Ensured Operations in the Commons: Counter-AA/AD Technologies of Interest

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Formed in 1958 to **PREVENT** and **CREATE** strategic surprise.

Capabilities, mission focused

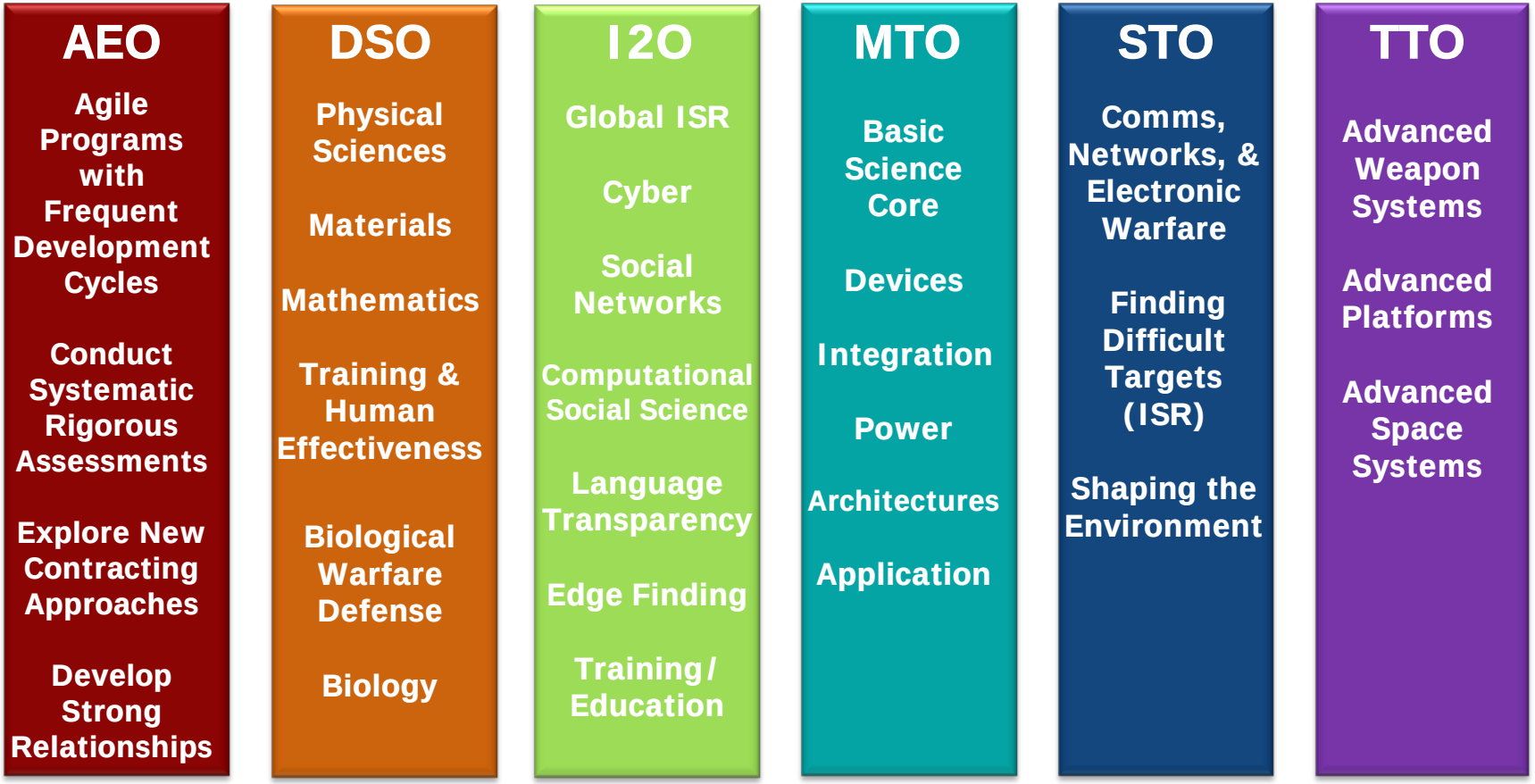
Finite duration projects

Diverse performers

Multi-disciplinary approach...from
basic research to system engineering

As the DoD's innovation engine, we
are committed to the boldest, creative leaps...

