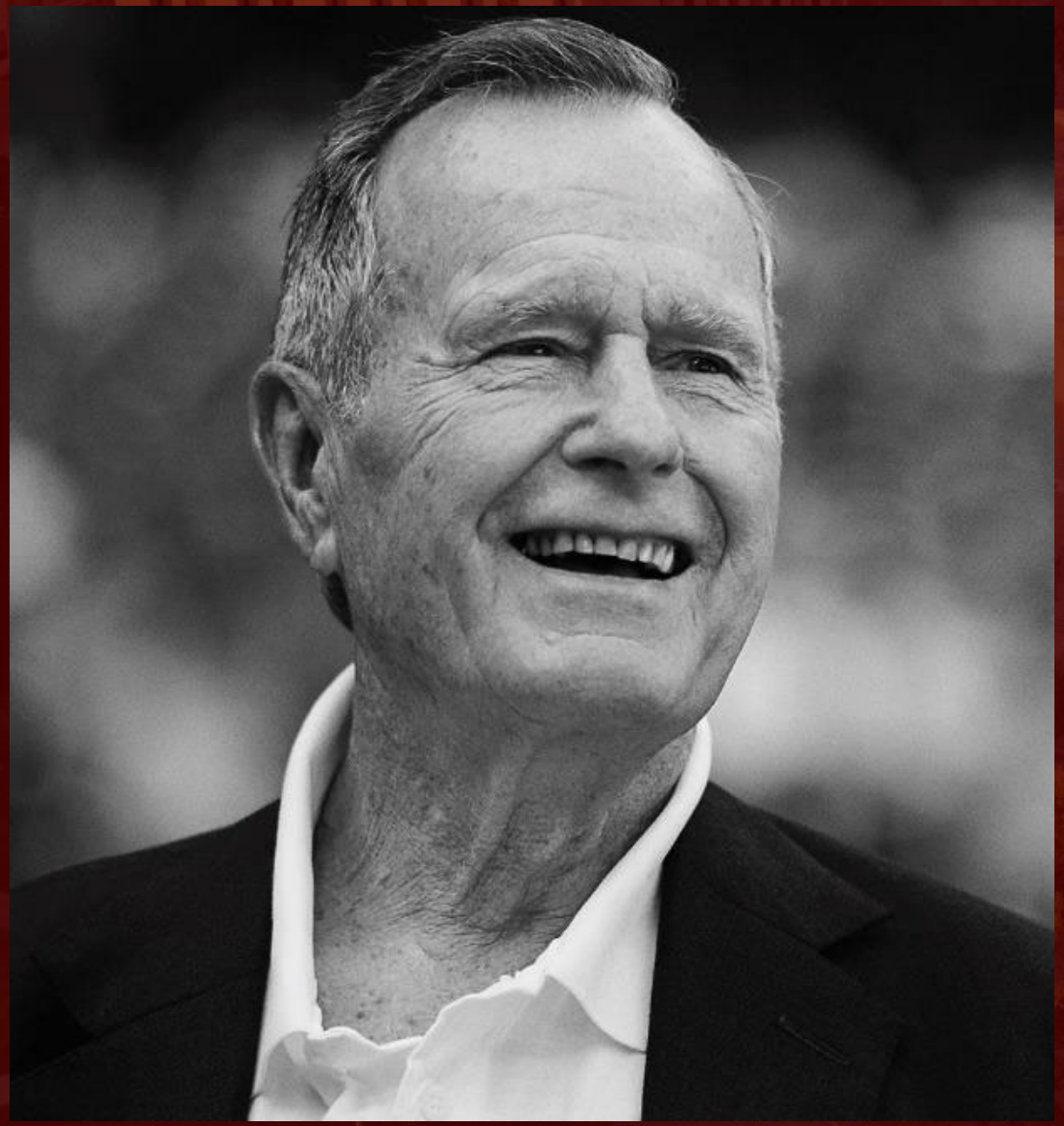


BUSH COMBAT DEVELOPMENT COMPLEX

"There is nothing more fulfilling than to serve your country and your fellow citizens and to do it well."

– Pres. George H.W. Bush

BUSH COMBAT DEVELOPMENT COMPLEX

Mission

Conduct research, development, test, and evaluation of critical national security technologies with world-class researchers and partners using relevant state-of-the-art laboratory and testing facilities.

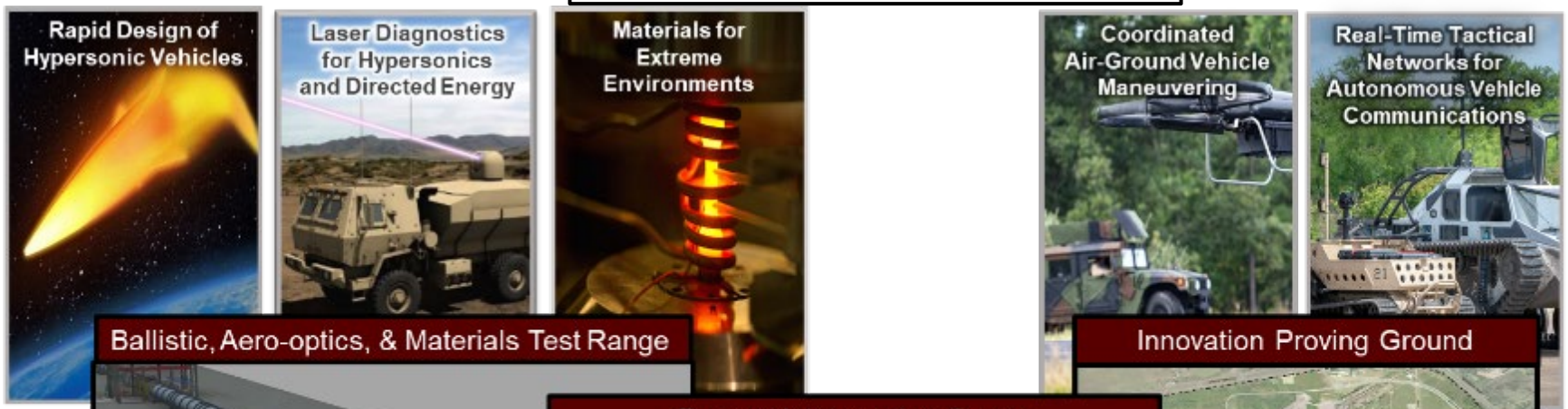
Vision

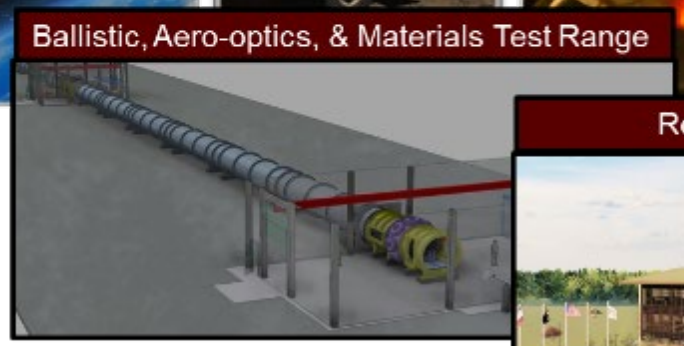
Accelerate the development, integration, and transfer of technology to advance United States defense and security capabilities in critical technology areas. We will operate with an agile mindset to help our partners deliver new capabilities for the nation.

