



***Integrity ★ Service ★ Excellence***

# **Mathematics, Information, and Life Sciences**

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**Dr. Hugh C. De Long  
Interim Director, RSL  
Air Force Office of Scientific  
Research  
Air Force Research Laboratory**

# Report Documentation Page

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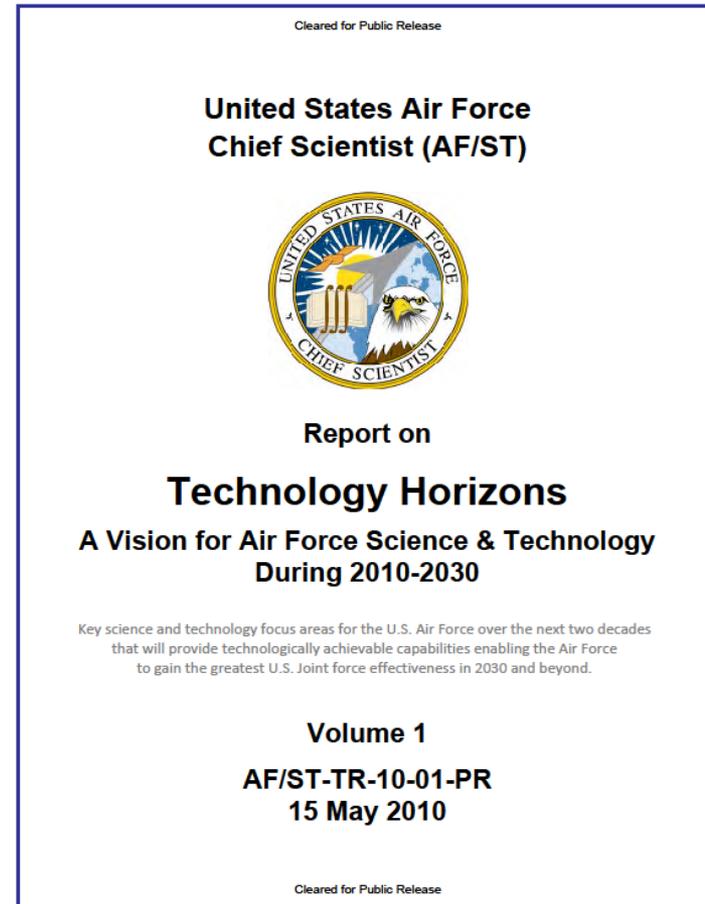
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# AF/ST Technology Horizons



- Focus on 10-20-year time horizon
- Tech Horizons Grand Challenges:
  - Inherently Intrusion-Resistant Cyber Networks
  - Trusted Highly-Autonomous Decision-Making Systems
  - Fractionated, Composable, Survivable Remote-Piloted Systems
  - Hyper-Precision Air Delivery in Difficult Environments
- Not all the technologies require new basic science



Available at: <http://www.af.mil/information/technologyhorizons.asp>



# The AirForce 10yr + 10 Yr Outlook: Technology Horizons Report



Priority Key Technology Areas / (RSL) as Research Opportunities !!!

- Autonomous systems
- Autonomous reasoning and learning
- Resilient autonomy
- Complex adaptive systems
- V&V for complex adaptive systems
- Collaborative/cooperative control
- Autonomous mission planning
- Cold-atom INS
- Chip-scale atomic clocks
- Ad hoc networks
- Polymorphic networks
- Agile networks
- Laser communications
- Frequency-agile RF systems
- Spectral mutability
- Dynamic spectrum access
- Quantum key distribution
- Multi-scale simulation technologies
- Coupled multi-physics simulations
- Embedded diagnostics
- Decision support tools
- Automated software generation
- Sensor-based processing
- Behavior prediction and anticipation
- Cognitive modeling
- Cognitive performance augmentation
- Human-machine interfaces

<http://www.af.mil/shared/media/document/AFD-100727-053.pdf>



# RSL Scientific Goals



## Information and Complex Networks

- Reliable and secure exchange of information
- Secure-by-design network and system software and architectures
- Exploitation of massive real-time data
- Mathematical basis for predictable operation of networks and systems