Engaging with DARPA



STO focus areas

Comms, Networks and EW

- Warfighter access to timely information.
- Communications in complex environments.
- Efficient spectrum utilization.

ISR

- Finding difficult targets.
- ISR in denied areas.

Shaping the Environment

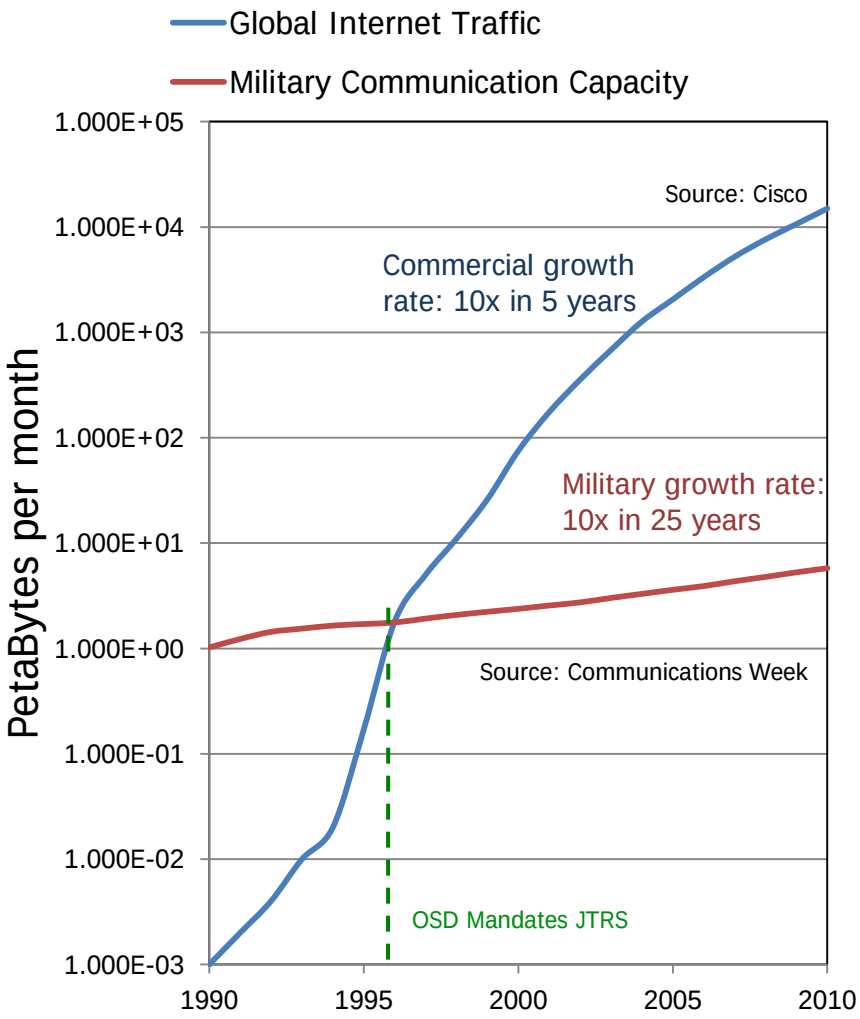
- All environment PNT.
- Asymmetric warfare.
- Extreme environment operations.

STO focus areas support critical military capabilities in all strategic environments:

- **Communications**– assured and reliable high bandwidth wireless worldwide with limited spectrum availability, contested RF operations, limited infrastructure, physical security, leverage of commercial technologies.
- **ISR** - finding difficult targets (underwater, underground, under canopy, inside of buildings, in a crowd, in weather, etc.) including ISR over denied areas.
- **Navigation -** GPS-equivalent location accuracy in GPS-denied areas, through flexible navigation systems that can be rapidly integrated and reconfigured to support air, land, and sea platforms in their operational environments.

Communications

Communication leadership has reversed which has created new challenges



In 20 years, Military Communications went from 1000x more capacity than Commercial to 1000x less today.

