
- **ROBOT-NEW Definition**
  - **robot: actuated mechanism programmable in two or more axes with a degree of autonomy, moving within its environment, to perform intended tasks**
    - **NOTE 1 A robot includes the control system (2.7) and interface of the control system.**
    - **NOTE 2 The classification of robot into industrial robot (2.9) or service robot (2.10) is done according to its intended application.**

WG 1: Vocabulary – New terms

- **Autonomy**
- **ability to perform intended tasks based on current state and sensing, without human intervention**

- **Robotic device**
- **actuated mechanism fulfilling the characteristics of an industrial robot (2.9) or a service robot (2.10), but lacking either the number of programmable axes (4.3) or the degree of autonomy (2.2)**
- **EXAMPLES Power assist device; teleoperated device; two-axis industrial manipulator (2.1)**
-

WG 1: Vocabulary – New terms

- **Service robot**
- **robot (2.6) that performs useful tasks for humans or equipment excluding industrial automation applications**
  - **NOTE 1 Industrial automation applications include, but are not limited to, manufacturing, inspection, packaging, and assembly.**
  - **NOTE 2 While articulated robots (3.15.5) used in production lines are industrial robots (2.9), similar articulated robots used for serving food are servicerobots (2.10).**

- **Personal service robot/Service robot for personal use**
- **service robot used for a non-commercial task, usually by lay person**

- **Professional service robot/Service robot for professional use**
- **service robot used for a commercial task, usually by properly trained operator**

WG 1: Vocabulary – New terms

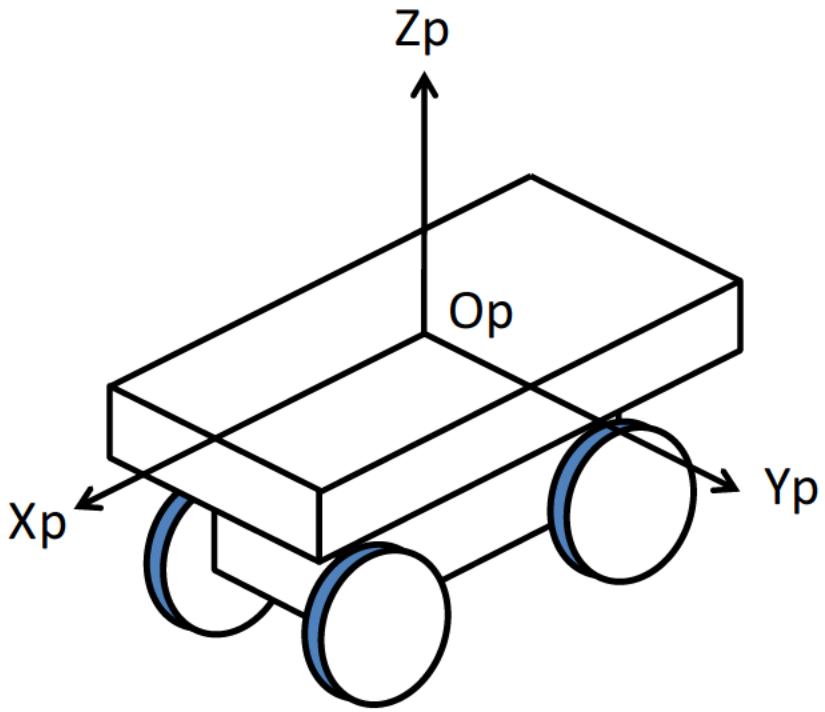
- **Human-robot interaction/HRI**
- tactile or other information exchanges between human and robot

- **User interface**
- means for information exchange between human and robot

- **Collaboration**
- work done by robot(s) and human(s) together to fulfil a task

- **Robot cooperation**
- interaction between multiple robots to ensure that their motions are effective together for the task