BCDC Capability Summary

BUSH COMBAT DEVELOPMENT COMPLEX

World Class Research Teams





State of the Art Facilities

- ***Internal World-Class, State-of-the-Art Facilities***
- ***Proximity to multiple external facilities that open the aperture on capabilities in the ecosystem***
- ***Dedicated research engineers***
- ***Customer-directed research***
- ***DCSA-cleared defense contractor***
- ***Award-winning security office***
- ***Ability to leverage the TAMUS broad base of faculty and graduate students***

"The Combat Development Complex will bring together diverse partners from businesses, academia, and most importantly, our Soldiers...when we bring the team together, we can innovate faster to develop game-changing solutions. By testing emerging technology in an operationally relevant environment...we can evaluate it early to ensure we're getting exactly what our troops need in the field."

-GEN John M. Murray
First CDR, U.S. Army Futures Command

IPG – Ecosystem of Capabilities

BUSH COMBAT DEVELOPMENT COMPLEX

Mission Statement: Provide outdoor test / experimentation facilities postured to rigorously assesses a myriad of technologies across a broad range of Technology Readiness Levels, from innovative prototypes to fully mature systems, doing so in an operationally relevant setting. Agile and adaptive, the IPG serves as a proving ground for proving grounds as its integration of a combination of cutting-edge capabilities delivers a unique ecosystem that enables tailorable tests and research efforts, all facilitating the development of inventive, synergistic strategies to open the aperture on evaluating advances in technology.

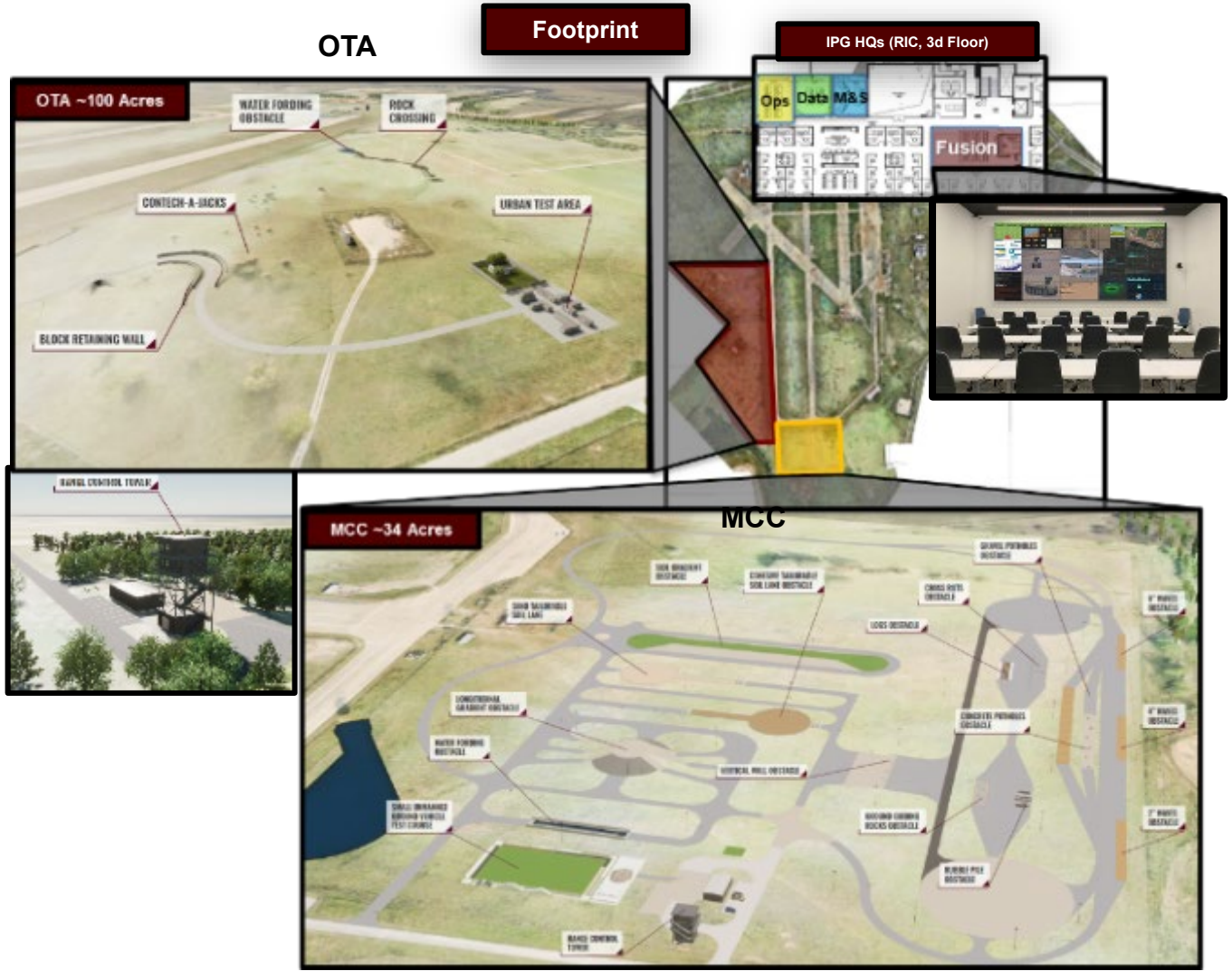
Capabilities

- **Realistic Environment:** Operational relevance and realism provided using Test Areas (Off-Road, Maneuver Challenge Course, and Subterranean) combined with airspace and battlefield effects
- **Full Instrumentation:** Integration of cutting-edge audio/visual and sensor technology to characterize the environment and provide comprehensive feedback on multiple capabilities and the environment in which they are operating
- **Stand-Alone Network:** 5G wireless, Mesh, and Fiber enabling real time streaming of large amounts of data at very low latency
- **Data Capture and Storage:** Ability to live stream data to a fusion cell affording immediate curating of data while storing massive amounts of data in a Data Lake facilitating reach-back and sharing/collaboration
- **Cybersecurity Operations:** Evaluation of the cyber resiliency of systems and the network as well as access to secure communications
- **Modeling and Simulation:** Incorporation of gaming and M&S Technologies to support (wrap around simulations, digital twinning, virtual environments) to expand SUT stimulation, distributed testing, and expand data generation
- **Test Integration Support:** Cells of experts (OPs, Data, M&S) to plan and execute events tailored to the users' needs fully connected to the BCDC Research Integration Center

"This has been powerful. I think you (IPG) are part of our solution with regard to accelerating modernization efforts and more efficient testing initiatives."

