# Introduction to the IEEE/NIST Workshop: Timing Challenges in the Smart Grid

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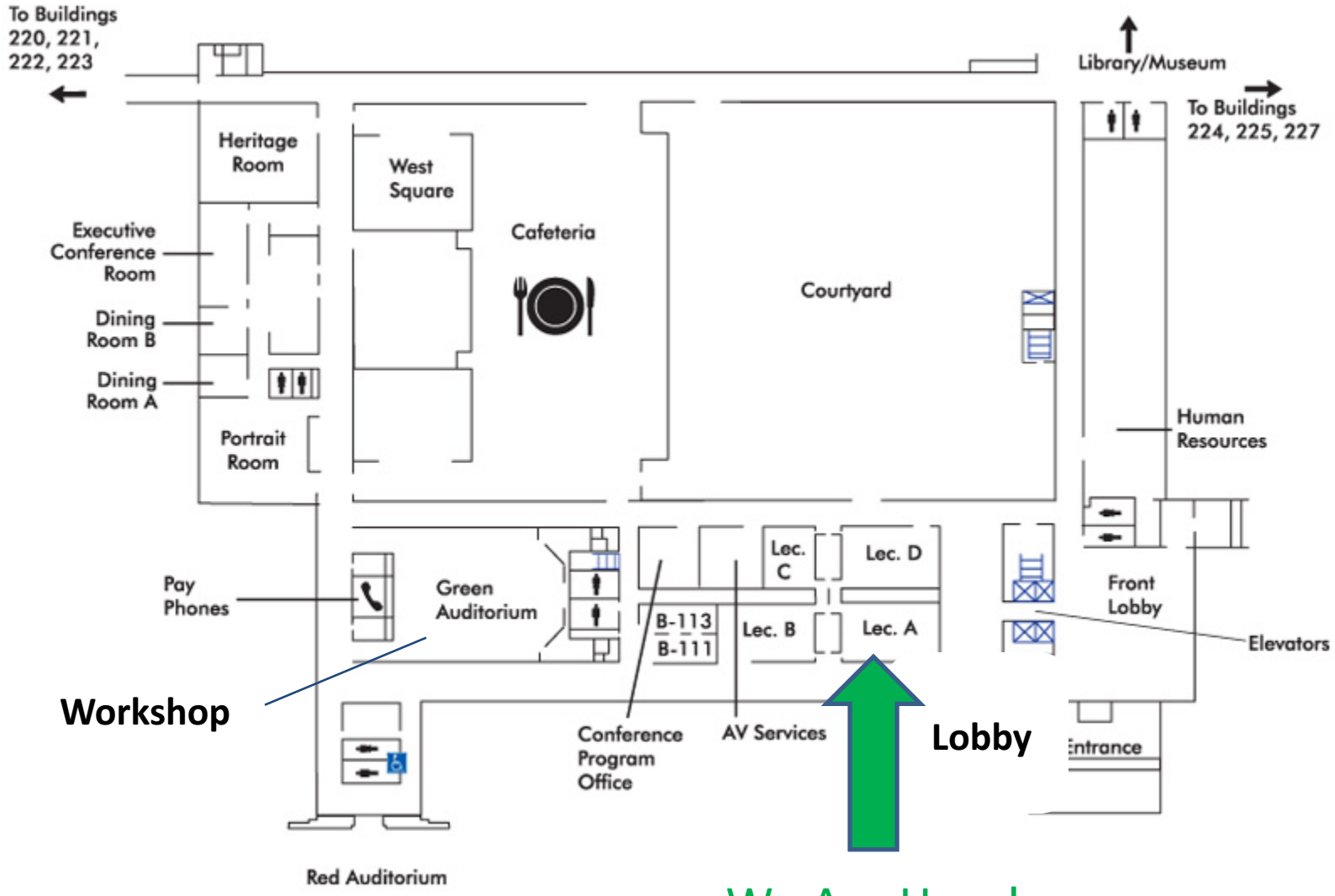
To Buildings
220, 221,
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Library/Museum
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Heritage
Room
West
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Cafeteria
