Assessing 5G need for Digital Twin Applications

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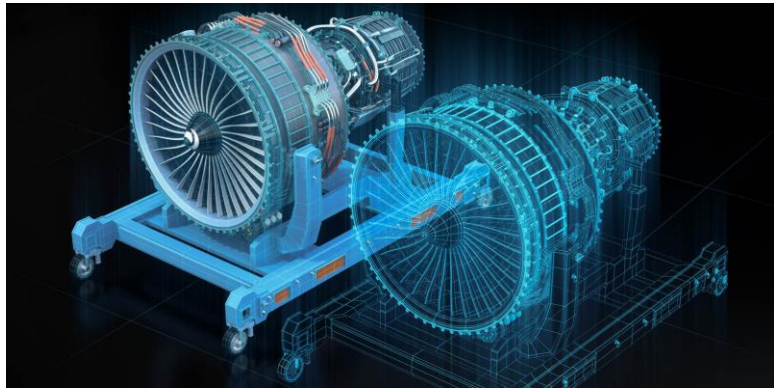
"5G end-to-end experimentation by verticals in EU projects"

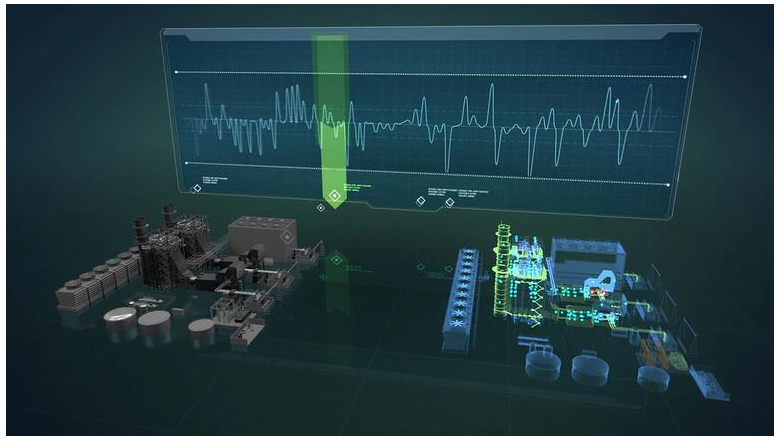
Online workshop

June 9th, 2020

Digital Twin and its requirements

- Virtual models of physical objects
  - ✓ Physical objects in physical world
  - ✓ Virtual models in virtual world
  - ✓ Real-time data to connect both worlds
- Requirements:
  - ✓ Latency < [20ms][1] - [10ms] [2]
  - ✓ Reliability > [99.999%][1] - [99.999%] [2]
  - ✓ Bandwidth > [UL: 40Mbps DL: 120Mbps][1]
  - ✓ Availability > [99.9999%] [1] - [99.9999%] [2]





[1][NGMN Verticals 5G low latency Use Cases and Requirements]

[2][Requirements of the robot manipulator used for this demonstration]

Cloud based Digital Twin applications

- On-demand network access to poll of resources (storage, computing, software, data, applications)
- Minimal management effort
- High QoS at lower cost
- Data sharing between virtual models