- **Military communications today results from decisions made in the 1990s.**
- **But we didn't predict:**
  - **The rate of commercial traffic growth.**
  - **The evolving diversity of services.**

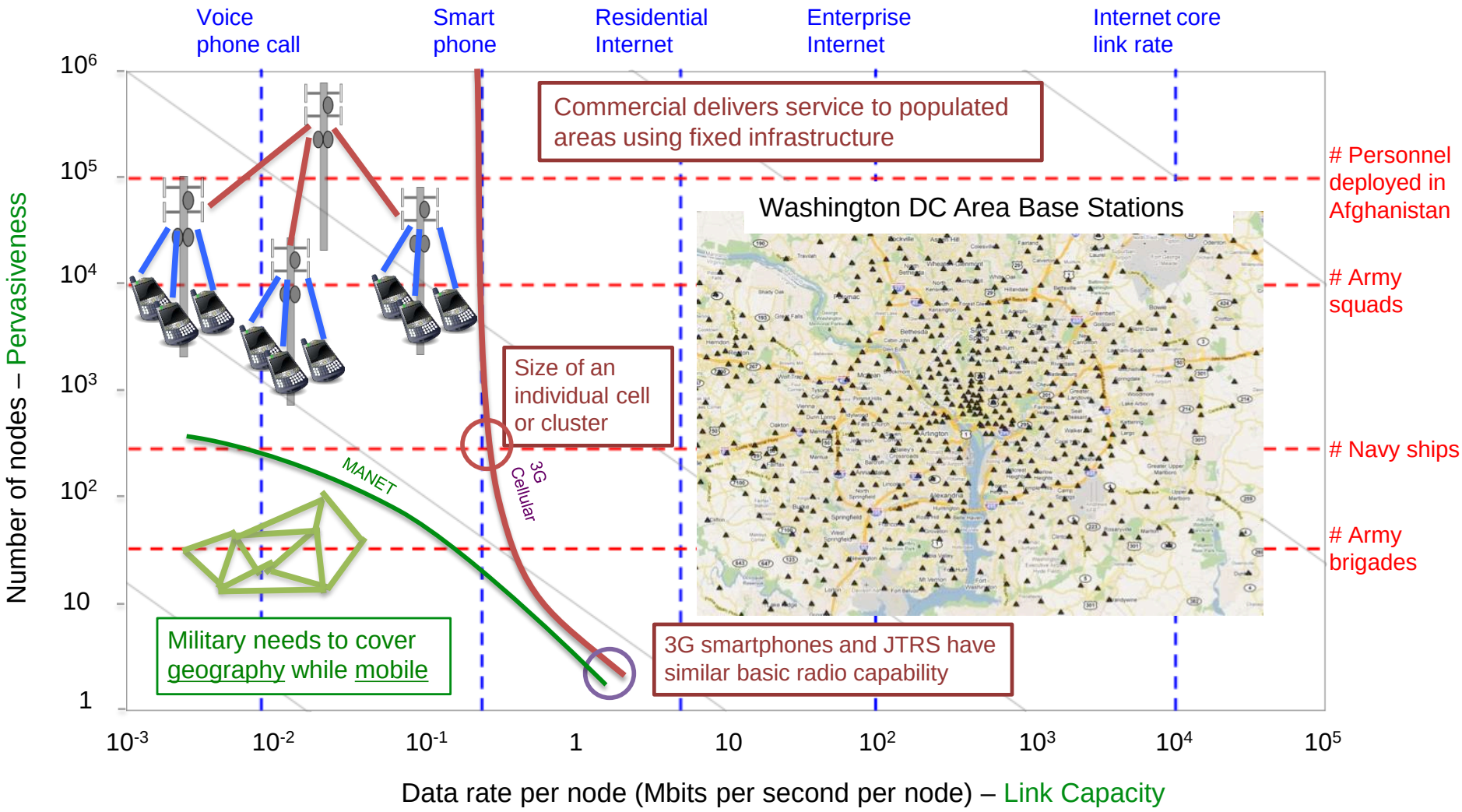
Challenges:

Military needs to cover geography while commercial needs to cover users

How to leverage the large investments in commercial telecom R&D to address DoD needs?

How to meet DoD-unique needs?

Why not just use cellular communications?



How do we replicate commercial infrastructure capability with military constraints?

Just use commercial technology?

Military unique operations limit commercial applicability

High interference	Aggressive Exploitation	Austere environments
• Persistent, aggressive jamming. • Congested spectrum. • Lack of spectrum coordination.	• Signal Geolocation. • Signal Fingerprinting. • Signal Interception. • Encryption. • Cyber Attack.	• Temperature range. • Shock, vibration. • Altitude. • Abuse. • SWAP, Battery life.