Courtyard
Executive
Conference
Room
Dining
Room B
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Room A
Portrait
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Human
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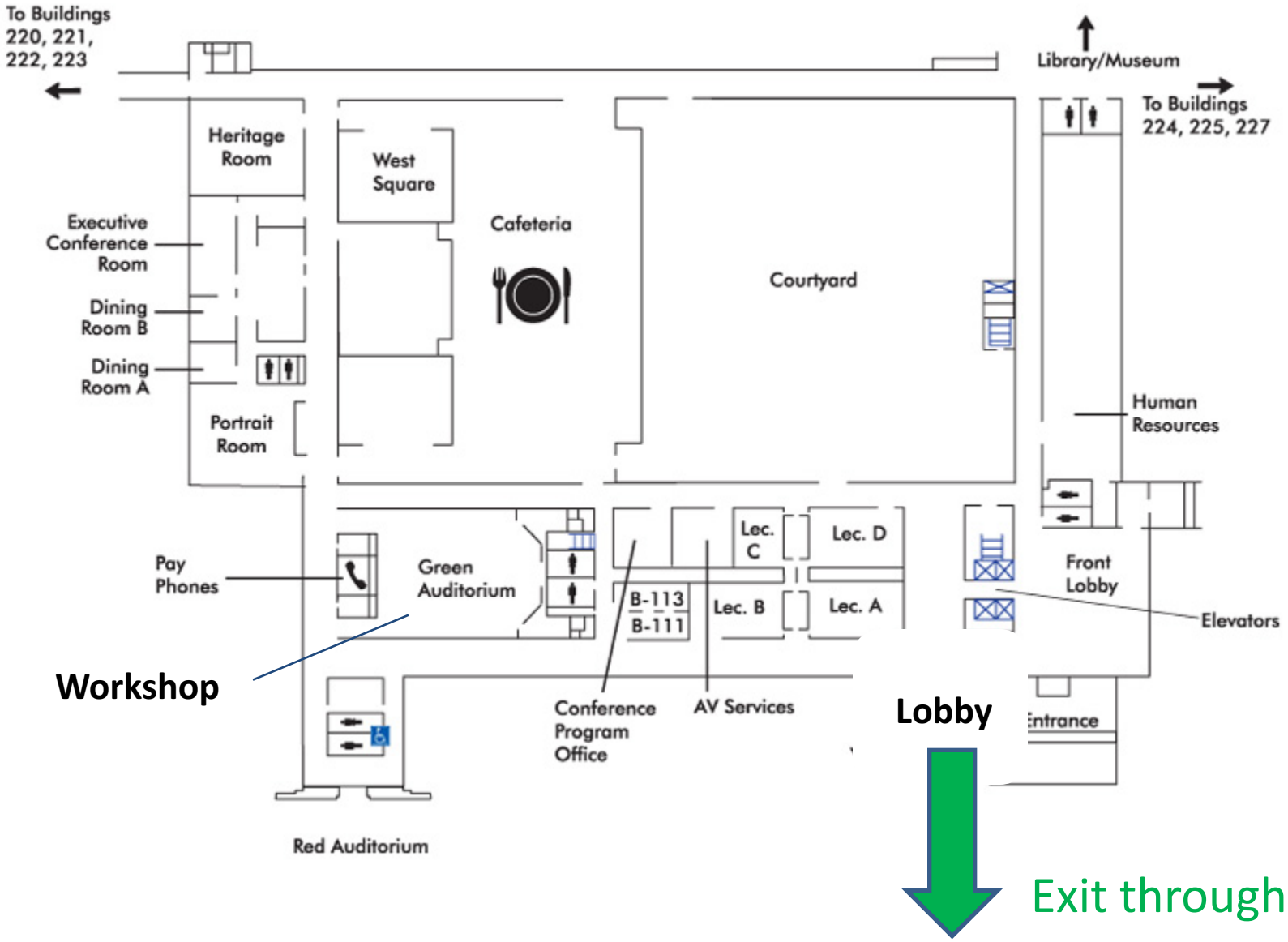
Lec. B
Lec. A
Front
Lobby
Elevators
Workshop
Conference
Program
Office
AV Services
Lobby
Entrance
Red Auditorium
We Are Here!

