
Georgia Tech

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

# Canonical Robot Command Language

Presented by: Andrew Price
Georgia Tech Research Institute

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# Our Goals

- Georgia Tech and NIST are performing cooperative research on agile assembly
  - Fixtureless assembly
  - Direct CAD to assembly
  - Robot, planning system, vision system, … agnostic
  - Error recovery and correction
- Will allow:
  - Lot-size 1 assembly on automated lines
  - Reduced line down time due to programming
  - Less human intervention due to assembly errors
  - More competition in all aspects of robotics

# Building Blocks

- P1872-2015 IEEE Standard for Ontologies for Robotics and Automation
  - Standardizes how artificial agents represent and communicate their knowledge about the world
  - Defines core ontology that represents the most general concepts, vocabulary, relations, and axioms
- Subgroup titled “Industrial Robot Ontology” of P1872 has been proposed

# Industrial Robot Ontology

- Desire to create an ontology that allows industrial robots to be more flexible and agile
- Examining workcell description and low-level robot control
- This talk focused on low-level robot control
  - Basis set of commands
  - Formal definition that allows compliant code to run on multiple robots without change
  - Ability to utilize set of commands on different vendor's robots with same results
  - Implemented as XML (schema and instance files)

# Two Classes of Commands

## Robot Agnostic

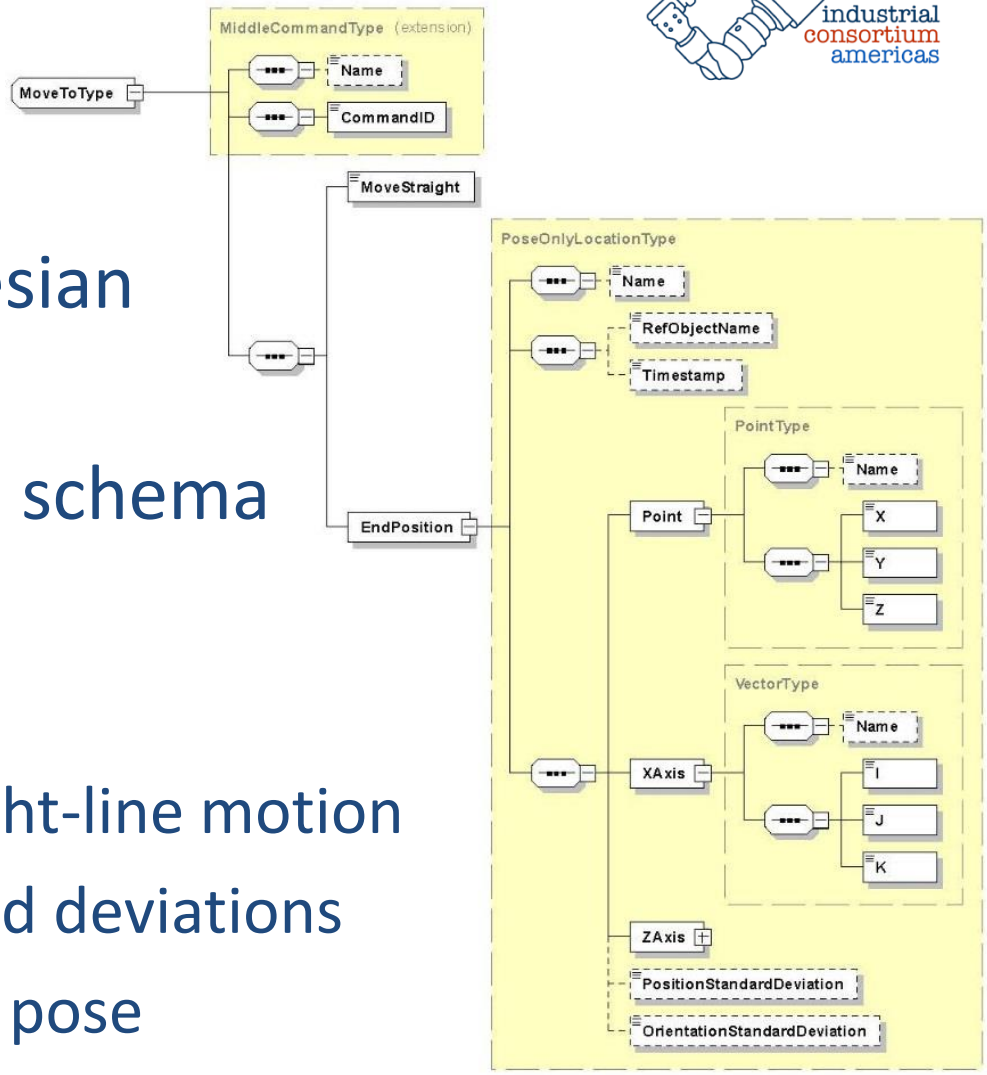
- Initialization/Termination
- Open/Close tool changer
- Dwell
- Get status
- Message
- Linear movement related
  - Move through
  - Move to
- Screw motion
- Run program
- Set (acc, speed, units, tolerance)
- Set end effector operation
- Stop motion