-MG Jay Gallivan
CDR, Army Test and Evaluation Command

Footprint



Mobility Challenge Course

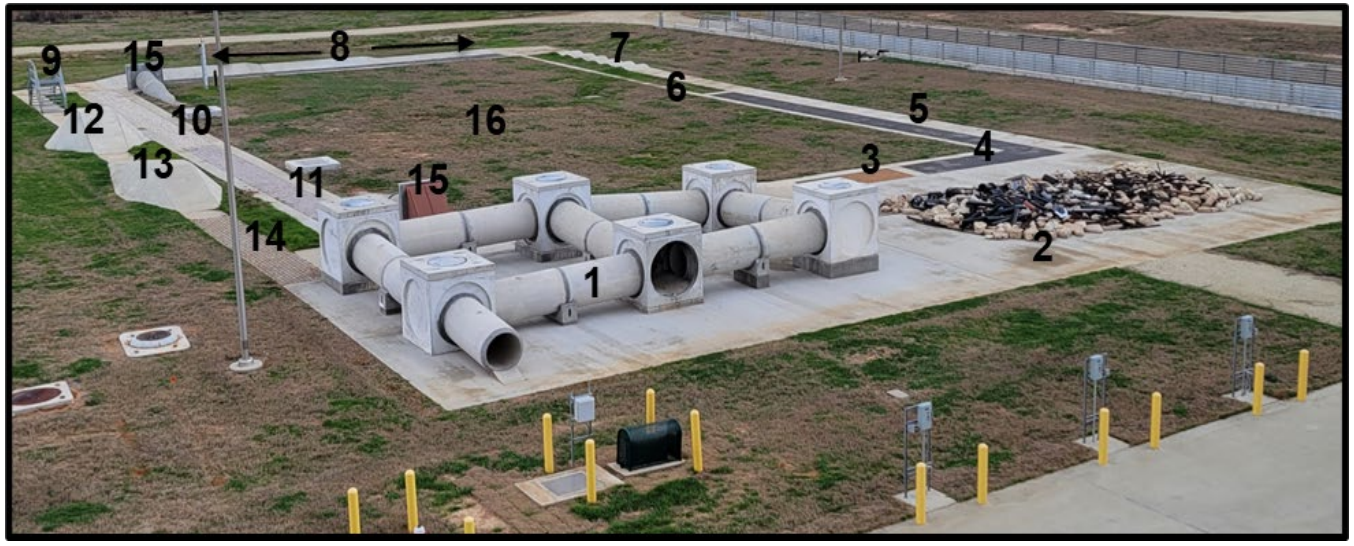
BUSH COMBAT DEVELOPMENT COMPLEX

MCC Key Attributes

- 34 Acres consisting of a 1.1 Mile (outer loop) test track and additional user terrain
- Test Track supports platforms (air and ground; wheeled, tracked, multi- pedal) ≤ 44 tons
- 30' Control and Observation Tower (cameras, radar, monitors)
- Concrete staging pad w/ wash point and 6xstation shore power vehicle chargers
- 2xbay storage facility
- Engineered obstacles including:
    1. 270'-long Water Fording Lane w/ variable depth up to 6'
    2. 20-45% Gradient Hill Climb
    3. 10-20% Side Gradient
    4. 30-40% Side Gradient
    5. Tailorable Soil Lane #1 (Sand) but can be swapped out to other soil
    6. Tailorable Soil Lane #2 (Clay) but can be swapped out to other soil
    7. Trafficability Lane #1 (Washboard 6",4", and 2", Waves, Potholes)
    8. Trafficability Lane #2 (Cross ruts, rocks, rubble, logs)
    9. 12"-36" Vertical Wall Climb
    10. Scaled air and ground vehicle (SAG-V) Course
    11. 70' floodable tunnel-36" diameter (Small air and ground vehicles)
    12. .25 mile asphalt straitaway
    13. Concrete Turning circle (200' diameter)
    14. Packed Gravel Turning circle (200' diameter)
    15. .75 miles of packed gravel trail
    16. 5 Acres of Off-Road Terrain
- All obstacles are concrete (minus the soil in 5 and 6)

MCC (Scaled Air/Ground vehicle Range) Key Attributes

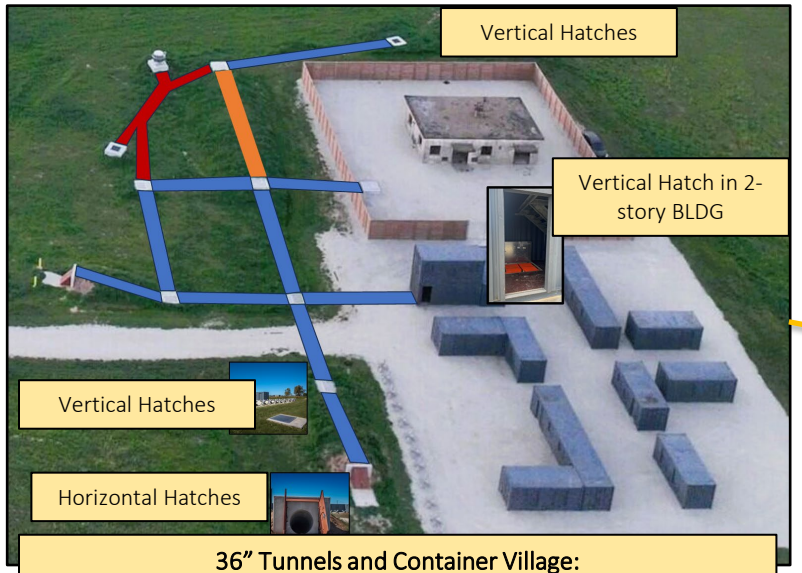
- 1.5 Acres of Test Area consisting of .25 miles of track and .75 acres of off-road area
- Obstacles and track support platforms (air & ground; wheeled, tracked, multi- pedal) ≤ 2 tons
- Supported by the MCC Control Tower, instrumentation and staging pad/storage
- Engineered obstacles including:
    1. Above ground Tunnel Course (36" w/multiple vertical and horizontal ingress points
    2. Rubble Pile
    3. Deep Sand Lane: 72 'L x 6'W x 20" depth
    4. Asphalt Lane: 106'L x 6'L
    5. Rough Concrete Lane: 86'L x 6'W
    6. Compacted Soil Lane: 74'L x 6'W l
    7. 6" Washboard Lane: 36'Lx6'W 6"
    8. Side Slopes x 3: 89'L x 6'W (24' at 10%, 24' at 20%, 24' at 30%)
    9. Stair Steps (18-24")
    10. 1"-3"Crushed Rock Lane: 73'L x 5'W
    11. 4"-6" Crushed Rock Lane: 78'L x 5'W Crushed Rock
    12. Longitudinal Gradient: 24'L x 5"W with 45% and 60% slopes
    13. Longitudinal Gradient: 41'L x 5"W with 30% and 15% slopes
    14. Belgian Rocks
    15: Floodable/Drainable Tunnel Lane 135'-36" diameter concrete culvert
    16. Off-Road Tailorable Area



