National Defense Industrial Association 32nd Annual National T&E Conference

Test and Evaluation of Autonomous Vehicles

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Test Resource Management Center (TRMC)

TRMC Autonomy T&E Initiative Lead

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San Diego CA

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TRMC Organization

As of 9 Feb 2017

Under Secretary of Defense for Acquisition, Technology & Logistics
Mr. James A. MacStravic (Acting)

Director,
Test Resource Management Center (TRMC)
Mr. G. Derrick Hinton (Acting)

Principal Deputy, TRMC
Mr. Paul D. Mann (Acting)

Chief Financial Officer

Chief Operating Officer

Deputy EA for Cyber Test Ranges

Range Director, National Cyber Range

Deputy Range Director, NCR

DD, T&E Range Oversight

PM, CTEIP

DD, Major Initiatives and Technical Analysis

Agency RO

AF RO

Army RO

Navy RO

PM, REP
Deputy PM, CTEIP

PM, T&E/S&T

Deputy PM, T&E/S&T

PM, JMETC

Director, TENA SDA

Test Resource Management Center (TRMC)

TRMC Mission

T&E Infrastructure

- MRTFB Planning, Assessment and Oversight
- Strategic Plan for DoD T&E Resources
- T&E Budget Certification

T&E Investments

- Test & Evaluation/Science & Technology (T&E/S&T) Program
- Central Test & Evaluation Investment Program (CTEIP)
- Joint Mission Environment Test Capability (JMETC)
- National Cyber Range (NCR)

The STEWARD of the DoD Test Infrastructure
Major Range and Test Facility Base (MRTFB): The "Critical Core"
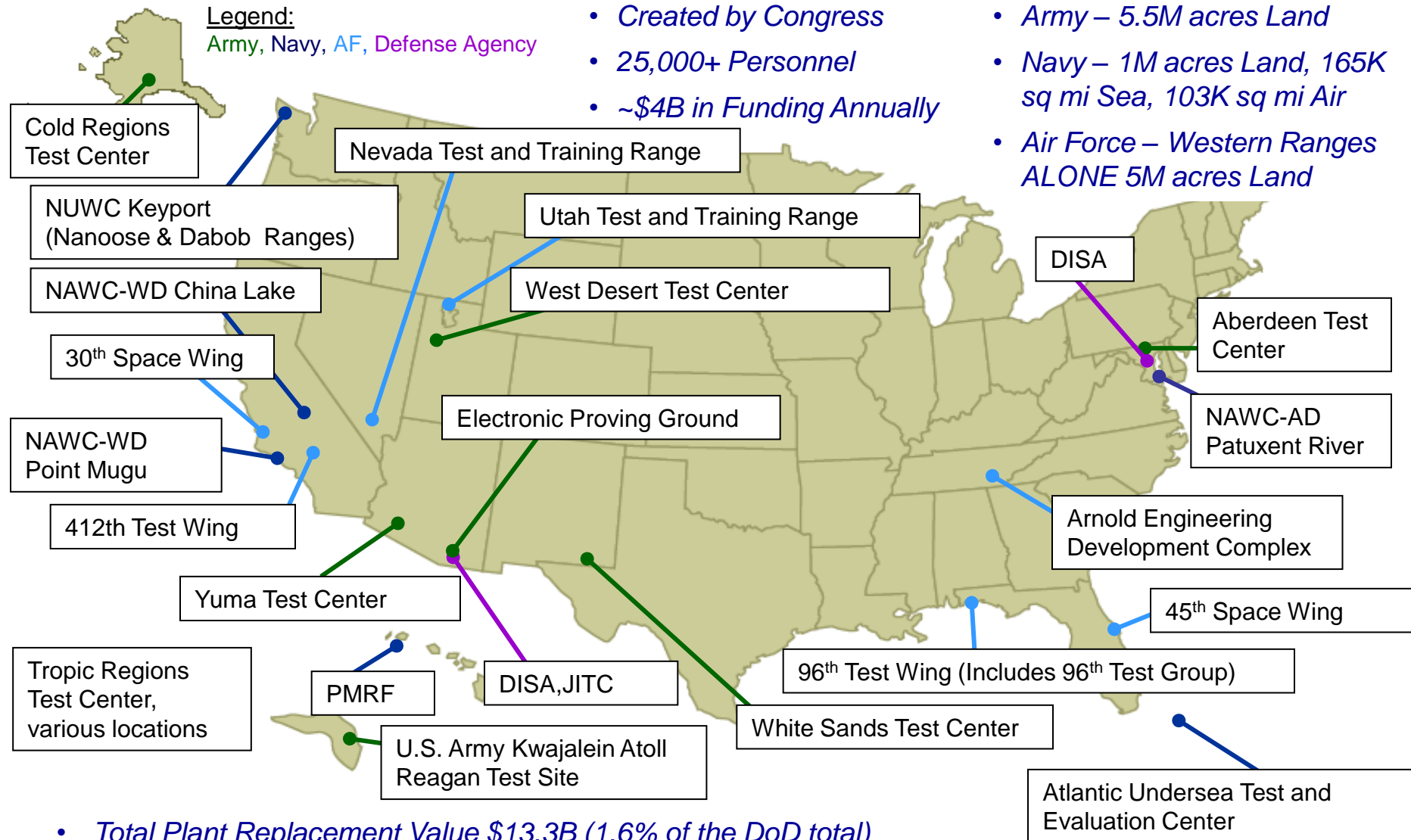### 23 Sites: Army-8; Navy-6; Air Force-7; Defense Agency-2
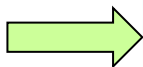
Legend:
Army, Navy, AF, Defense Agency