What tactical communications does the military need?

Building blocks

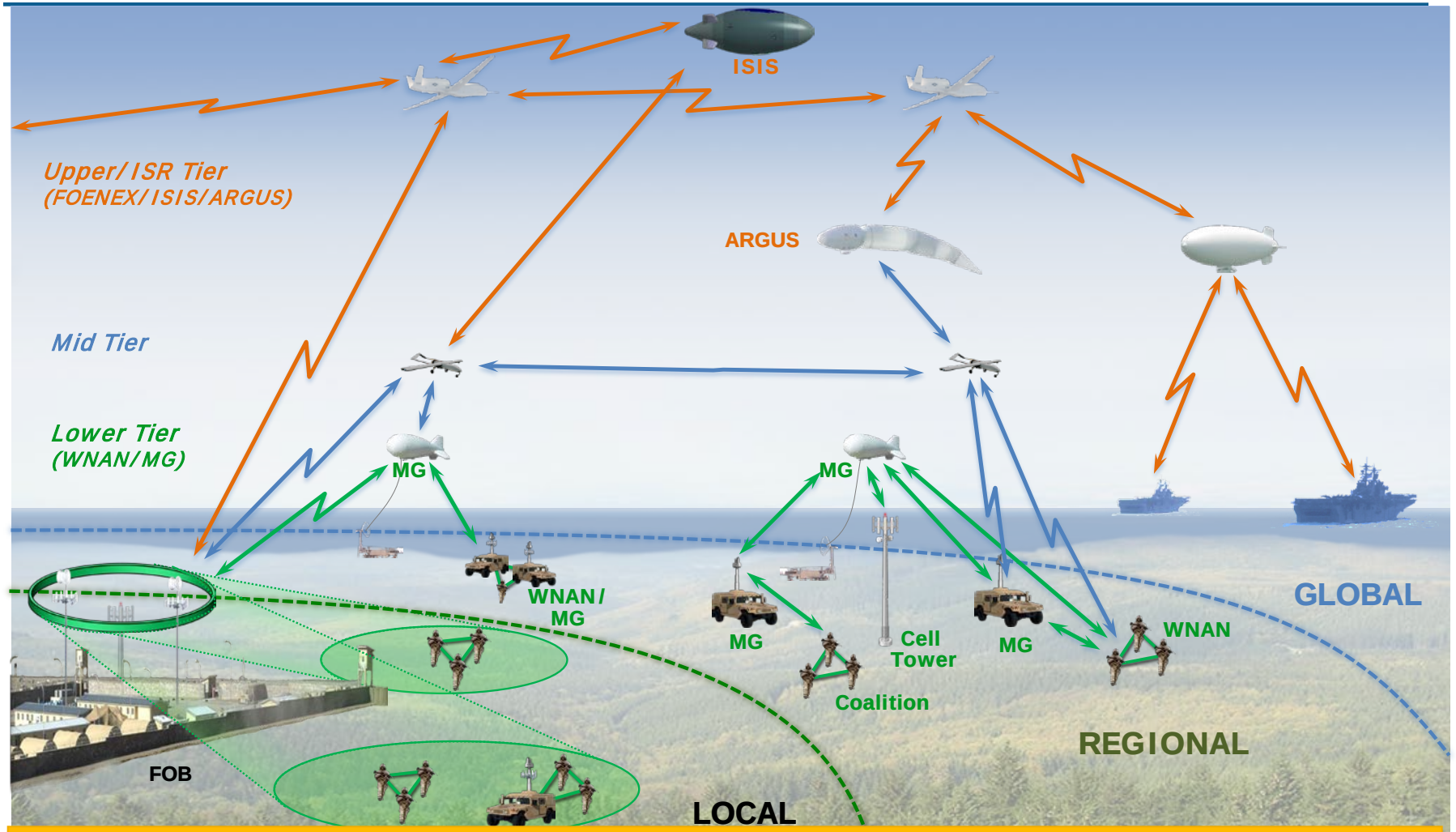
Technology enablers

- Aligned with commercial:
  - Components to access more spectrum.
  - Low power devices.
  - Efficient data dissemination.
- Military-specific:
  - High power RF and optical components.
  - Security.