- ✓ Interoperable
- ✓ Smart
- ✓ Adaptable
- ✓ Distributed

Cloud based Digital Twin limitations

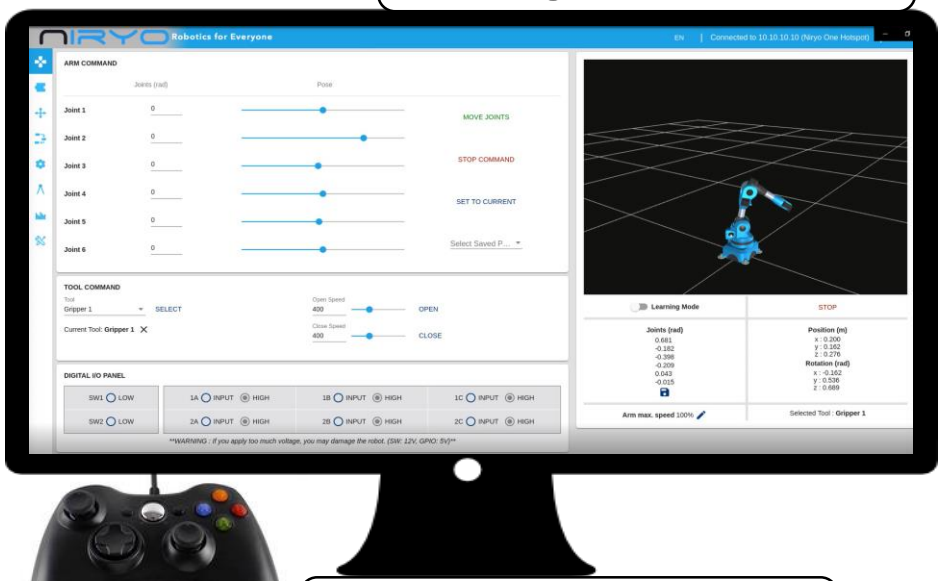
- Unavailability
- Network congestion and wireless interferences
  - Latency
  - Unpredictable jitter
  - Packet loss
  - Limited BW
- Time-sensitive processing on-board
- Privacy and Security
- Data filtering

5G-DIVE approach

- Edge and Fog
  - Network context information
  - Low-latency
  - Computation and data distribution
  - Privacy and security
- 5G connectivity
  - Low latency
  - High bandwidth
  - High reliability

- ✓ Reduce price of physical objects
- ✓ Improve real time operation
- ✓ Faster response to environment changes