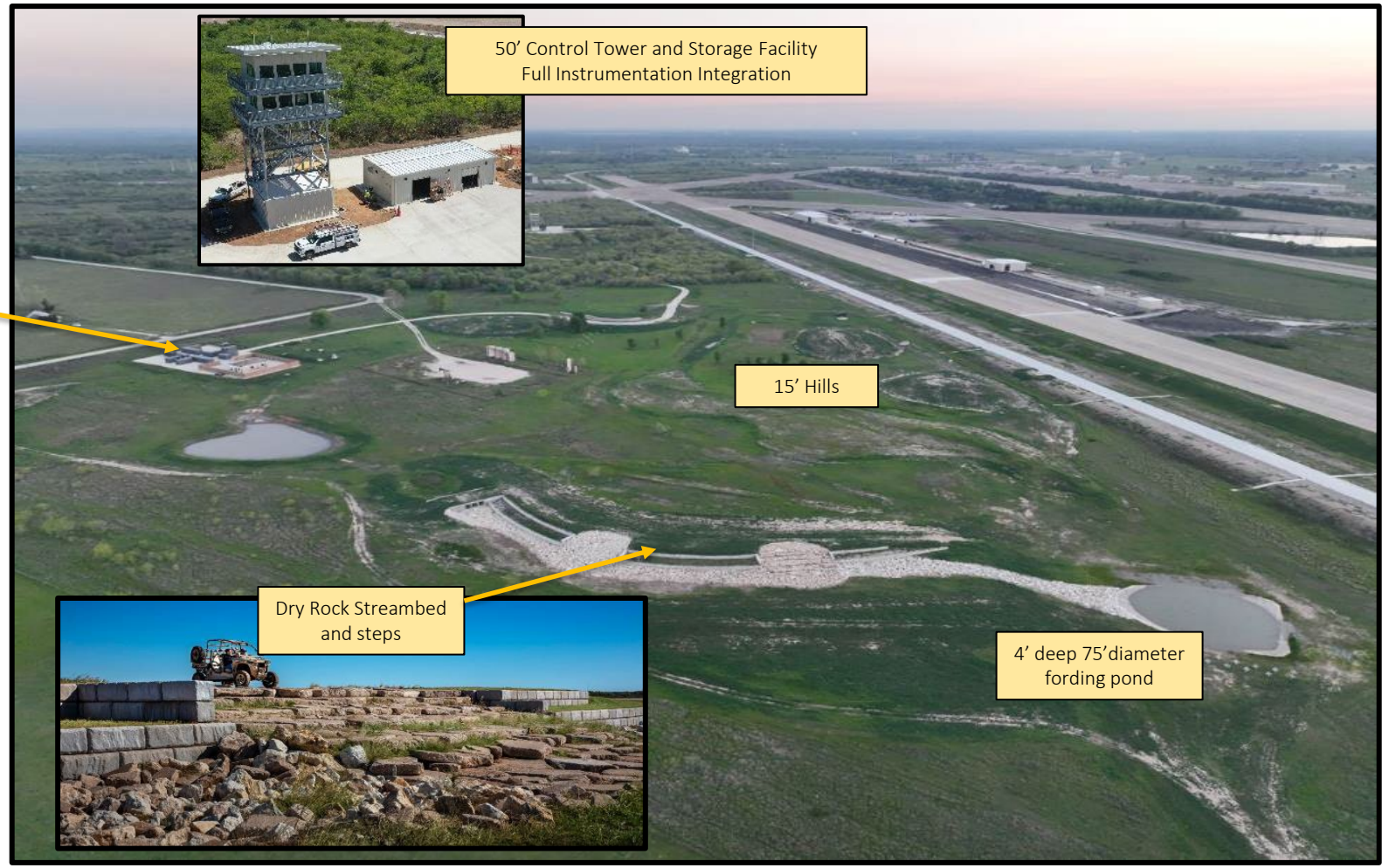
Off-Road Test Area

BUSH COMBAT DEVELOPMENT COMPLEX

Attributes
- 100 Acres of **Complex Terrain** (forest, hills, trails, and open maneuver)
- 50’ Control and Observation Tower (cameras, radar, monitors)
- Concrete staging pad w/ wash point and 6xstation shore power vehicle chargers
- 2xbay storage facility
- Reconfigurable Urban Environment consisting of 7 x 1-story and 1 x 2-story Bldgs
- Engineered obstacles in an operational setting (water fording pond, rubble bed)
- Tailorable to user requirements in terms of land modification and incorporation of situational obstacles
- 600 feet of concrete tunnels 36” with Faraday and wind generation capability



36” Tunnels and Container Village:
- 2x Horizontal Ingress sites
- 8x Vertical Ingress Sites
- BLUE = Normal Tunnel
- ORANGE = 70’ “Faraday” Cage (20’ overburden replication)
- RED = Wind Tunnel (15mph)



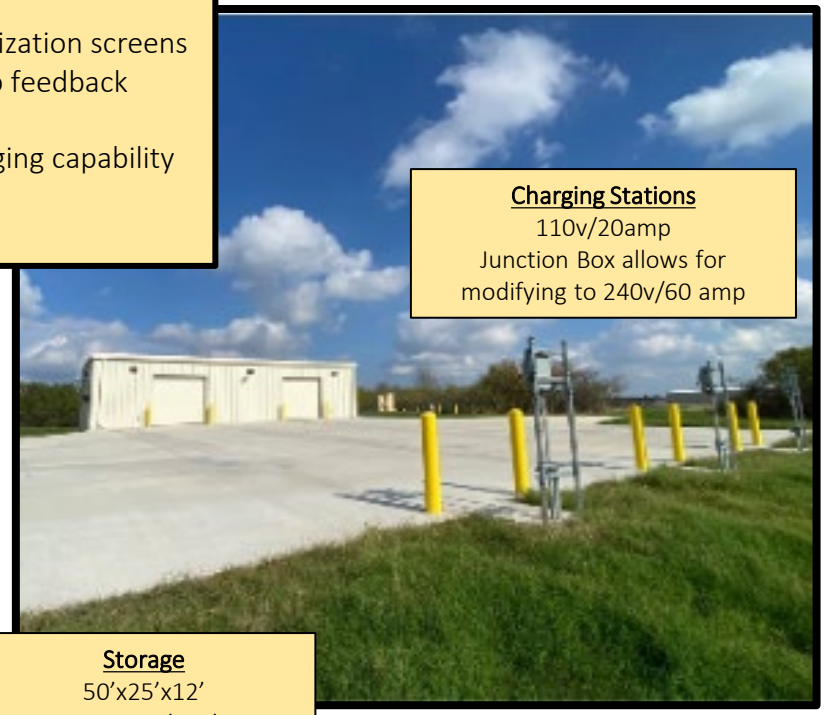
Command and Control/Logistics Facilities