System capabilities

- Aligned with commercial:
  - Spectrum sharing.
  - High frequency communications (short range).
  - Architectures and processes for rapid technology refresh.
  - Interoperable devices via the network.
  - Black core.
- Military-specific:
  - High frequency communications (long range).
  - Communications with and without infrastructure.
  - Electronic protection (e.g. AJ, anti-geo).
  - High assuredness.

Communication vision (local→regional→global)

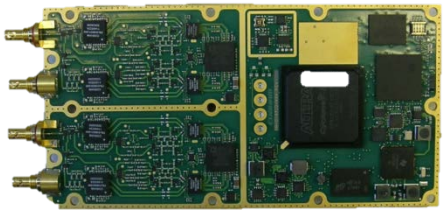


- CENTCOM Focus (1995-2012)
- Mobile Ground Forces - Cost, SWAP, and Assurance

Some key challenges for advanced architectures

- Communications in RF-denied environments.
- Counter advances in adversary electronic warfare capabilities.
- Multifunctional devices.

Recent initiatives

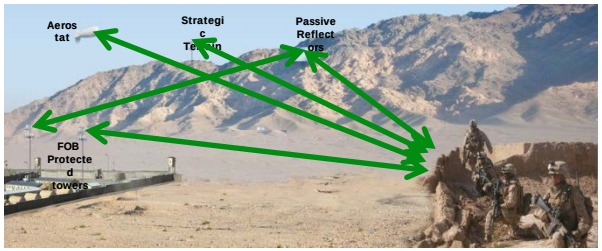


WNAN

- Commercial components for rapid and cost-effective refresh.
- Integrate SoA spectrum access and mobile networking technologies.

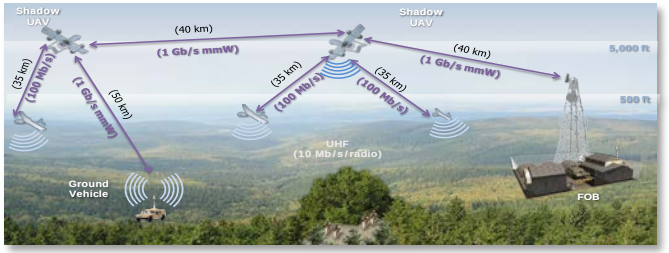
MAINGATE

- IP-Based voice and data interoperability via gateway.
- Federated security approach (black core).
- Mobile ad hoc network backbone.



Fixed Wireless at a Distance

- Massive Multiple Input Multiple Output Distributed antennas.
- Mbps at 10's of kilometers.



Mobile Hot Spots

- Leverage of commercial millimeter wave components.
- Increase power levels to achieve military range requirements.
- Low SWAP for small platforms.

Comms, Networks and EW programs provide Warfighter access to timely information, communications in complex environments, and efficient spectrum utilization.

ISR

ISR landscape

ISR in current operations has been characterized by an environment that is generally **permissive access** for our sensors and sensor platforms.

- Most of the focus has been on tracking vehicles/people and mapping the environment.
- This is a **data-rich** environment limited only by the cost (time/money) of collection and our ability to convert information to knowledge.

There is an additional set of important targets for which, even in permissive environments, only limited and often ambiguous signals can be collected.

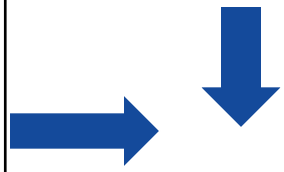
- These **data-poor** environments include finding WMD, submarines, tunnels, activity inside of buildings, as well as human ID.

As the current conflicts wind down, it is likely that the need to collect against areas that are **restrictive access** will increase.

- This greatly complicates ISR for both data-rich and data poor environments.

Each region (permissive/restricted, data-rich/data-poor) has its own set of technical challenges.