# Emergency Procedures

- In an emergency, please exit lobby doors
- Once outside, NIST staff will lead you to assembly points in the parking lots
- If alarm sounds, loudspeaker instructions will follow with additional information (shelter in place, etc.)



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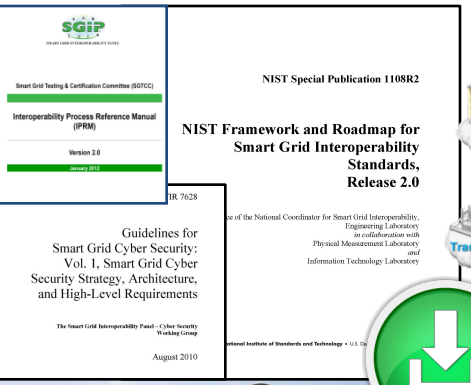
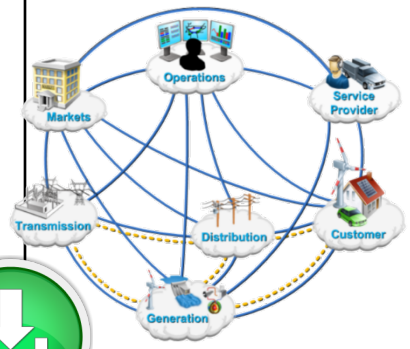
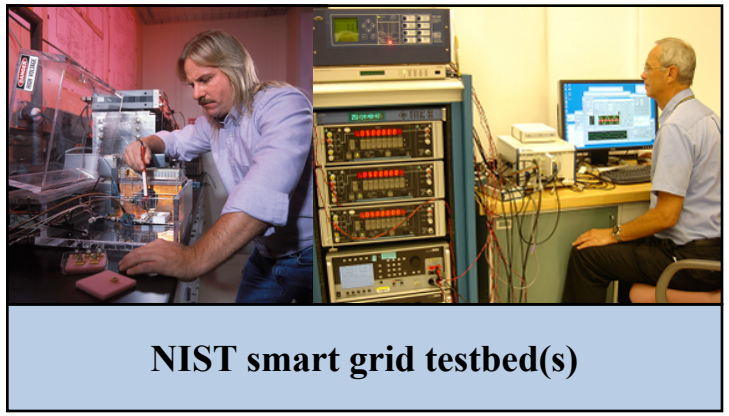
# Stakeholder Engagement in Smart Grid is Important

- Energy Independence and Security Act (2007)
  - NIST: responsibility to work with stakeholders to coordinate development of a consensus-based framework for smart grid interoperability standards: initial workshops, Smart Grid Interoperability Panel (SGIP), … SG R&D portfolio
  - DOE: numerous stakeholder engagement activities, ARRA projects, Nat'l Labs
  - IEEE, IEC, EPRI, NEMA, GWAC, EEI, NRECA, APPA, UCAIug, NAESB, …
  - Utilities; State/Fed Regulators; Universities: UCLA, U.Illinois, CMU, U-NH, …