BUSH COMBAT DEVELOPMENT COMPLEX

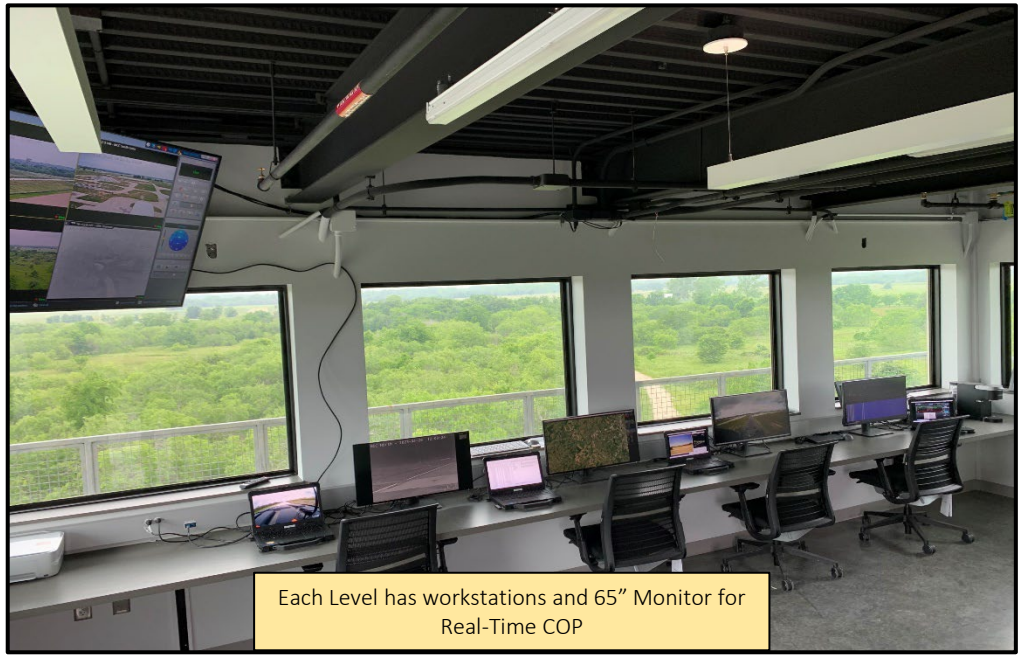
Both Range Facilities are supported by:

- A two-level control tower with Fiber Access and data visualization screens
- High resolution (Day/Thermal) PTZ Range Cameras for video feedback
- A storage facility with power and wiFi
- Vehicle Charging Stations equipped to provide Level 2 Charging capability
- A 200'x 75' Concrete Staging Pad
- A wash Station with power washer

Control Tower
Climate Controlled
120v power
WiFi



Charging Stations
110v/20amp
Junction Box allows for modifying to 240v/60 amp



Each Level has workstations and 65" Monitor for Real-Time COP

Storage
50'x25'x12'
Doors 10'x10'
Shore Power (120V)

BCDC-Research Integration Center (RIC)

BUSH COMBAT DEVELOPMENT COMPLEX

The BCDC's RIC provides three-stories of world-class office, laboratory, integration and maintenance bay space less than a quarter of a mile from the IPG and BAM Ranges resulting in an unmatched ability to exercise and accelerate iterative testing and research in a truly collaborative environment.

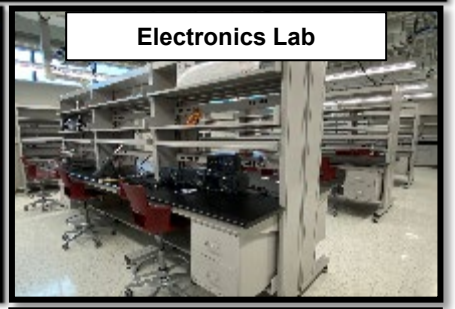
Key Attributes

- Multiple Conference Rooms and Cubicle Space
- Two Maker's Space Areas
  - ✓ 1st fabrication area containing large commercial power tools (band saw, end mill, CNC machine, etc.), hand tools, etc.
  - ✓ 2nd area is work assembly and benchtop testing
- A Laser Lab and clean space
- An Electronics Lab fully outfitted with oscilloscopes, adjustable power supplies, and spectrum analyzers
- Six Integration Bays
  - ✓ Four Open Integration Bays (50' x 50'), two of which contain a 5-ton overhead lift, one contains a recessed service pit (4'x25'x5')
  - ✓ Two Secure Integration Bays (1,482ft^2 & 975ft^2)
  - ✓ Standard Shore Power (120V) can modify up to 240/60A
  - ✓ Doors (13.5'W x 16'H)
- Forklifts
  - ✓ 5,000lbs capacity, electric forklift
  - ✓ 10,000lbs capacity Telehandler forklift
- Welding area with table & fume hood
- Industrial 3D printing


RIC (Front)


RIC (Rear w/ "behind the wire" user space)

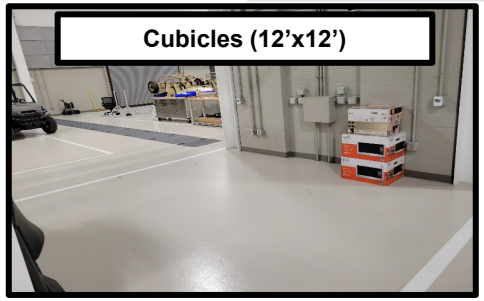

Large Conference RM up to 60


Electronics Lab


Integration Bays


Small CON RM up to 15


Makers Space

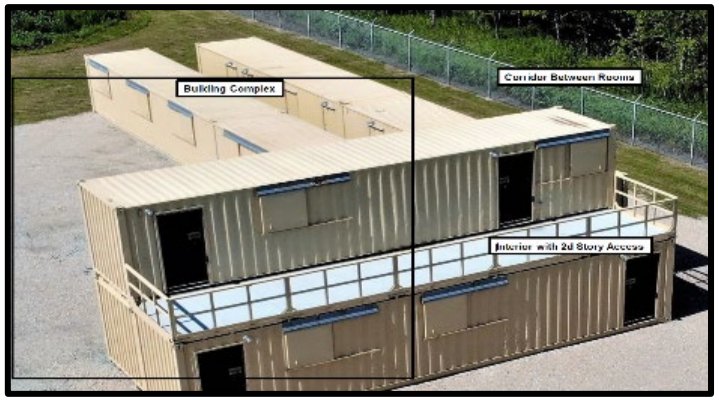

Cubicles (12'x12')

Capability Multipliers on RELLIS

BUSH COMBAT DEVELOPMENT COMPLEX

The BCDC is postured for cutting edge support to users not only through use of its internal ranges/facilities but also because of its proximity to the RELLIS ecosystem of capabilities including: 1800 acres of maneuver space (RTAs), 5 x Runways, numerous small arms ranges, an environmental chamber, a Demolition facility, and Class G airspace all within 2500 acres of secure access training area.