- *Created by Congress*
- *25,000+ Personnel*
- *~$4B in Funding Annually*

- *Army – 5.5M acres Land*
- *Navy – 1M acres Land, 165K sq mi Sea, 103K sq mi Air*
- *Air Force – Western Ranges ALONE 5M acres Land*

Cold Regions Test Center

NUWC Keyport (Nanoose & Dabob Ranges)

NAWC-WD China Lake

30th Space Wing

NAWC-WD Point Mugu

412th Test Wing

Tropic Regions Test Center, various locations

Nevada Test and Training Range

Utah Test and Training Range

West Desert Test Center

Electronic Proving Ground

Yuma Test Center

PMRF

DISA,JITC

U.S. Army Kwajalein Atoll Reagan Test Site

White Sands Test Center

96th Test Wing (Includes 96th Test Group)

DISA

Aberdeen Test Center

NAWC-AD Patuxent River

Arnold Engineering Development Complex

45th Space Wing

Atlantic Undersea Test and Evaluation Center

- *Total Plant Replacement Value $13.3B (1.6% of the DoD total)*

The Autonomy Challenge

Smart Phones

Smart Cars

We haven't seen anything yet

Computing Power & Connectivity (y-axis)

Pace of technology advancement next 10 years ≈50X Improvement

Pace of technology advancement last 10 years

However, our tech is advancing exponentially

Cannot apply today's assumptions to predict tomorrow's reality

We are conditioned to think linearly

Today

Time (x-axis)
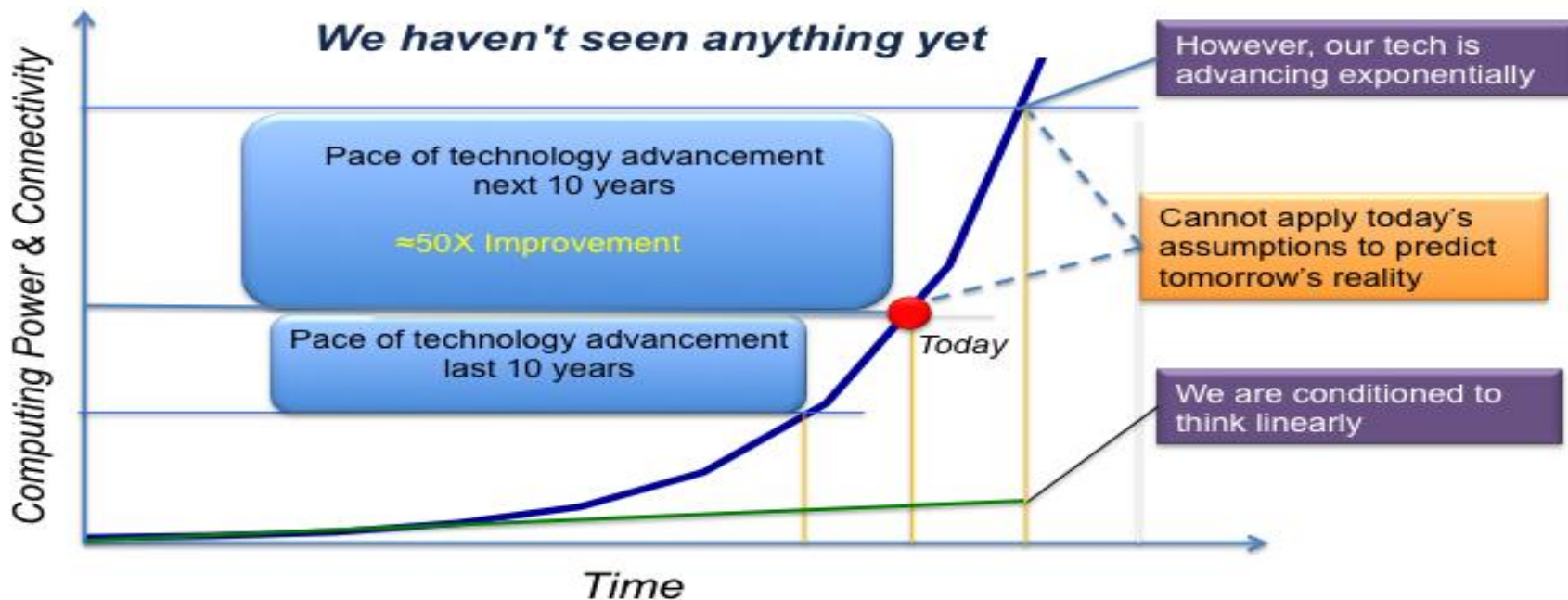
Autonomy presents unique challenges/opportunities to the tester