ISO 9787: Coordinate systems



- **Figure 6 — Example of mobile platform coordinate system**

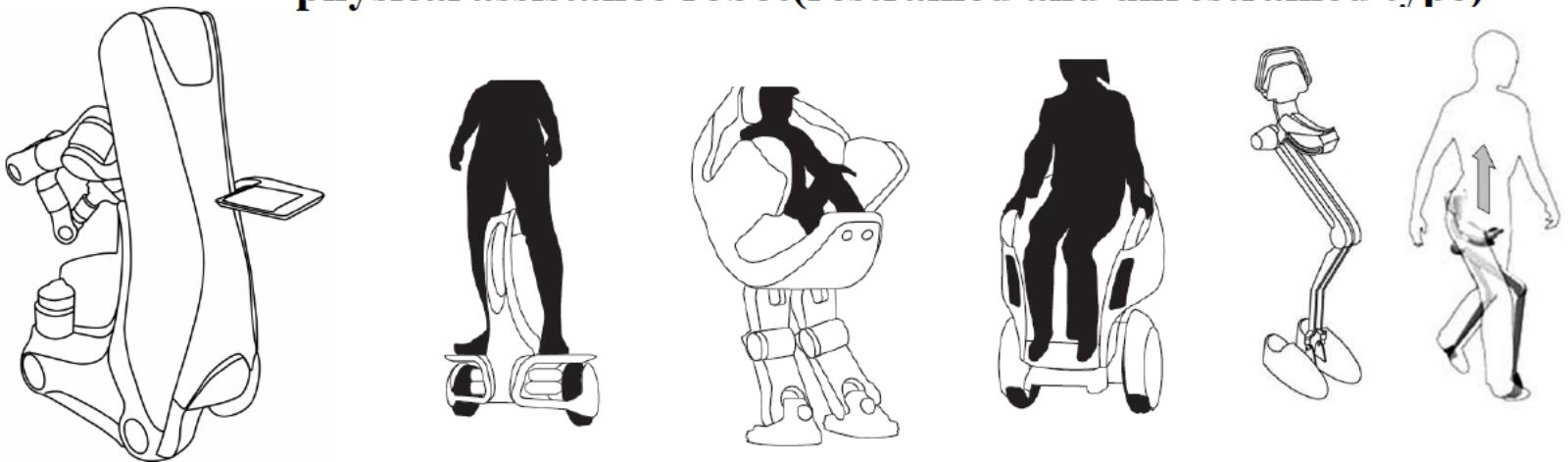
ISO TC184/SC2/WG3 – Industrial Safety

- **Convenor: Jeff Fryman, Robotic Industries Association, USA**
- **It has been active more than 10 years.**
- **Must satisfy ISO 10218 to export robotic products**
  - **USA: ANSI/RIA 15.06, EU: CEN**

- **10218 has been split into two parts.**
  - **Part 1(Robot) – Revised in 2006 and 2011**
    - **Cableless Teach Pendants**
    - **Simultaneous Motion**
    - **Collaborative Operation(Hand guiding, Speed and position monitoring, Power and force limiting)**
  - **Part 2(Robot System and Integration) – Published in 2011**
    - **Safety issues at system integration - Location, power, lighting, grounding, and end-effectors**
- **New Proposal: ISO/TS 15066 *Robots and robotic devices - Safety requirements - Industrial collaborative workspace***

WG 7: Personal Care Safety

- **Structure**
  - Convenor: Gurvinder Virk, CLAWAR Ltd, UK
  - Started from Oct. 2006 for Safety of Personal Care Robots
  - Consists of more than 30 experts representing USA, UK, Germany, France, Italy, Japan, Korea, IEEE.
- **Current Status**
  - ISO 13482: Safety requirements- Nonmedical personal care robot
  - Types
    - mobile servant robot
    - person carrier robot
    - physical assistance robot(restrained and unrestrained type)



WG 7: Personal Care Safety - 2

- **International Standard by 2013**
  - NWIP(New Work Item Proposal) approved in Feb. 2009
  - CD(Committee Draft), approved in Feb. 2010
  - DIS(Draft International Standard), approved in Feb. 2012
  - FDIS(Final Draft International Standard), to be approved in 2013

- **Major Sections**
  - Hazard identification and risk assessment
  - Safety requirement and protective measures
    - E-stop, Maximum speed, Force control, Human detection, Operational modes, Physical HRI
  - Verification and validation

JWG 9 Safety for Medical devices using robotic technology

- **Scope of work**
  - The range of medical applications being considered cover invasive and non-invasive procedures such as surgery, rehabilitation therapy, imaging and other robots and robotic devices for medical diagnosis and treatment.
  - In collaboration with
    - IEC/TC 62 (Electrical equipment in medical practice)
  - Will be published as IEC 60601-1-x Collateral standards.
  - Formed in June 2011 and experts from US, UK, Germany, France, Japan, Korea, China, Italy.