## Robot Specific

- Joint related
  - Control mode (position, force, torque)
  - Actuate joint(s)
  - Configure joint(s) report
- Set parameters (robot, end effector)

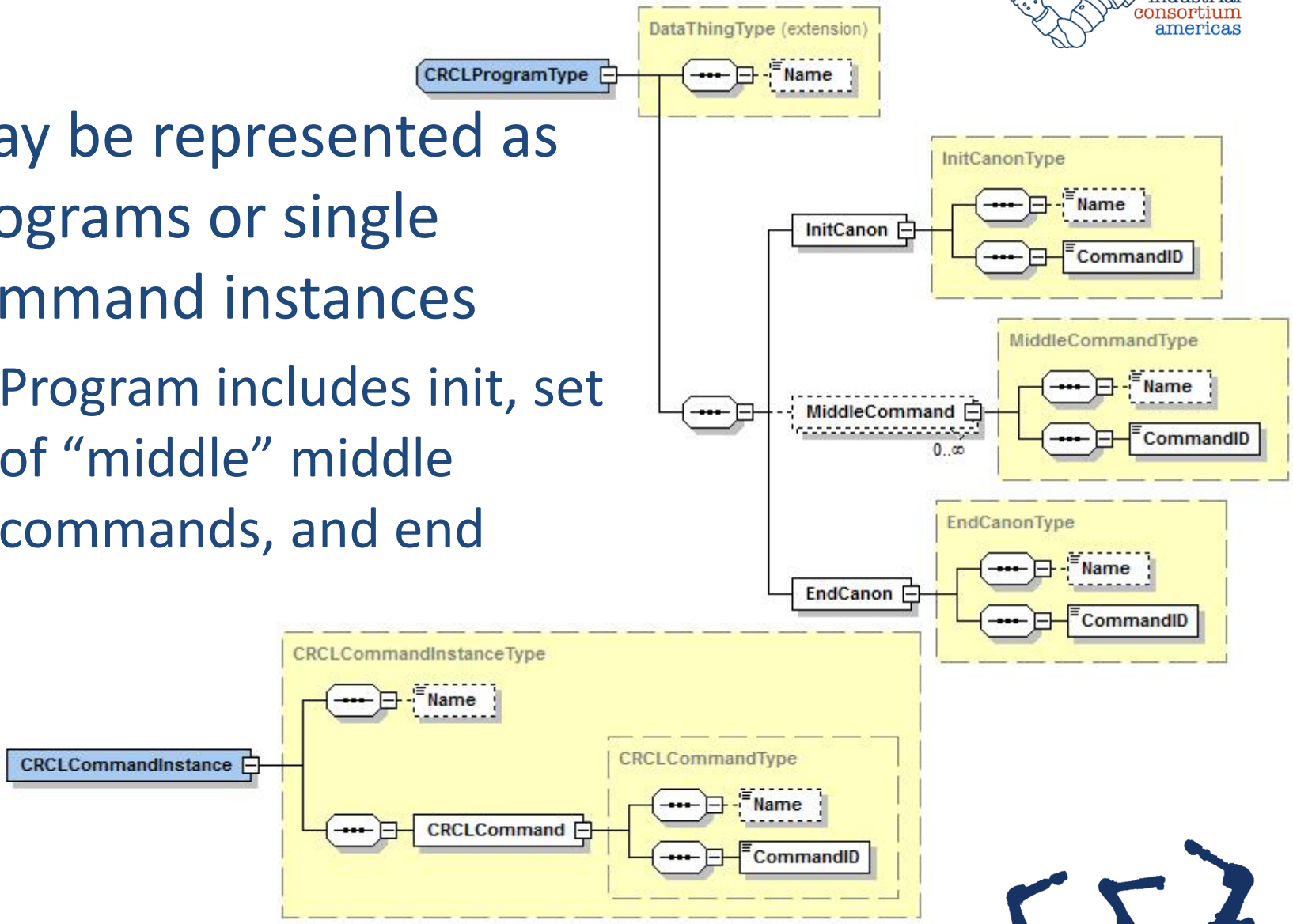
# Example Command

- MoveTo allows robot motion to single Cartesian pose
- Composed of multiple schema elements
- Allows:
  - Requirement for straight-line motion
  - Specification of allowed deviations
  - Specification of 6-DOF pose