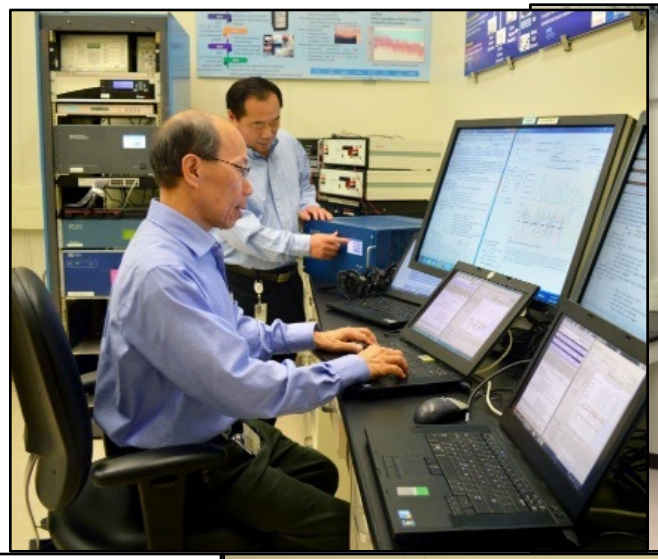


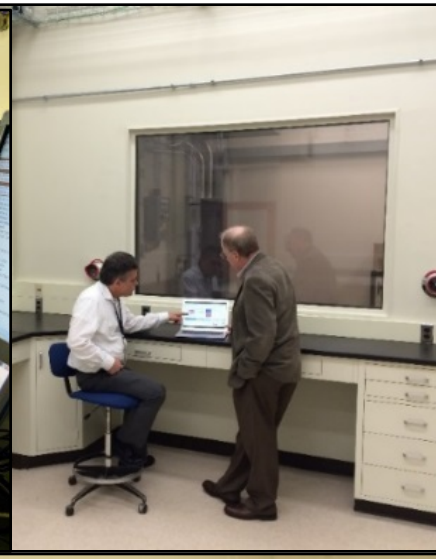


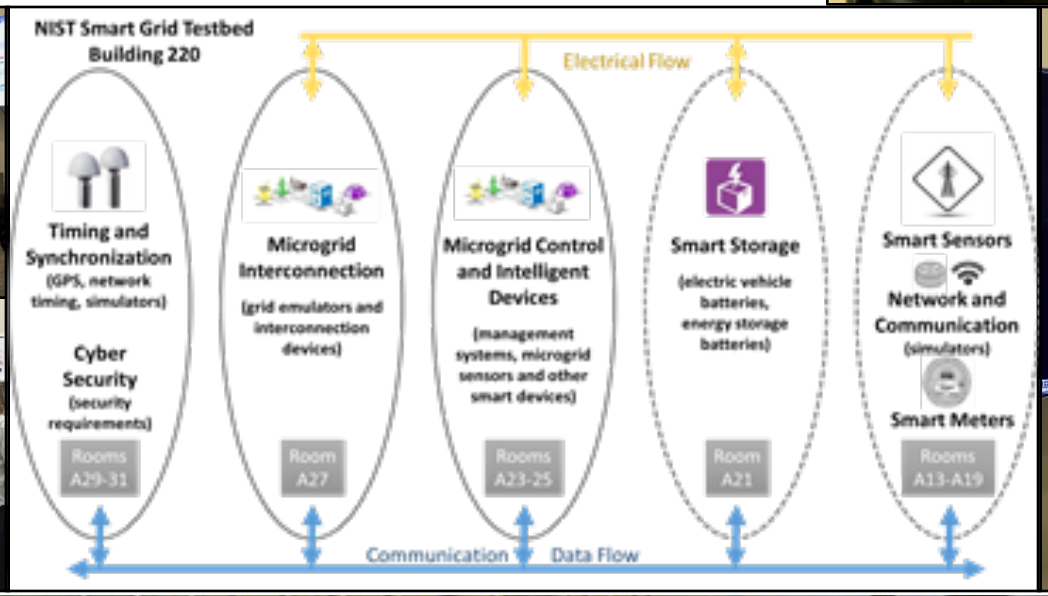
NIST smart grid testbed(s)

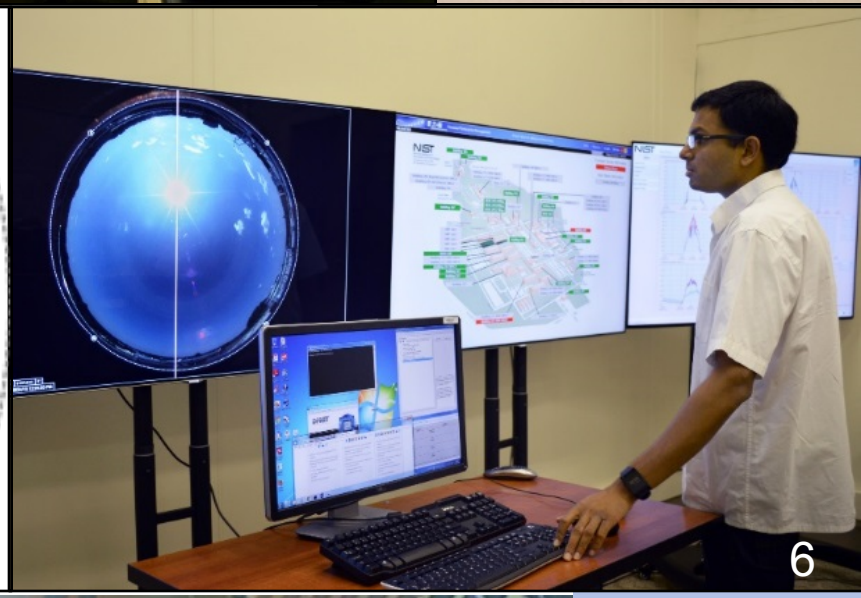
# NIST Smart Grid Interoperability Testbed