ISR landscape – challenges

Operational challenges	**Collection characteristics**	**Technical challenges permissive access** (e.g., Iraq, Afghanistan)	**Technical challenges restricted access** (e.g., Iran, N. Korea)
• Tracking vehicles and dismounts • 3D mapping • Uncovering Social/Cyber networks	**Data-Rich** - collection limited by number/availability of assets and ability to derive knowledge from information	• Performance vs. cost (time, personnel, funds) • Exploitation/big data	**Operate at Standoff** **Operate within denied space** • Vulnerability – cost trade • Sensor/platform capabilities
• Tracking submarines • Finding WMD • Finding Tunnels • Activity inside of buildings • Human ID • Operations in challenged environments	**Data-Poor** – limited signals that are often ambiguous	**Finding Difficult Targets** • Understanding "physics" of signatures • Developing/tailoring sensors and sensor systems to balance Pd, Pfa • Area coverage	

ISR landscape – STO focus

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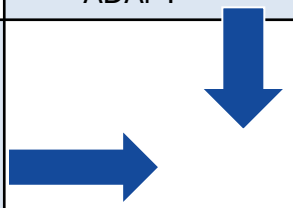
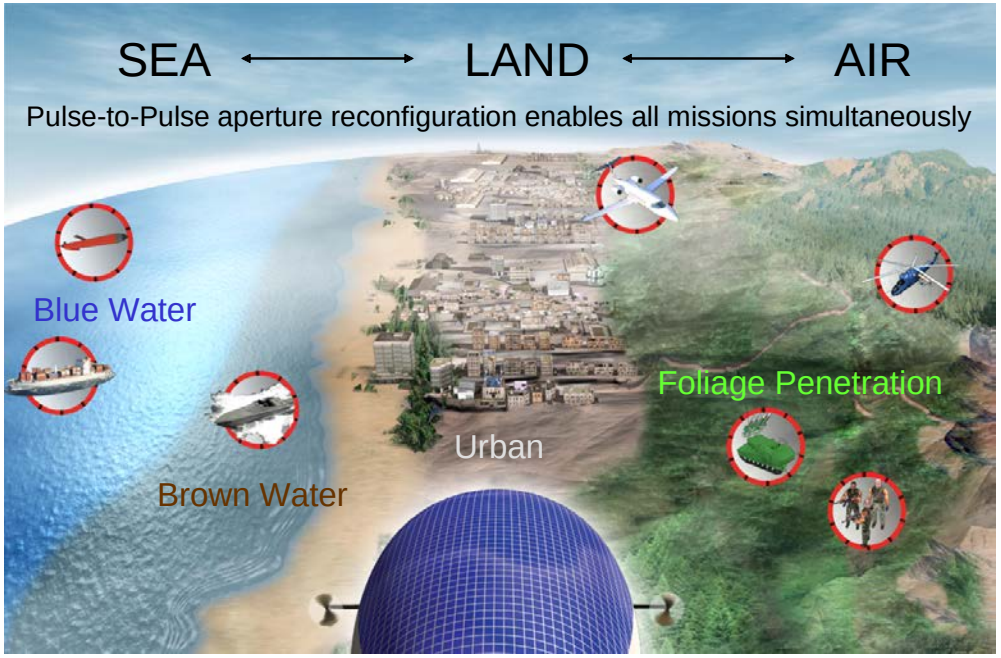
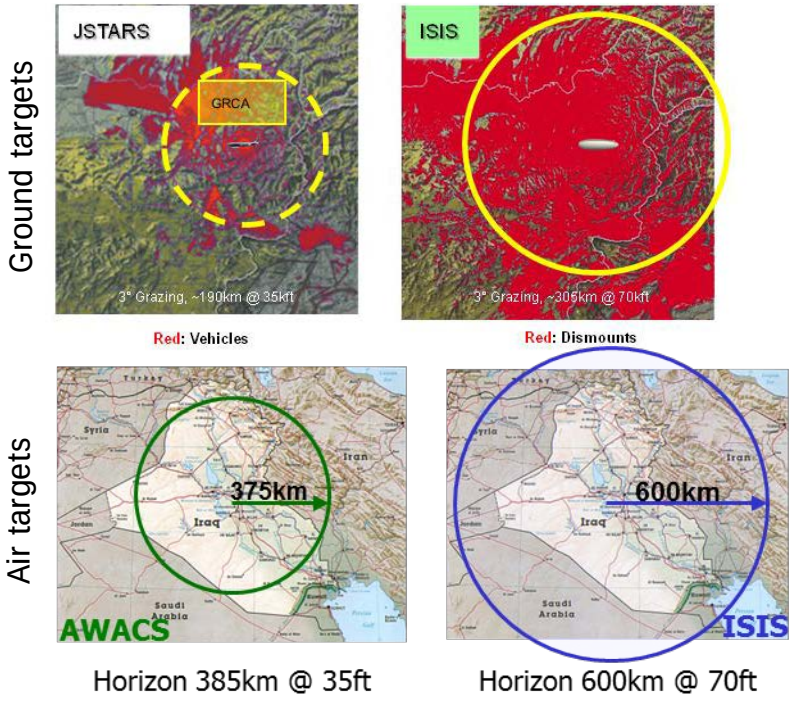
• Tracking submarines • Finding WMD • Finding Tunnels • Human ID • Activity inside of buildings • Operation in challenged environments	**Data-Poor** – limited signals that are often ambiguous	**Finding Difficult Targets** • DASH • MIST • ViSAR • ISIS • HALOE • Radio Map • Arctic	