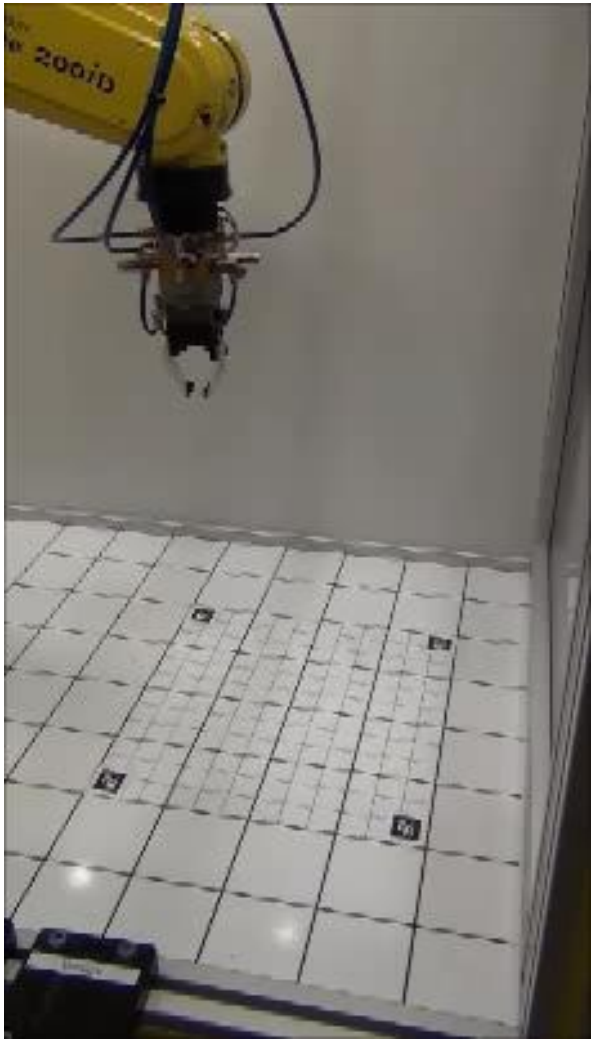


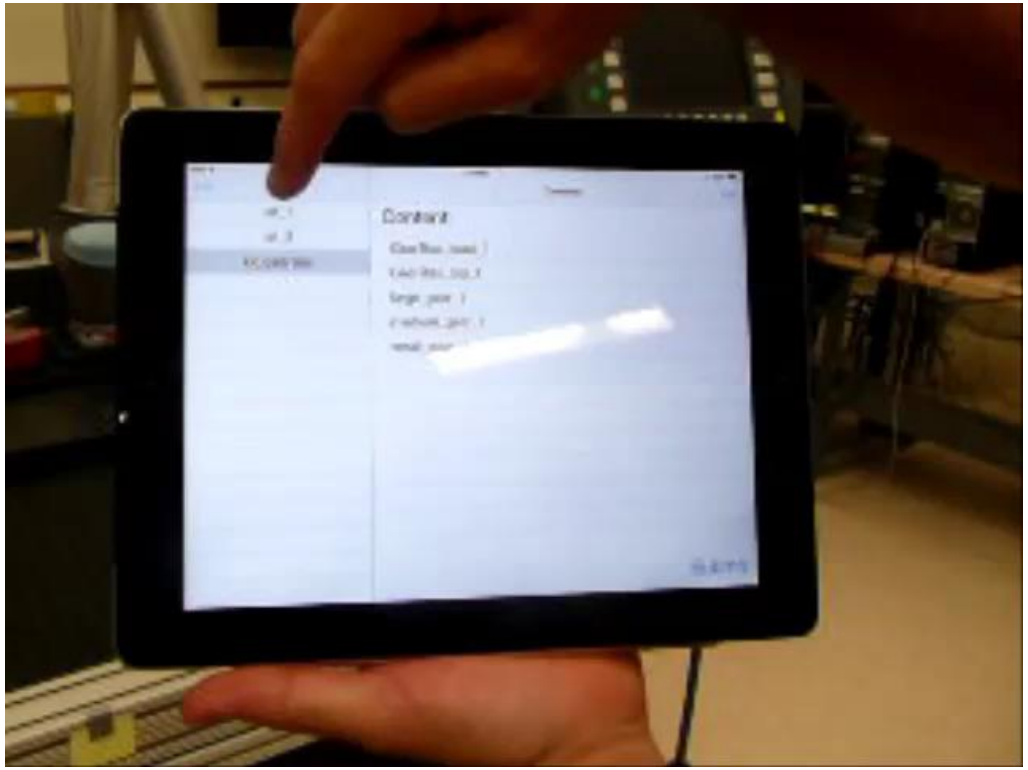
# Sets of Commands – A Robot Program

- May be represented as programs or single command instances
  - Program includes init, set of “middle” middle commands, and end



# CRCL In Operation





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# Also Needed…

- Vision commands
  - CVCLAddPoseType
  - CVCLInitCanonType
  - CVCLLookForGraspType
  - CVCLLookForObjectType
- High-level planning language
  - PDDL-to-CxCL mapping contained in separate schema to allow new PDDL commands without need to program robot

# Future Work

- Include in ROS-I distribution (anticipated mid April)
- Work with community to validate set of CRCL commands
  - Move towards IEEE standard
- Develop basis set of vision/math commands necessary for low-level control of assembly system
- Continue development of sample implementation

# How To Get Involved

- IEEE Study Group Meeting at ICRA
  - Seattle, Washington
  - May 26th (Tuesday) – same day as some ICRA workshops
  - Part of the IEEE Ontologies for Robotics and Automation (ORA) Study Group Meeting
  - Room and time TBD
  - All are welcome!
- Participate in monthly IEEE ORA telecons
- Contact Steve or Craig for more information (contact info on next slide)

# Contact Info


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http://www.nist.gov/el/isd/crcl.cfm