- Testbed partial construction, initial operations
  - Microgrid Facilities (AC and DC Grid Emulators, Smart Inverters) including safety monitoring/daily operational coordination
  - Timing and Synchronization / Cybersecurity (GPS Antenna, IEEE 1588 Clocks, Network Switches)
  - Interoperability test of smart sensors for Smart Grid
- Focus areas: Microgrids, Merging Units, Sensors





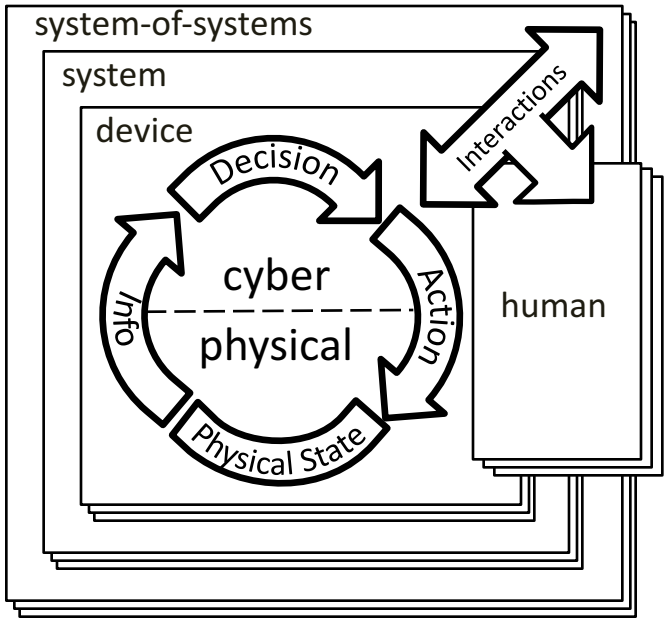


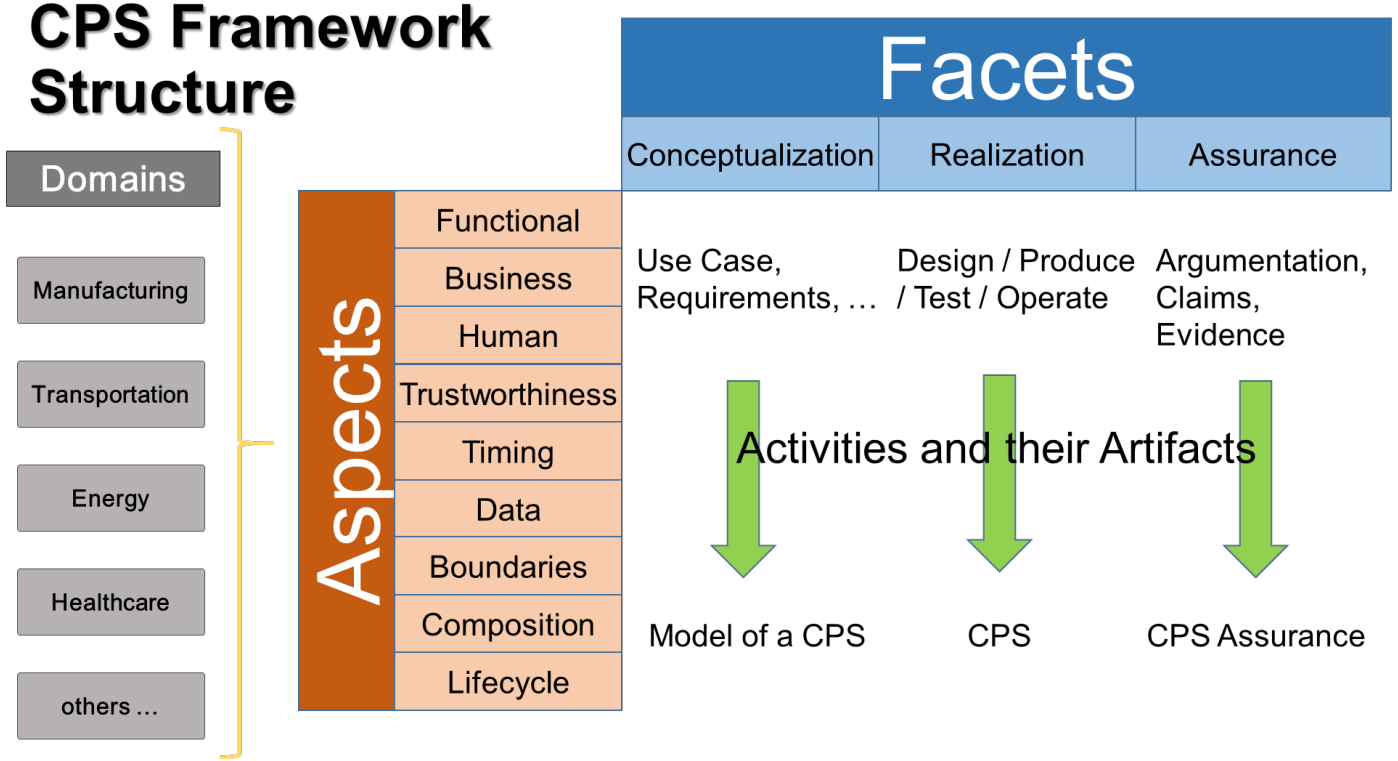
# Smart Grid is an example of an IoT/ Cyber-Physical System infrastructure

