



C2 and Comms—New C4ISR and Operational Implications

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C4ISR Convergence



- Velocity of Tech Change
- Cyber and EW
- Explosion of Sensors
 - Open Source ISR—GIS, UASs, 24x7 News Cycle, Social Media
 - IoT Sensors as ISR contributors
- OODA Loop & Decision Cycles
- People and Organizational Changes
- Processes and Technology Changes
- Emerging Research Areas

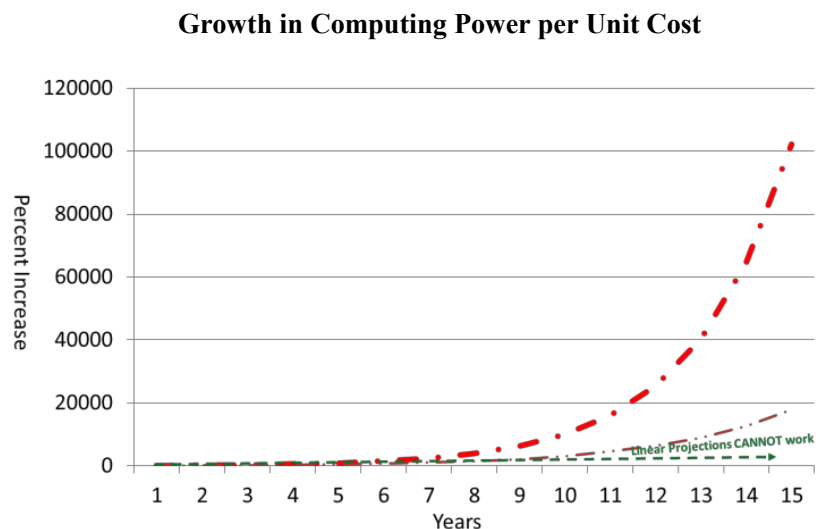
Velocity of Tech Change

If a factor, e.g. computing power/unit cost, doubles every 18 mo, 5 yr increase is 900%, 10 yr 10,000%

Biotech even faster, robotics ubiquitous, nano poised for breakout, energy impacts global

Interactions complicate things

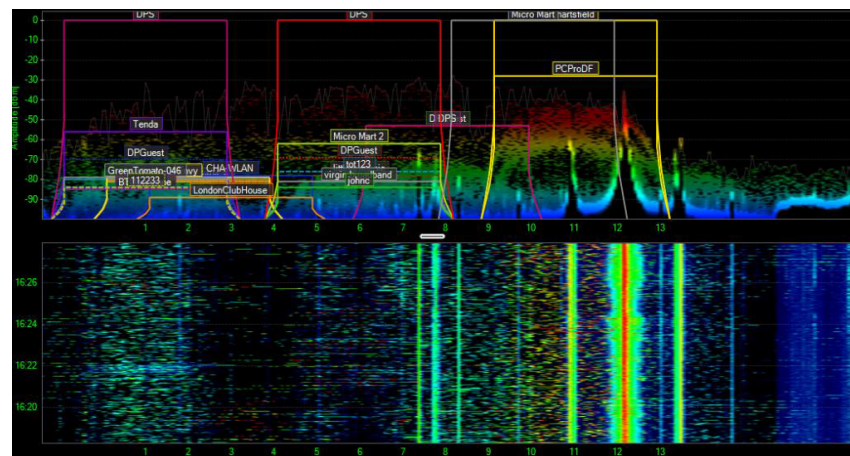
Linear projections CAN'T work



Capability doubles every 18 months — · — · Capability doubles every 24 months — · · · —

Cyber and EW

- Maneuver in Electromagnetic Spectrum (EMS) Space
 - Navy Electromagnetic Maneuver Warfare (EMW)
 - Army Cyber Electromagnetic Activities (CEMA)
 - EW Planning & Management Tool (EWPMPT)
 - Marine Corps Cyber EW Coordination Cell (CEWCC)
 - USAF
- C4ISR Implications



Explosion of Sensors (1)

Open Source ISR-GIS



Near-Real-Time Coverage:

- Terra Bella (formerly SkyBox),
- Planet Labs data

HiRes:

- GeoEye (.41m pan, 1.65m multi-spectral);
- DigitalGlobe (.31m pan on Worldview 3)
- Licensing issues

Image courtesy Dr. Walter Dorn

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Explosion of Sensors (2)

UASs



Israeli



American



Japanese



Canadian



Australian

Hand launched



Slide Courtesy Dr. Walter Dorn

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Explosion of Sensors (3)

IV4 (Info Volume, Velocity, Veracity, Value)