WG 8: Service Robots

- **Structure**
  - Convenor: Seungbin Moon, Sejong University, Korea
  - Started from Oct. 2006.
  - Task is not only to explore the need for standardization but also to develop standards for service robots.
  - Consists of more than 30 experts representing USA, UK, Germany, France, Italy, Japan, China, Sweden, Korea, Hungary, IEEE, IEC, IFR, OMG.

- **Study Groups**
  - SG 2: Performance => NWIP is proposed.
  - SG 4: Modularity => Study Group is formed.

- **Any new issues could be discussed here**

Service Robot – Performance Criteria

- **Robots and robotic devices — Performance criteria and related test methods for service robot**
  - Part 1: Wheeled mobile servant robot
  - Part 2: Wheeled person carrier robot
  - Part 3: Restrained wearable robots
  - Part 4: Legged robots

- **Part 1. Wheeled mobile servant robot**
  - Speed on different surfaces
  - Prevention of falling down
  - Mobility over the slope
  - Mobility over the sill
  - Stopping time
  - Obstacle avoidance
  - Obstacle detection
  - Relative distance/speed b/w human and ro

WG 8/Study Group on Modularity

- **Structure**
  - Internal study group is formed in June 2011.
  - Expanded in Oct. 2012
  - First meeting in Seoul, Oct. 2012.
  - Second meeting in San Francisco, Jan. 2013
  - Third meeting in Bristol, June 2013
  - Fourth meeting in Beijing, Oct. 2013

SG Discussion in Seoul

- **What is Modularity?**
  - Interoperability
  - Interface
  - Interchageability
  - Robot component

- **Scope**
  - Software interface
    - Architecture, Software component model, Componet API
    - Communication protocol, OS support
  - Hardware interface
    - connectors, sensor interface, communication physical layer
    - Manipulator link module
  - Mechanical interface
    - Motor shaft

Needs on Modularization

- **Industrial robots**
  - Market is fully developed already and end-users are system integrators.
  - Software : Major manufacturers do not want open up their software.
  - Hardware interface: Major manufacturers do not have much interest.
  - Mechanical interface: Some(mechanical interface) are standardized already.

- **Personal care robots**
  - Similar to consumer electronics industry, where end-users are individuals.
  - Software : Needed
  - Hardware interface : Needed
  - Mechanical interface : Needed

- **Medical robots**
  - It should consider regulation or safety issues.
  - Software :
  - Hardware interface: Surgery tool interface could be helpful.
  - Mechanical interface :