Demonstration set-up



Digital Twin

Update robot pose

State publisher

Robot drivers

Controller

Get robot current pose

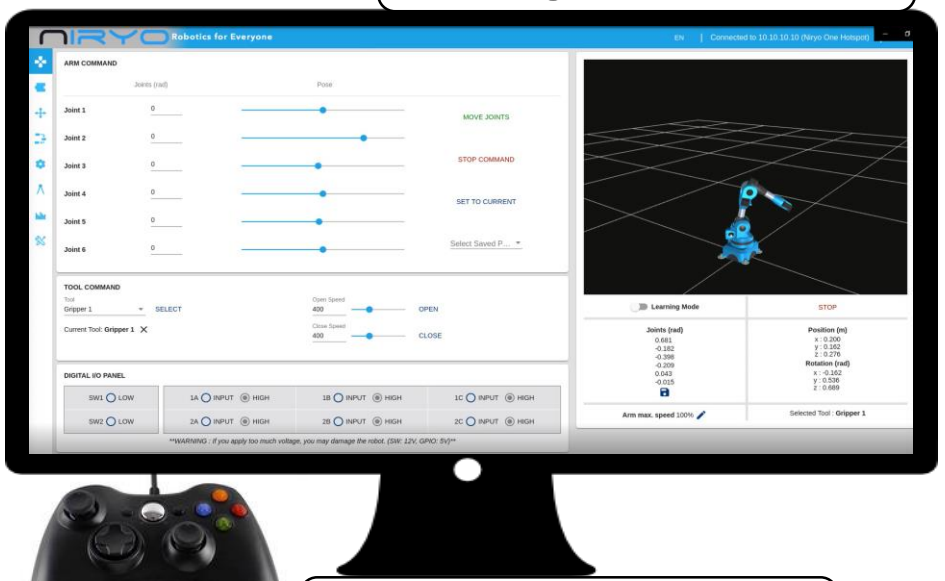
Execute movement command

Joints movement command

Motion planning

17 June 2020

Demonstration set-up



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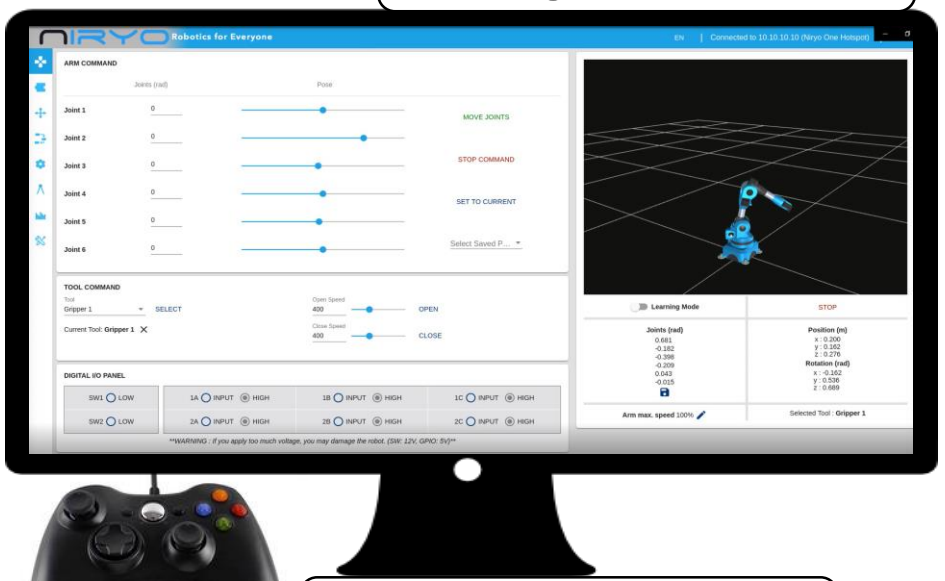

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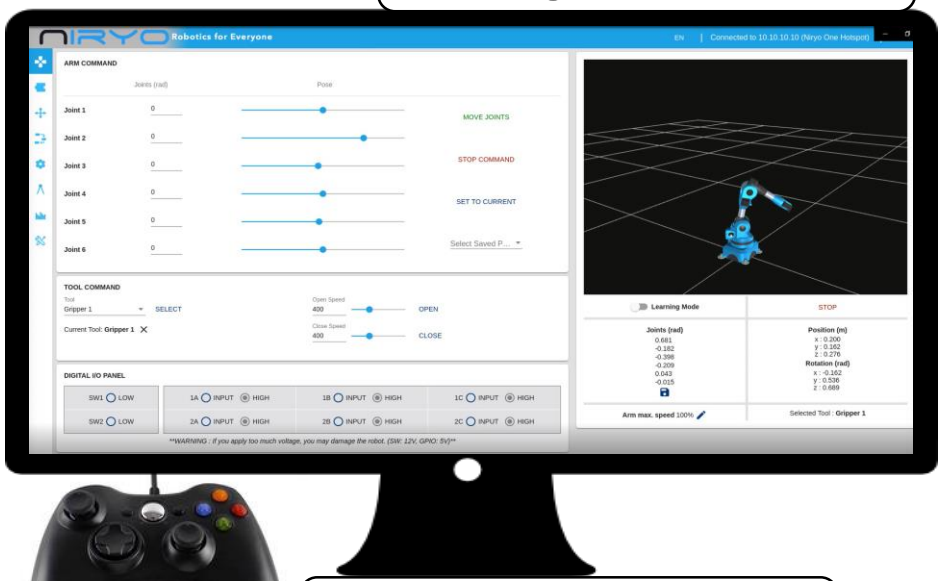

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Demonstration

1. Digital Twin application over Ethernet
2. Latency effects in Digital Twin applications over 802.11ac
   - artificial delay from the robot manipulator to the virtual model (UL latency)
   - artificial delay from the virtual model to the robot manipulator (DL latency)
3. Packet-loss effects in Digital Twin applications over 802.11ac
   - UL artificial packet-loss
   - DL artificial packet-loss

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Digital Twin application over Ethernet

Conclusions

- Ethernet connections provide the sufficient values in terms of bandwidth, latency and reliability.
- Wireless domain:
  - latency effects
    - Operate on delayed data
    - Decrease reaction time
    - Decrease precision
  - packet-loss effects
    - Difficult to manipulate the physical object
    - Unpredictable and uncontrolled movements
    - Glitches in the virtual model
    - Unreliable data

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