DT&E / TRMC Autonomy Initiative

Objective: Determine the methodologies, infrastructure, and resources required to efficiently test technologies needed to field autonomous systems

| Automated	Autonomous
• Intentional	• Intentional
• Mission Capable	• Mission Capable
• Independent	• Independent
• Deterministic	• Probabilistic
• Certainty	• Uncertainty
• Verified Trust	• Statistical Trust
• Expected Trust	• Earned Trust
• Chaotic Foundation	• Random Foundation
• Clockworks	• Free Will

To be autonomous, a system must have the capability to independently compose and select among different courses of action to accomplish goals based on its knowledge and understanding of the world, itself, and the situation.
Defense Science Board

Driving to an Autonomy T&E Solution
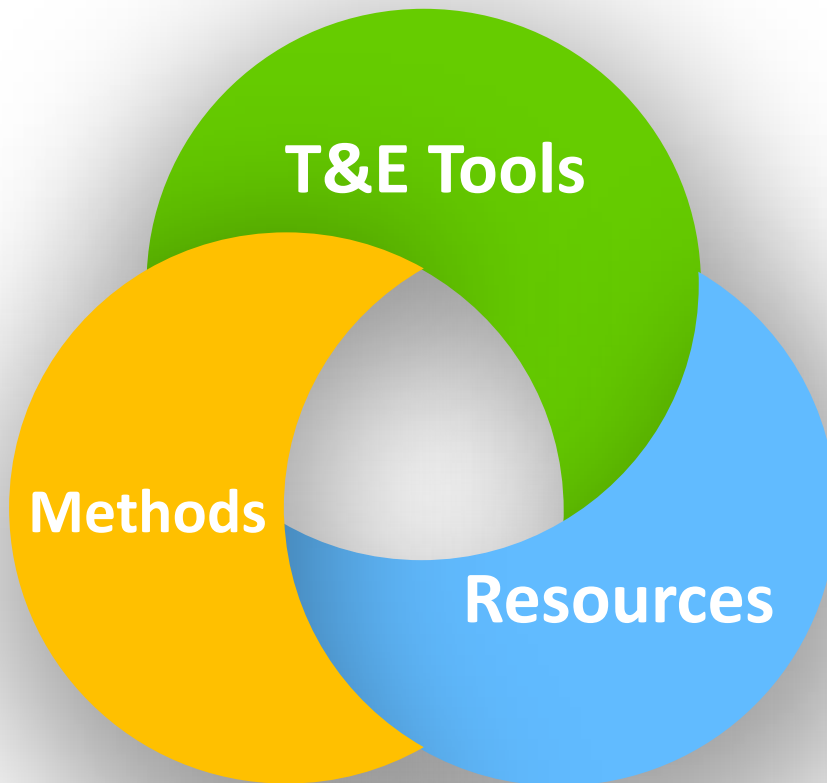
T&E Tools

- Trust & Risk Measurement
- Autonomy Function Introspection Tools
- Intelligent Planning Tools
- Enterprise (Big Data) Analytics

Methodologies

- Methods, metrics, processes for autonomy
- Standard test cases, interfaces
- Training & education
- Policy development & coordination
- Culture

Resources

- High fidelity M&S architectures
- Autonomy and environment models
- World Models (including MRTFB models)
- Agile and adaptive ranges
- Scalable

Distributed Autonomy T&E Test Capability

Distributed LVC Environment

T&E Data Repository and Big Data Analytics

T&E Architecture

T&E Facility with Focused Expertise on Cyber Testing

T&E Data Science Center

- Standards
- Models
- Architectures
- Interfaces

- Staff
- Education
- Training
- Policy
- Culture

Evaluation Environment For Autonomy Innovation

Air Domain

Ground Domain

Maritime Domain

T&E Facilities with Focused Expertise on Airborne Autonomy

T&E Facilities with Focused Expertise on Vehicle & Ground Autonomy

T&E Facilities with Focused Expertise on Seaborne & Subsurface Autonomy