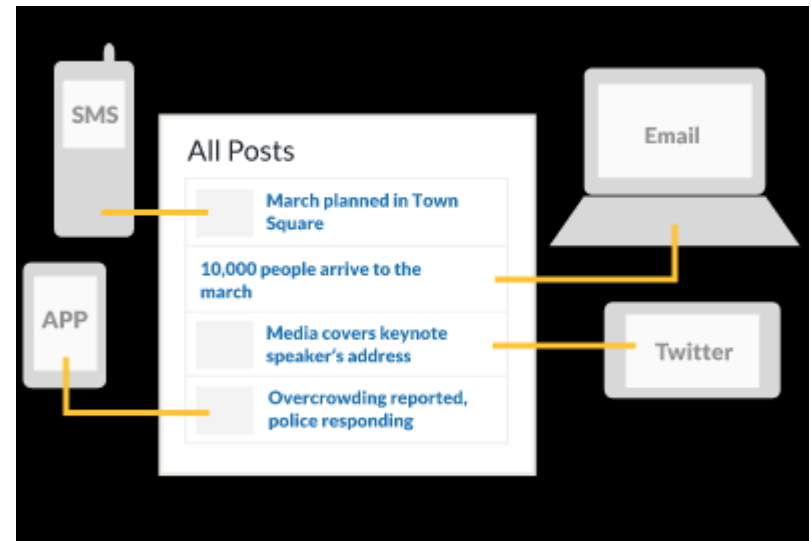


From Patrick Meier iRevolution

Ushahidi



24x7 News Cycle



Public-Private, Whole-of-Govt, Transnational

Explosion of Sensors (4)

Mobile, Wearable

- Mobile, Wearable
 - Cameras, radios, GPS receivers, accelerometers



- Health monitors
- Personal Geiger counters in Japan



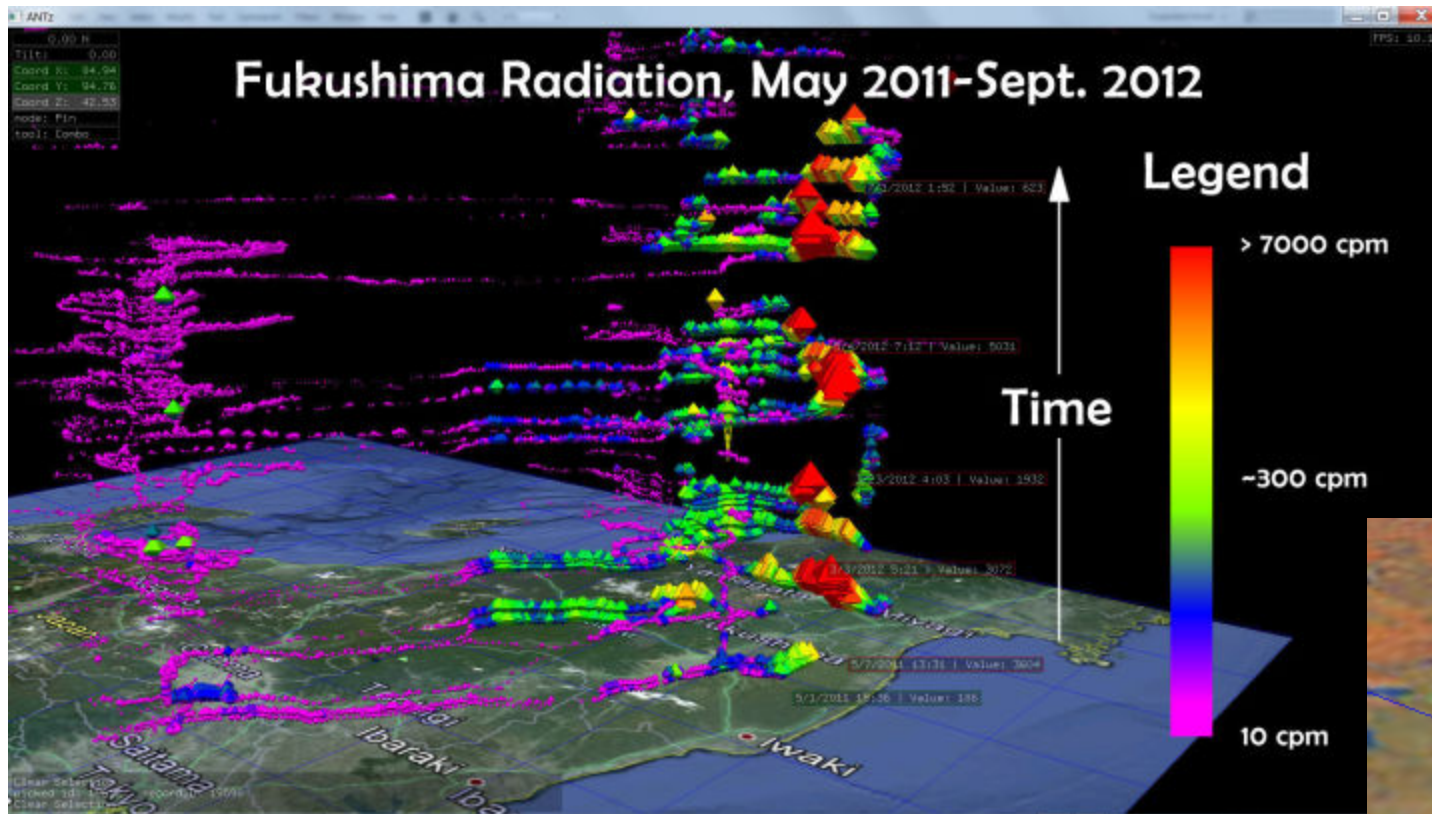
Explosion of Sensors (5)

