Emerging Technologies & Security

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Introduction to Emerging Technologies Panel
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Assessing Emerging Tech

• **Understanding “emerging technologies”**
  – What are those new developments at cusp of science and application that may have major impacts on global society overall and in particular on “security” aspects of society?
    • What are tech trends and prospects?
    • Who is likely to have what capabilities?

• **What are implications of “emerging technologies” on security?**
  – Must also understand the policy processes and mechanisms for “emerging techs” and their prospects—who is doing what to explore, develop and *implement* the technology?

Emerging technologies don’t “just emerge”—they’re made to emerge through purposive action
Emerging Technologies [one list...]

- **Technotronics**—from microelectronics to nanotronics, quantum-spintronics and biotronics
- **MEMs**
- **Nano Tech**—nanomachines, self assembly, nanotubes

Mobile telecommunications networks
- **Sensors and Sensing systems**—smart sensors, distributed sensing, RFID, sensor nets and swarms, biosensors
- **Info tech**—virtual reality, ubiquitous computing, grid computing
- **Robotics**—intelligent systems, robot teams, nanobots, human augmentation
- **Autonomous Systems**—unmanned combat air vehicles, organic air vehicles, micro air vehicles, UGS, UUVs/USVs

- **Biotech**—genetic engineering, bio-diagnostics, bio-remediation, bio-weapons
- **Energy & Propulsion**—fuel cells, directed energy, superconductors
Emerging Technology—other prospects…

• Engineered materials—application-specific materials—electrically active polymers, bio-engineered materials
• Advanced displays—flexible displays, holographics
• Cognitive processing—aided cognition
• Universal translation
• Alternative energy—biomass; solar; fusion…
• T-rays (terahertz radiation)
• Synthetic fuels
• Alternative propulsion—nutating engine, etc.
• Microfluidic optical fibers
• Volumetrically controlled manufacturing
• Telegenics—virtual tele-presence
• Psycho-pharmaceuticals
• Synthetic biology
• Bayesian machine learning
• Humanoids……

Cyberspace--nexus of computer systems and networks, in which electronic data are stored and communication takes place.

- Approaching physical limits
  - “Moore’s Law”—the implications of smaller feature size
  - Moore’s Law is a behavioral projection based on faith in human ingenuity and business opportunity—it is not a physical law.
Beyond Moore’s Law: Spintronics / Biotronics?

• **Spintronics**
  – Uses electron's "spin" to determine its state with potential to create computing devices that are considerably faster than current silicon devices.
  – Spintronics should also, in theory, dissipate little heat

• **Biotronics?**

  ![Diagram of DNA structure with metal ions and H-bonds]

  **What do we get?**

  Molecularly changing DNA’s conductivity by replacing imino protons of base pairs by metal ions

**Metallic Conduction through Engineered DNA: DNA Nanoelectronic Building Blocks**

MEMS \rightarrow MEMSification

- Accelerometers for controlling auto air bags, arming and safing of weapons
  - Today, because of MEMS, the accelerometer and electronics are integrated on a single chip at a cost of under $10. The small size (about the dimensions of a sugar cube) provides a quicker response to rapid deceleration.
  - Intelligent tires...
- Fail-safe locks for nuclear weapons
- Micronozzles that direct the ink in inkjet printers
- Miniature robots (micro-robots); micro-tweezers
- Video projection chips with a million micro-mirrors
- Defense and aerospace
  - Navigational gyroscopes,
  - Sensors--border control, environmental monitoring
  - Munitions guidance
- Medicine
  - Microfluidic DNA Analysis
  - Disposable blood pressure transducers
  - Hearing aids
- Telecommunications
  - Cell phones—integrated systems-on-chip
  - MEMS-based optical switches
Nano-MEMS

• Nano → molecular-level, self assembly of system
• Chemical
  – Nano-wires
  – “Three-dimensional MEMS with functionalized carbon nanotubes”
  – Nanoelectronic building elements for nanoMEMS and bioMEMS
  – Carbon and ceramic microcoils for MEMS by microwave CVD

• Biological
  – DNA-based structures
  – Virus generated

MEMS-based nano-systems may be key to future sensing and perhaps future autonomous robotics
DARPA impact — From computers to Interactive Information

- DARPA and Info Tech—“Toward Man Computer Symbiosis”
  - Making computers interactive
  - Internetted computing
  - Virtual reality

Intelligent systems

- Are “cognitive” cybersystems our goal?
- Should they be?

How close to Licklider’s Vision are we getting?
Cognitive Systems:

“Systems that know what they’re doing”

- A cognitive system
  - can **reason**, using substantial amounts of appropriately represented knowledge
  - can **learn** from its experience so that it performs better tomorrow than it did today
  - can **explain** itself and **be told** what to do
  - can be aware of its own capabilities and **reflect** on its own behavior
  - can **respond robustly** to surprise
Augmented Reality: Virtual “X-Ray” Zoom Vision with Intelligent Rifle

- UAV images behind building
- Building pixels are stripped from image
- Threat is rendered
- Soldier calls indirect or direct fires using rifle

Comm. link
A Possible Vision:
Tactical-Level “ISR/Weapon” System of Systems

**Functions Performed By ISR/Weapon System**
- C²
- Detection/Classification
- ID
- Tracking
- Sensor-Shooter Link
- Shooter-Weapon Link
  (<5sec Engage Latency)
- BDA
- Weapon Resupply

**Arsenal UAV**
- Delivers lethal & ISR UAVs
- Maintains needed types and numbers

**VTOL UAV**
- Identifies Targets
- VIS/LWIR Imager
- 3D Ladar
- Magnetometer
- MMW Designator
- Tasks Lethal UAVs

**Loitering Lethal UAVs**
- RDX airframes
- MMW all-weather seekers

**Cell Leader**
- Interactive Display
- Controls VTOL UAV

**Detection Sensors**
- ISR UAVs
- UGS
- Cell Troopers

**MMW Tags**
- Tracking

Deploy
# Emerging Technologies and Security: Issues

- Information technology has fundamentally transformed our society, economy, and our lives.
- Emerging technologies will transform information technology in fundamental ways—and this emerging infotech will provide the basis for greater wealth, healthier and longer lives, and improved security capabilities.
- Technological convergence of bio-nano-info techs present phenomenal new prospects—and raise daunting ethical concerns.
- All of these developments raise potential as well for misuse and have security downside.....
Emerging Technologies and Security: Issues

- Security cannot be **assured** by technological measures
  - Security is an on-going process
  - Security requires forethought and constant vigilance
  - If it can be used for bad—it will be…. And others will have access to it....

- A fundamental flaw in our thinking has been the assumption that we can maintain technological superiority without making substantial investments in it....

- Others globally are becoming just as good as we are—we have to recognize this as the new reality