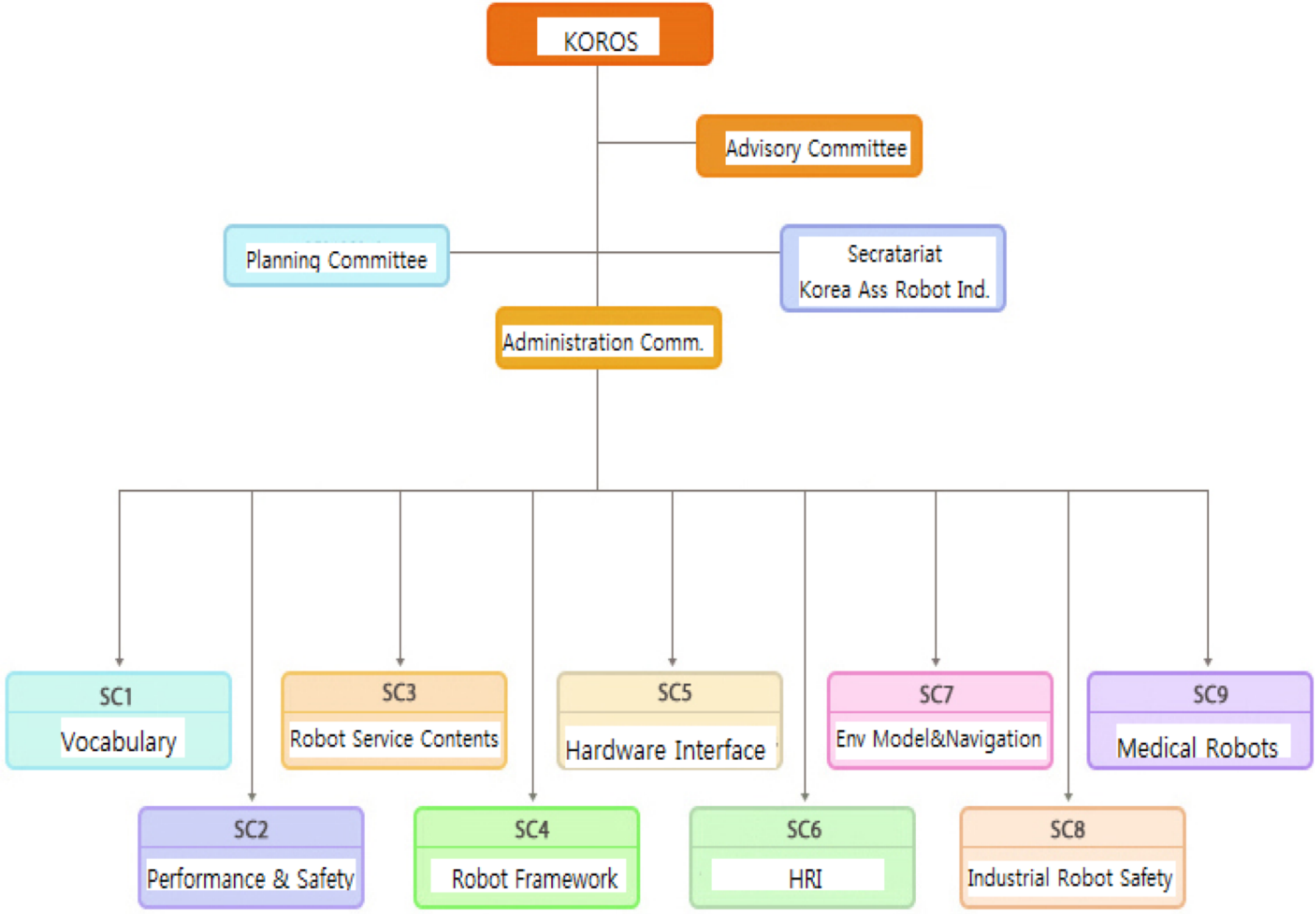
Urgency and Feasibility

- **What will be most urgent issues?**
  - **Software :**
  - **Hardware interface:**
  - **Mechanical interface:**

- **Will they be feasible?**
  - **OMG, OPROS, and China agree to discuss more on issue of merging into one software interface standard. More inputs from other countries will be sought.**
  - **Other groups, including ROS and OROCOS, will be invited to join the group.**
  - **Hardware interface and mechanical interface were discussed and will be further discussed in the future meetings.**

Korean Activities

- **KOROS (Korean Robot Standard) Forum**
  - Formed in 2005: www.koros.or.kr
  - Maintains 68 standards currently
  - 9 SCs
- **KS (Korea Industrial Standard)**
  - 21 industrial robot standards
  - 15 standards for service robots, including vocabularies, safety, performance.
- **R-mark Certification**
  - Cleaning robot certification initiated in 2009.
  - Education tool robot certification under preparation now.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Advisory Committee
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Secratariat
Korea Ass Robot Ind.
Administration Comm.
SC1
Vocabulary
SC3
Robot Service Contents
SC5
Hardware Interface
SC7
Env Model&Navigation
SC9
Medical Robots
SC2
Performance & Safety
SC4
Robot Framework
SC6
HRI
SC8
Industrial Robot Safety

Thank you !