Integrated Sensor Is Structure (ISIS)

High altitude, precision radar provides an all weather, high-definition, integrated picture of all moving targets.





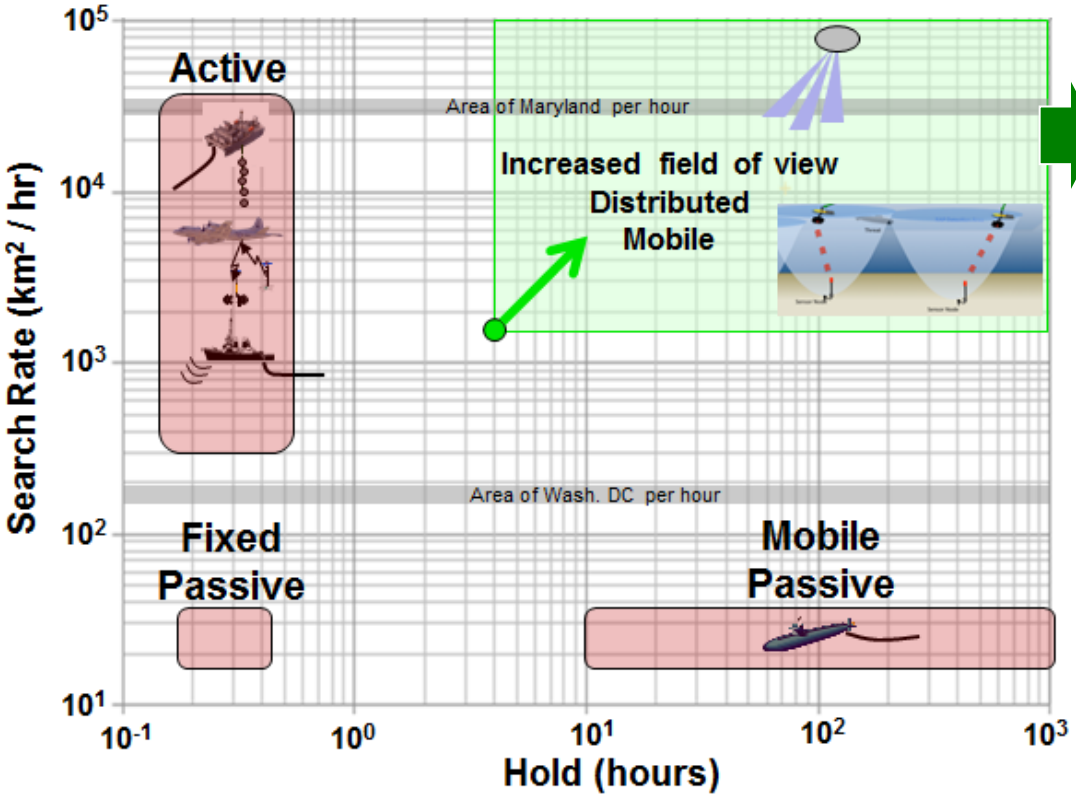
- Precision knowledge of all air and ground moving targets to include foliage obscured.
- Engagement quality target tracks – air, ground, and maritime.
- 24/7/365 sensing with 99% on-station capability.