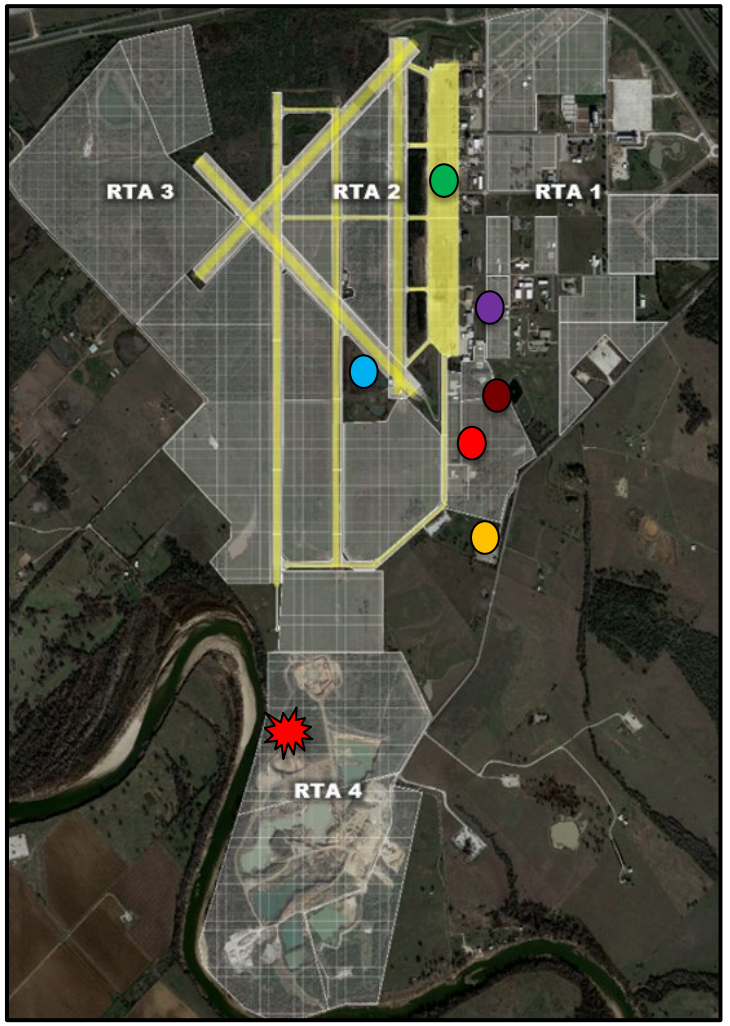
Tactical Village
Non-ballistic



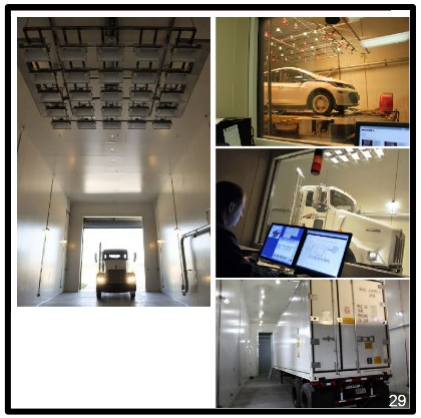
Private Airfield
2x 7,000' aircraft rated runways
3x 5,000' runways
Part 61, 107 & COA waivers

Erosion Pond
6' deep x .70 acre

Demolition Range
Up to 25lbs w/magazine



Environmental Chamber
-60 to +140 F
Employ rain, ice, or fog
Dynnometer equipped
HET size spacing



2x Pistol Ranges
Calibers up to .50

300 Yard Rifle Range
Calibers up to .50

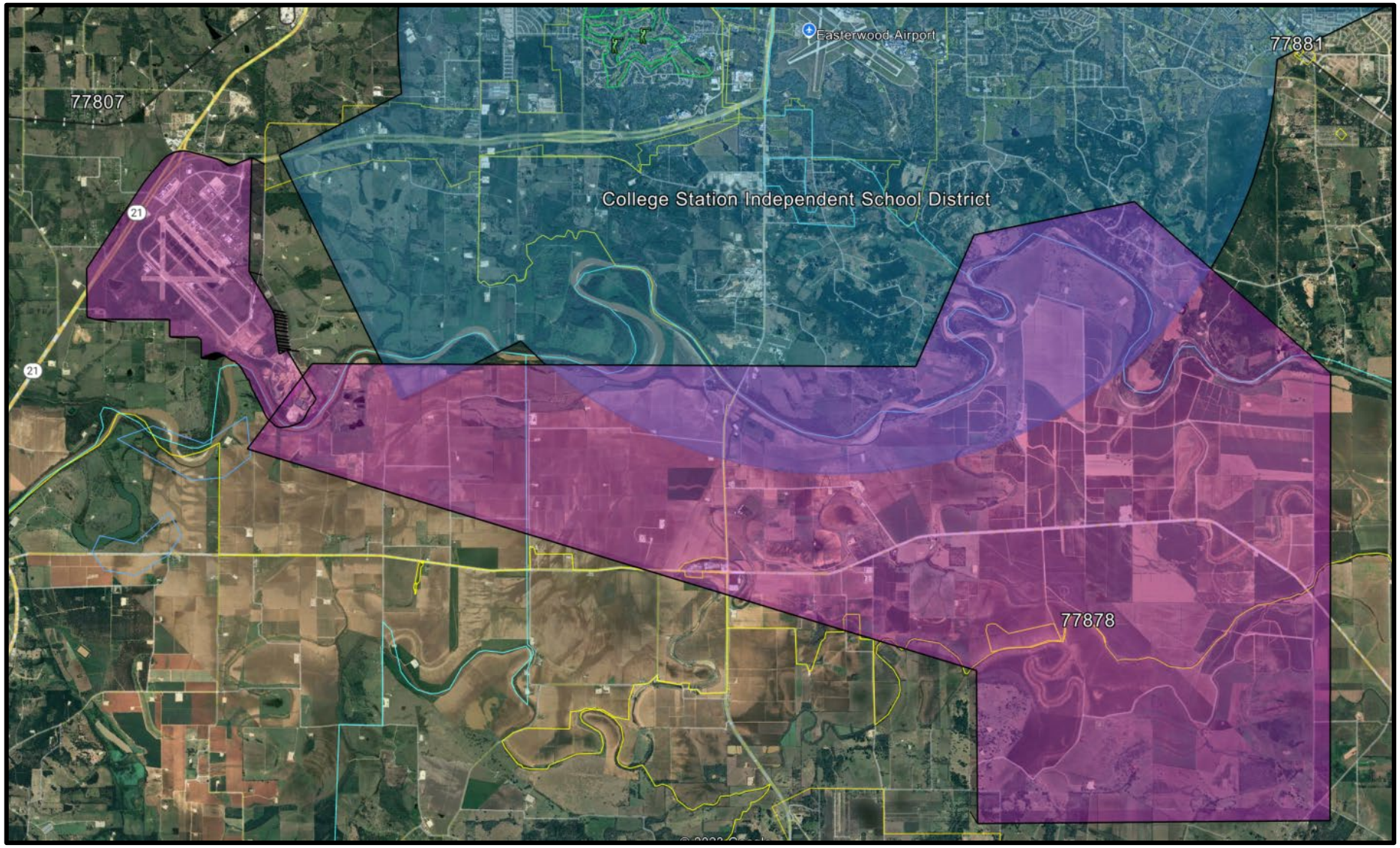
Indoor Shoothouse
Calibers up to 5.56

RELLIS UAS

BUSH COMBAT DEVELOPMENT COMPLEX

RELLIS CUAS Capabilities

- Part 107 Focused UAS
- COAs in Place to support expanded operations:
  - 12-mile Air Corridor for GRPs 1-2
  - Extended Ceiling up to 1,000’ AGL
  - Operations using platforms greater than 55lbs (GRP 3)
  - 1 x PiC controlling Multiple UAS
  - Close working airspace support with TAMUS-facilitated Easterwood Regional Airport
- 2400 Acres of Class G Airspace over the Campus with an additional 12-mile corridor extending to additional maneuver space
- Resident 5G and MESH Networks on RELLIS with expeditionary MESH capability for extended control and backhaul
- Expeditionary Radar capability in support of localized air/ground COP and data



IPG – Instrumentation

BUSH COMBAT DEVELOPMENT COMPLEX

The equipment and instrumentation is foundational to the IPG Ecosystem as it provides the IPG Team with the capability to characterize the environment, collect SUT data, and then merge the data and the conditions to paint a true picture on a SUT's ability to operate in realistic conditions.