- NIST CPS Public Working Group (industry, academia, government)
- CPS Framework Release 1.0 (May2016) provides technical foundation for CPS/IoT
- Collaboration site: https://pages.nist.gov/cpspwg/

**Cyber-Physical System**




**CPS Framework Structure**



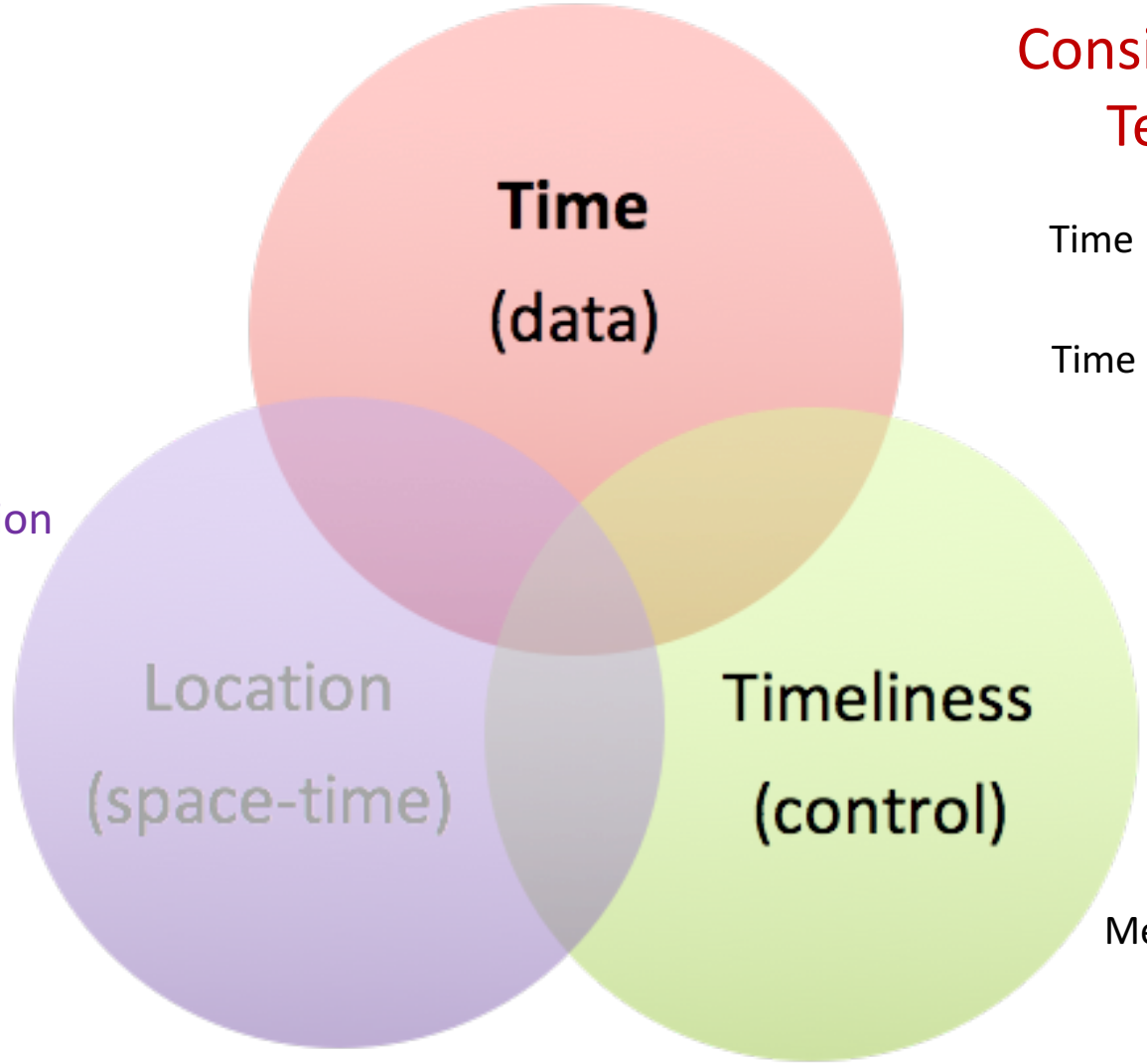

**Timing Aspect concerns:**

**Synchronization**
time, phase, frequency

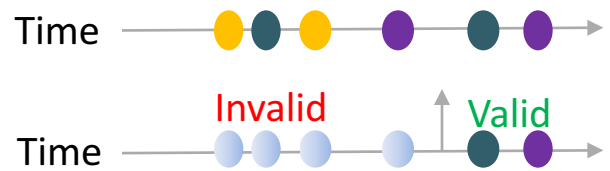
**Time Awareness**
time correctness by design

**Time-Interval and Latency**
bounded, deterministic, accurate TIs

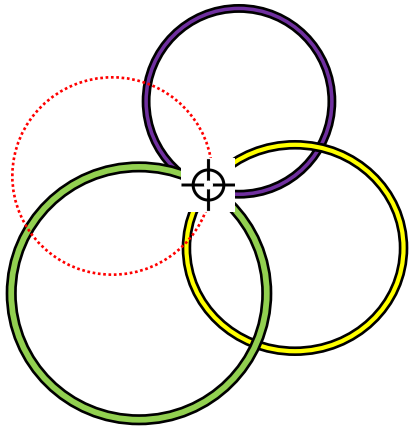
# The Importance of Time in Distributed CPS Applications



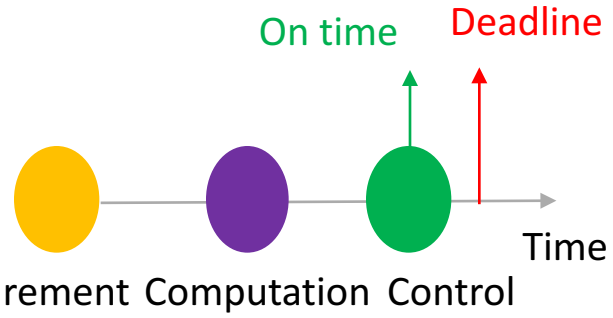

Consistent Ordering and Temporal Validity




GNSS ”pseudo”-triangulation



Real-time



# Timing Challenges (Examples)

- Assurance of wide area time synchronization traceability (GPS, etc.)
- Intentional and unintentional risks to precision timing reliability
- Monitoring and anomaly detection of synchronization performance
- Impact of security on synchronization performance
- Multiple time scales

# NIST Objectives for this Workshop

- Understand the impact of existing timing challenges on future power systems measurement applications and algorithms
  - Spatio-temporal analysis: explore effects in the time and space domain (fault detection and location)
  - Time-frequency analysis: explore effects in the time and frequency domain at multiple resolutions (identifying transients)
- Prioritize and identify timing metrology needs (research and standards)
  - Timing performance metrics based on experimental impact studies
  - Monitoring and anomaly detection strategies
  - Industry conformity and interoperability standards for time