Internet of Things (IoT)

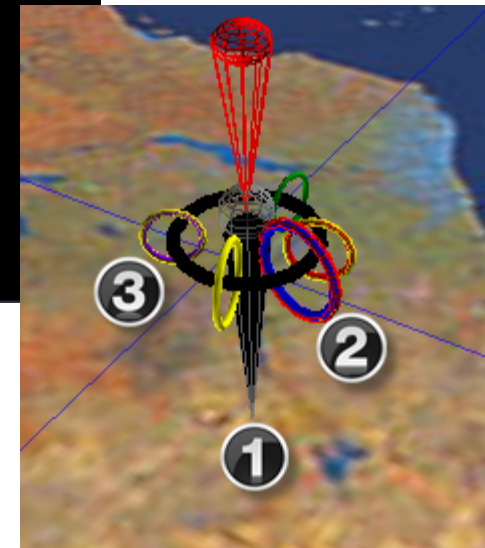
- IoT (Cloud of Everything is better name)
 - Gartner est. 21 billion connected devices by 2020
 - Cheap chips and sensors (insecure and networked)
 - Software-defined everything (SDR, SDN) etc.)
 - People at the center
 - Huge attack surface
 - Biggest market of all



Data Visualization/Virtual Reality



Graphics by SynglyphX



Info Sharing and Security

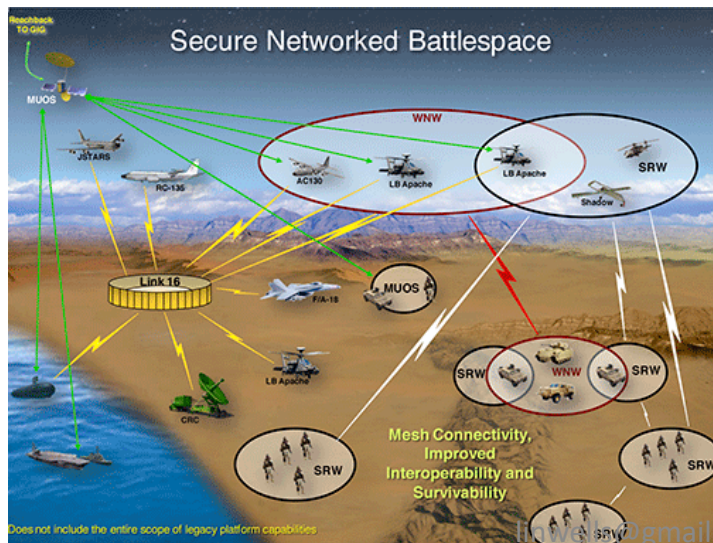
- Info Sharing Rules
 - Create immediate value
 - Give back better
 - Share derivative works
- Alternative approaches to cybersecurity
 - Big data
 - NRT anomaly detection
 - Supply chain
- Major policy, legal, moral, ethical issues
- Privacy



Command and Control/Sensemaking/ Decision Support



How to achieve
“Unity of Action”
when there’s no
“Unity of Control?”