1. 3x Tower & 1x Mobile Trailer Mounted Camera
- a) Bi-spectral (Day/Thermal)
- b) PTZ Capability
- c) Visual Video Resolution 1920 x 1080
- d) Thermal Video Res: 640 x 480

2. Trideum (DAS) Data Acquisition Systems
- a) Small form factor (<2lbs, <5" x 5" x 2.5")
- b) Dynamics, Telemetry, Diagnostics, Messaging
- c) 5G, WiFi Capable
- d) Self-powered (battery)
- e) RTK GPS positioning
- f) IP67 Rating
- g) Camera integration (day and LV)

3. Echodyne Radar System
- a) Provides Integrated Air/Ground COP
- b) Fully Exportable
- c) Up to 20 simultaneous tracks
- d) <1 second track acquisition rate for new tracks

4. Skydio X2d
- a) "Blue UAS"

5. Atmospheric Transmissometer
- a) Visibility characterization

6. Portable Weather Station
- a) Temperature
- b) Relative Humidity
- c) Wind speed & direction
- d) Ambient light levels

7. CACI Spectrum Analyzer
- a) Up to 26GHz
- b) Integrate w/ RELLIS System
- c) Signal Location Identification
- d) Supports Signal Deconfliction

8. Silvus Radio (Mesh) Network
- a) Data transmission rates up to 100mbs
- b) S- & C-band capable
- c) IP68 rating
- d) Variable channel bandwidth (20/10/5 MHz)
- e) Onboard storage 64GB
- f) Interference Avoidance, Interference Cancellation, internal spectrum analyzer
- a) AES256 encryption (FIPS140-2 Lvl 2 with Suite B algorithms)

9. NETGEAR Nighthawk (5100 & 5200)
- a) mmWave, sub6, and C-Band capability
- b) Wifi capable
- c) Max throughput 1.2Gbps (on 5GHz) 600Mbps (on 2.4GHz)

10. Battlefield Effects
- a) Personnel and Vehicle Target Lifters
- b) Wide Range of Pyrotechnics

RELLIS NextG Research Testbed

RELLIS INNOVATION & TECH CAMPUS

Network of Networks

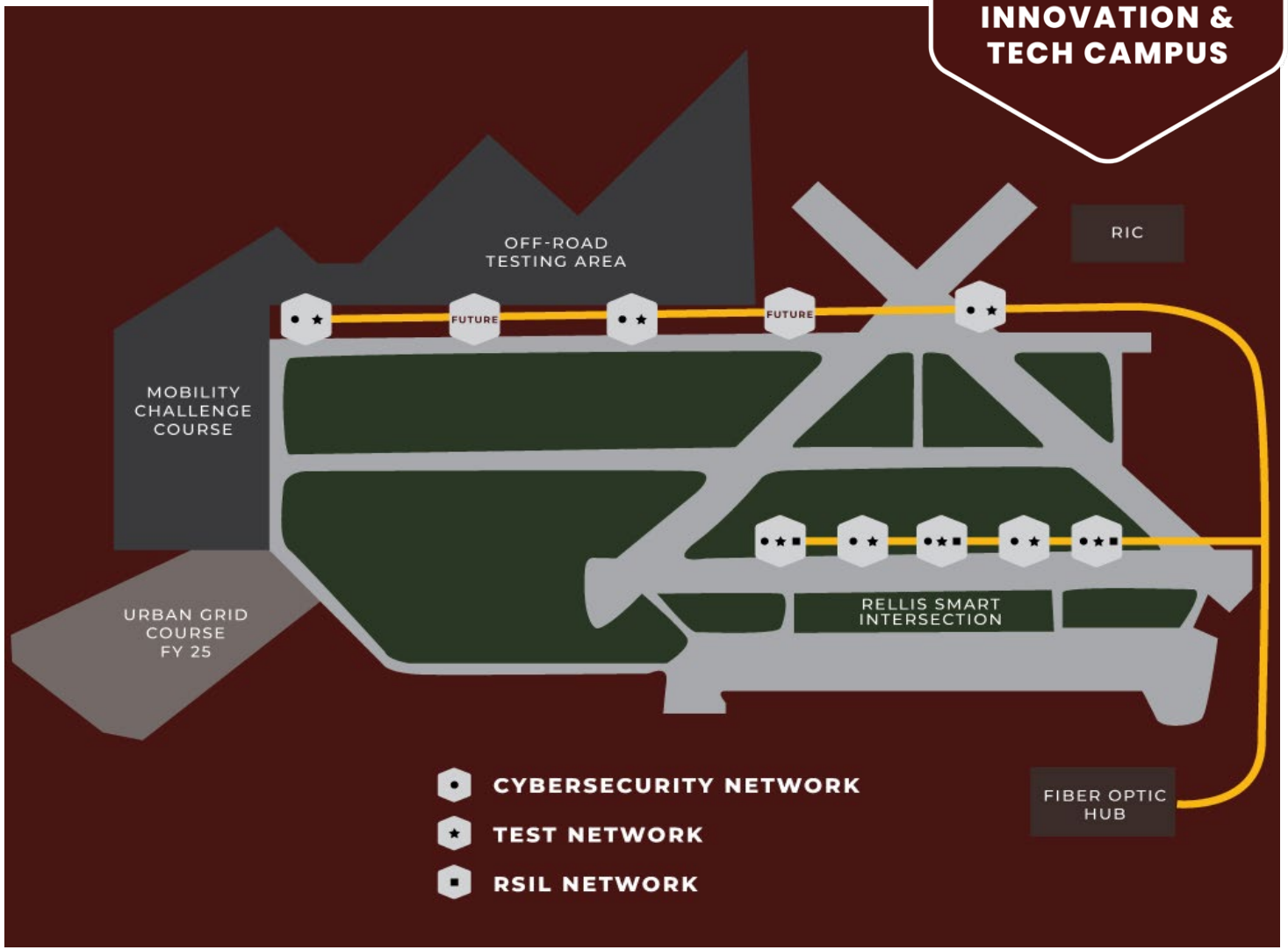
- Coexisting private networks – Cyber, Test and RELLIS Spectrum Innovation Laboratory (RSIL)
  - Operational environments (“ours & theirs”)
  - Range operations & data support
- Utilizes Sub-Six, C-Band and mmWave frequencies
- Fiber optic backbone
- Edge compute
- Silvus radio wireless mesh network
- FCC Program experimental license
- Covers three different engineered test facilities
- 100 Gbps connection to the outside world