## Decision Making

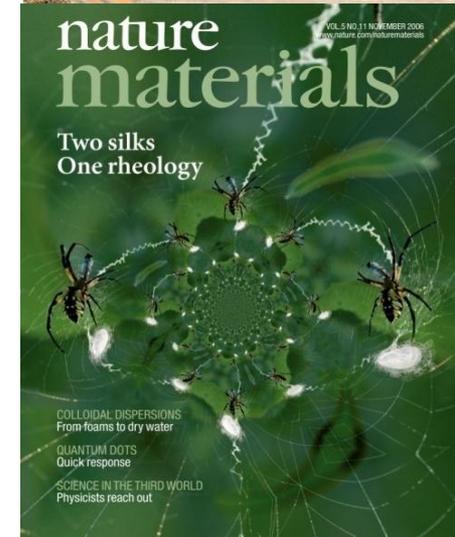
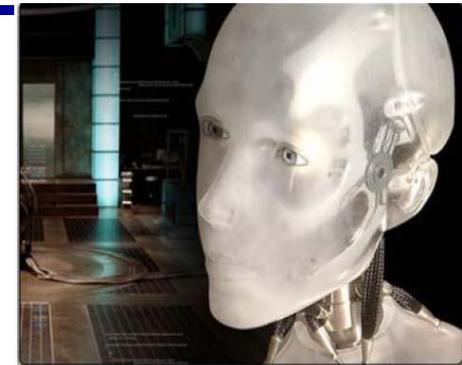
- Mathematical laws, foundational scientific principles, and new, reliable and robust decision-making algorithms
- Trust and mixed human-machine decision making.
- Understanding and predicting socio-cultural variations of influence

## Dynamical Systems, Optimization & Control, and Computational Math

- Mathematical foundations of control including V&V
- Distributed, multiagent control; quantum control; vision-based control
- Optimization and discrete mathematics for solving large, complex problems
- Multidisciplinary optimization and control; complex systems
- Uncertainty quantification
- Computational strategies for complex multiscale system modeling

## Natural Materials and Systems

- Using, mimicking, or altering ways that natural systems build materials and sensors and perform under extreme conditions.





# RSL Technical Programs



## Information and Complex Networks

Complex Networks (Bonneau)

Information and Operations Security (Herklotz)

Software and Systems (Bonneau)

Science of Information, Computation and Fusion (Nguyen)

Dynamic Data Driven Applications Systems (DDDAS) (Darema)

## Decision Making

Cognitive Modeling and Robust Decision Making (Myung)

Trust and Influence (Lyons)

## Dynamical Systems, Optimization & Control, and Computational Math

Dynamics and Control (Fahroo)

Optimization and Discrete Mathematics (Hearn)

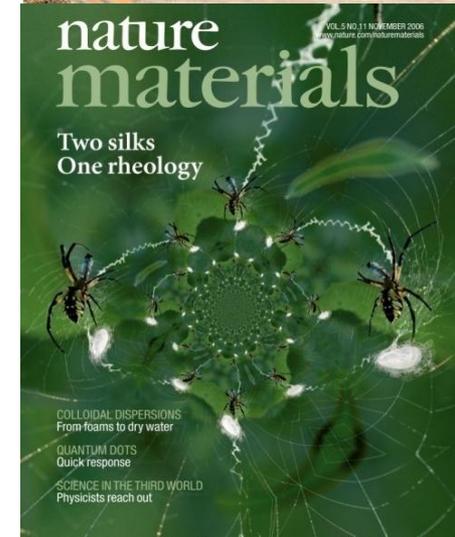
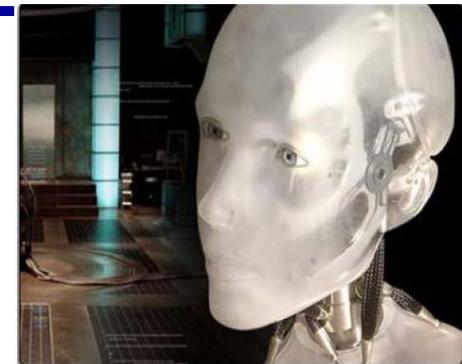
Computational Mathematics (Fahroo)

## Natural Materials and Systems

Sensory Information Systems (Larkin)

Bioenergy (Bradshaw)

Natural Materials and Systems (DeLong)





# Some New Directions



**(Cross-Directorate /Cross-DoD/Cross-Agencies/International Collaborations)**

## **Additional topics of emphasis in FY12 BAA**

**Bionavigation (Bio)**

**Neuromorphic Computing (Human)**

**Multi-scale Modeling (Math)**

**Foundations of Information Systems (Info)**

## **BRI Topics**

**Bionanocombinatorics (Bio)**

**Trust & Influence (Human)**

**Design Under Uncertainty (Math)**

## **Areas of reduced emphasis:**

**Biofuels (Bio)**

**Agent-based systems and software (Info)**

**Computational methods of socio-cultural modeling (Human)**



QUESTIONS?