OODA Loop & Decision Cycles

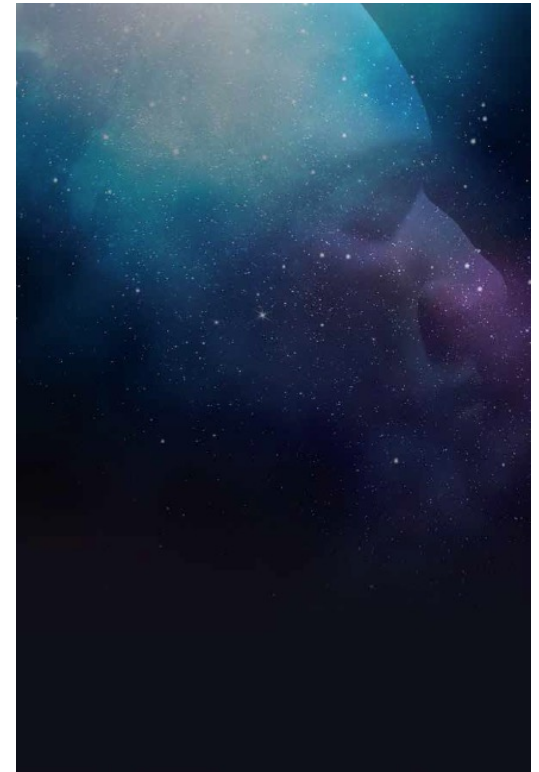
- “Observe” and “Orient” phases increasingly electromagnetic
- “Decide” and “Act” supported by information processing
- Cyber can dominate OODA loop in any domain
- Tech changes
 - Processing power
 - Machine learning
 - Sensor proliferation
 - Army 2050 battlefield—can you move?
- Speed of decisions
 - “Man-on-the-loop,” vice “Man-in-the-loop”



Image courtesy successing.com

People and Organizational Changes (1)

- Need institutions to act quickly enough
 - And people to run them
 - Life-long learning supported by point of need content delivery
 - Leverage explosion of innovation in private sector adult education
 - **No lesson is learned until behavior changes**
- Realistic ranges, M&S, wargames
 - Cross-cutting
 - Cyber and EMW
- Feedback loops



People and Organizational Changes (2)

- Address massive, continuous data feeds
- Reach beyond the .mil domain
 - Engage with non-traditional mission partners
 - Support to PKO/HADR
 - Humanitarian cyber
 - Build for resilience
- Info sharing rules critical
 - Give info back better



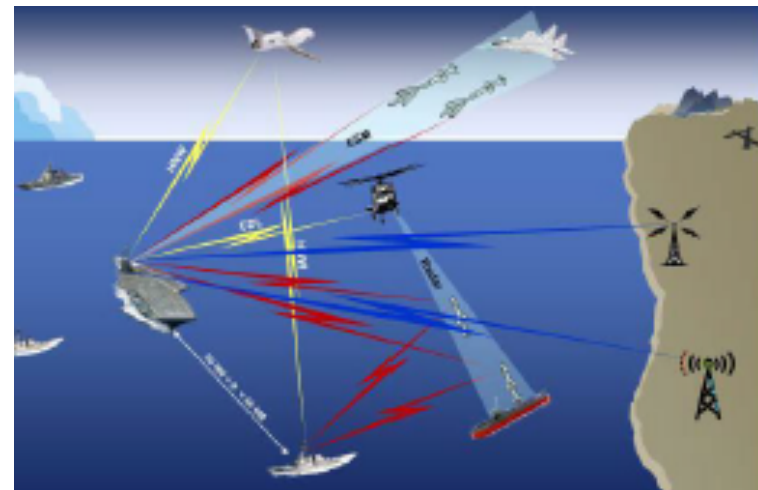
Process & Technology Changes (1)

- Much info will be outside of/faster than TPED
- Open architectures
- Civ-Mil, public-private, trans-national convergence
 - Changing conditions for RMA
- *Economist* article on future of computing
- BRINE (bio-robo-info-nano-energy)



Process & Technology Changes (2)

- Frequency-agile equipment
 - Navy will buy EMW systems
 - IT & OT
 - Digital-analog issues
 - Army cognitive radios and IEW&S
- 3rd Offset Strategy
 - Deep Learning Systems
 - Human-Machine Collaboration
 - Human-Machine Combat Teaming
 - Assisted Human Operations
 - Network-Enabled, Cyber-Hardened Weapons



Emerging Research Areas

- C4I & Cyber implications of ubiquitous sensor world
- C2 of large-scale swarms, MUM-T
- Trusted internet and resilient/reliable network ops
- Networked (technological & sociological) approaches to civil-military operations
- Expanded inter-organizational/international collaboration
 - Information sharing and analysis in a less trusting environment
 - Better public-private partnerships
- Training for staff development
- Experimentation & prototyping
- Add cyber into C2 simulations



Questions?