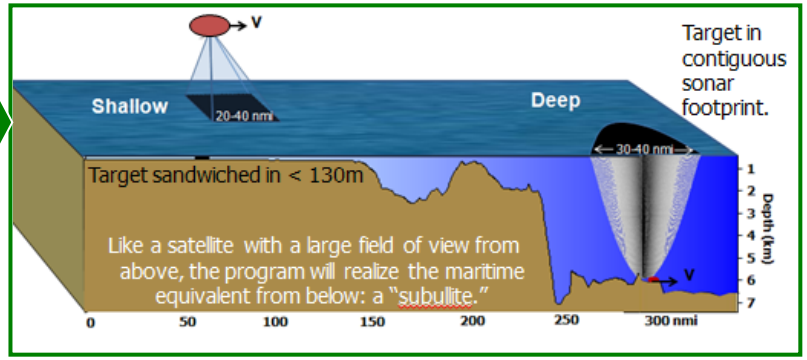
- Designed for 10 year operational lifetime (launch and forget).
- No in-theater ground support.
- Potential for substantial reduction in O&S cost.

Distributed Agile Submarine Hunting (DASH)

Goal:

- Search (>500 x 500 km) and hold (track) targets – at reduced risk and cost:
  - Active sonar has long range but episodic holding.
  - Passive sonar has short range but continuous holding.
  - Achieve both with scalable distributed systems that standoff from water line.





Approach:

- Sonar from below.
- Non-acoustic sensing from above.

Technical opportunities

Finding Difficult Targets

•New system concepts for collecting hidden or difficult data.

•Combining sensor modalities and exploiting new algorithms.

•Computational approaches for otherwise unachievable resolution and ranges.

Operate at standoff

- Sensor resolution vs. range and cost.
- Nontraditional sensing modalities.

Operate within denied space

- Risk-tolerant advantage with distributed, lower-cost sensors .
- Survivable sensors (countermeasure-resistant) and sensor platforms.

Overarching opportunities

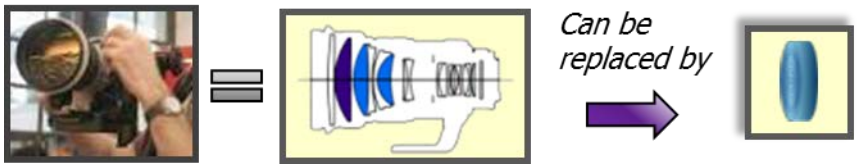
•Leveraging commercial products and practices.

•Providing multifunctional sensor systems for increased capability at reduced system weight and power.

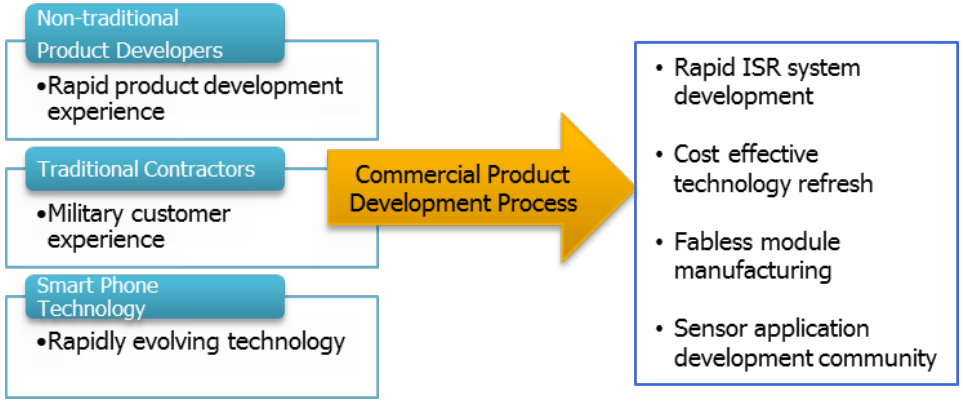
Making sensors cost-effective and weight/power efficient

- Adapt commercial hardware and software development processes for use with military sensor system development.
- Rapid manufacture of sensor systems that incorporates new optical components and fabrication methods.
- Multifunctional sensor systems for increased capability at reduced system weight and power.

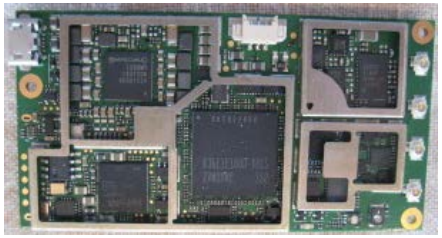
Manufacturable GRIN lenses (MGRIN)



ADAPT



Low cost sensor systems through the use of commercial development processes



Above - First ADAPT hardware delivered in July 2012

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