Test/Cyber Network

- Cisco Core both Standalone and Non-Standalone utilizing Nokia RAN

RSIL Network

- Opensource Core with various RAN options



BRAZOS VALLEY RESEARCH RANGE (BVRR)

Ready to Support Research, Development, Testing, and Experimentation (RDT&E)

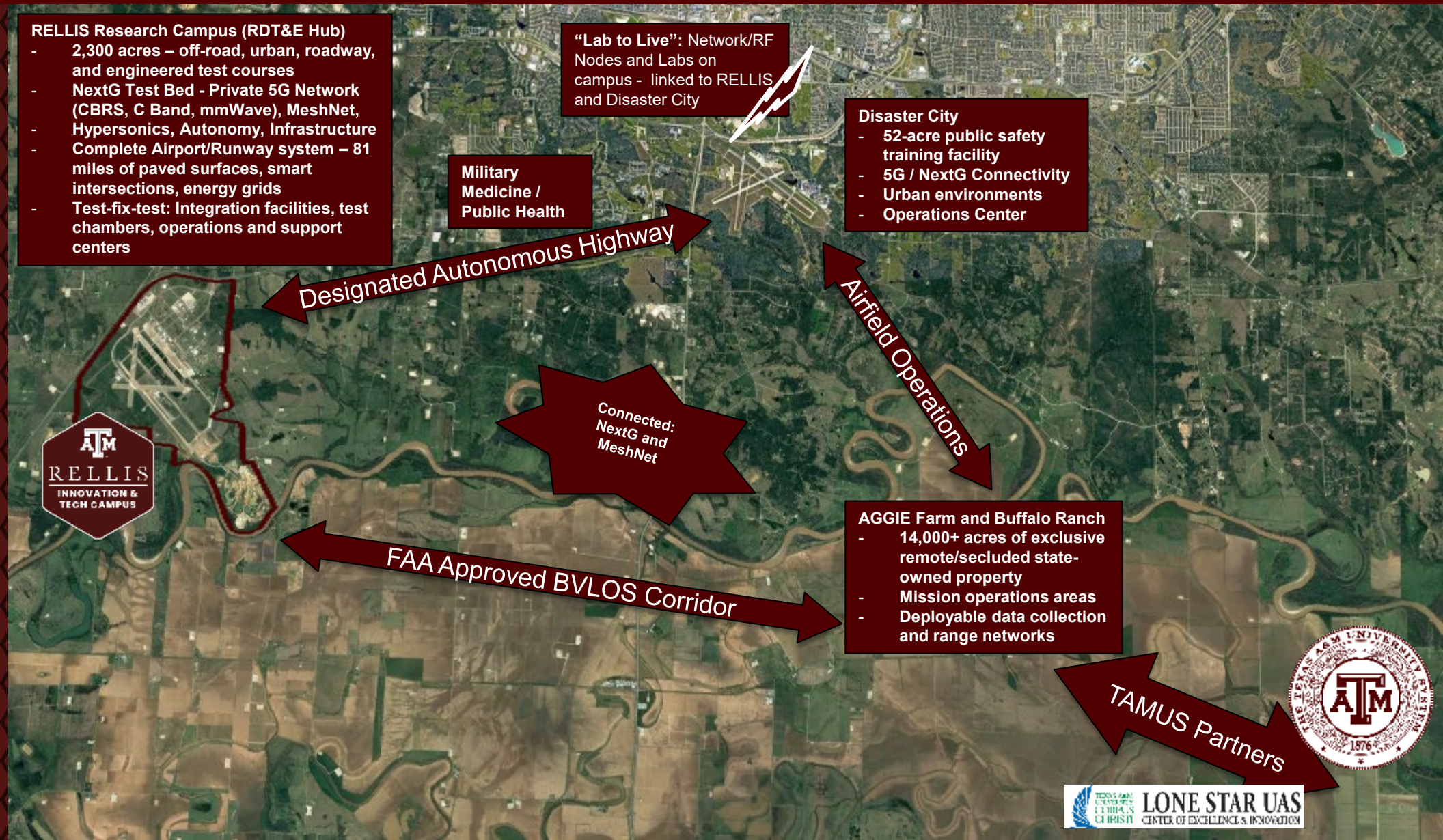
60+ square miles/40,000+ acres:

- Connected
- Relevant and realistic environments
- Basic and applied research
- Proving grounds for experimentation and testing

Ongoing Modernization:

- UAS/CounterUAS (HEL/DE, EW, HPM) test infrastructure
- Adding urban research and test facilities
- Enhancing data acquisition and analysis tools
- Extending network coverage (5G/NextG, MeshNet) and digital twins across BVRR

Open for business: Supporting internal research as well as external government, academia, and industry customers



Innovation Proving Ground (IPG)

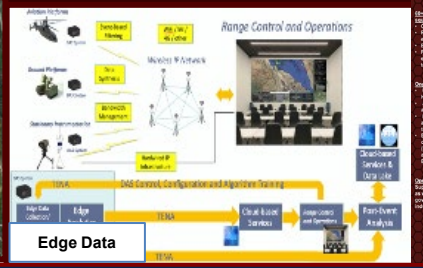
BUSH COMBAT DEVELOPMENT COMPLEX

Test-fix-test

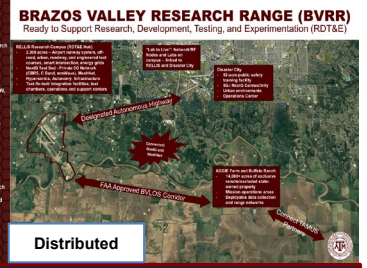

System performance


Mission-based


NextG



Edge Data



Distributed

Realistic –Relevant – Real-time

CRITICAL CAPABILITIES

Realistic Environments

- Instrumented Test Ranges: Mobility Challenge Course (34 acres), Off-road Test Area (100 acres), 2300-acre research campus (RELLIS)
- Extended test corridors, distributed test sites (BVRR – 44,000 acres)
- Augmented by simulations, network/cyber effects, threat emulators

Connected

- Mission-support networks - 5G / NextG Testbed, MeshNet, PNT, fiber, Wi-Fi
- Cross – campus/TAMUS connectivity(Lab to Live, NextG Testbed)
- Real-time monitoring & control for testers and researchers

The Right Data

- BCDC-led edge-compute & streaming analytics innovations
- In-house high-performance computing
- 100+ years of DoD T&E and operations experience

NATIONAL IMPACT

- ✓ **Diverse research & test applications -** sensors, networks, autonomous air & ground platforms & teams, counterUAS, electric vehicles – and evolving
- ✓ **Risk reduction**: Anchored in applied research and Test-Fix-Test
- ✓ **Tailorable events** - Prototype, experiment, integrate, test
- ✓ **Relevant data** - Compatible with DoD standards for analysis and reporting
- ✓ **Proving ground for proving grounds –** test technologies &methodologies

Shift Left, Look Right: Learn early, share often!