

Modernizing Systems and Software

- How Evolving Trends in Future Trends in Systems and Software Technology Bode Well for Advancing the Precision of Technology

21st Anniversary - Systems & Software Technology Conference
April 20 – 23, 2009
Salt Lake Palace Convention Center
Salt Lake City, UT 84101
Theme: Technology : Advancing Precision

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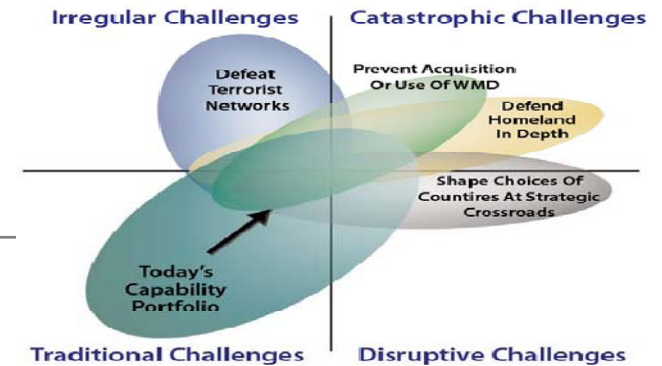


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Overview

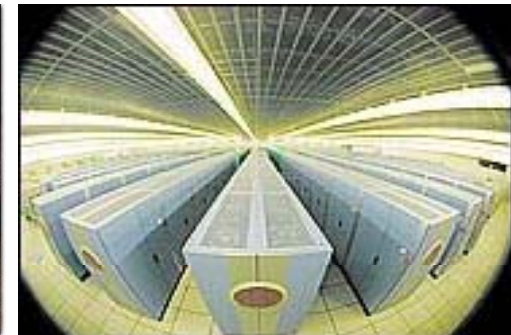


- **Transformational Trends**

- Development
- Acquisition
- Human Element
- Risk Management
- Communications

- **Ten Future Trends**

- **Wrap-up**



Visions of Transformation 2025, 2006 Quadrennial Defense Review



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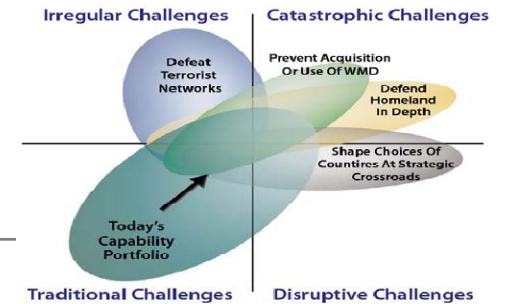
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Development: Need for Space, Air, Ground, Water, Underwater Software-Intensive Systems that are Interconnected

- Several million SLOC programs; “Hybrid” systems combining legacy re-use, COTS, new development
- Multi-contractor teams using different processes; dispersed engineering, development & operational locations
- New technologies create opportunities/challenges; products change/evolve, corporations mutate
- Business/operational needs change - often faster than full system capability can be implemented
- Skillset Shortfalls; Cost and schedule constraints
- Demands for increased integration, interoperability, system of system capabilities
- Enterprise perspectives/requirements; sustainment concerns



**Development Complexity of
Software-Intensive Systems
is Increasing**



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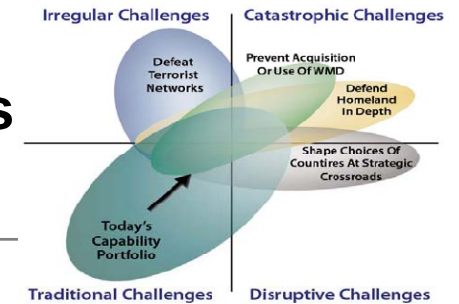
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Software Engineering Trends That Impact Systems Engineering



Traditional

- Standalone systems
- Mostly source code
- Requirements-driven
- Control over evolution
- Focus on software
- Stable requirements
- Premium on cost
- Staffing workable

Future

- Everything connected-maybe
- Mostly COTS components
- Requirements are emergent
- No control over COTS evolution
- Focus on systems and software
- Rapid change
- Premium on value, speed, quality
- Scarcity of critical talent

Emerging Dynamics of Bringing Systems and Software Engineering in Continued Partnership



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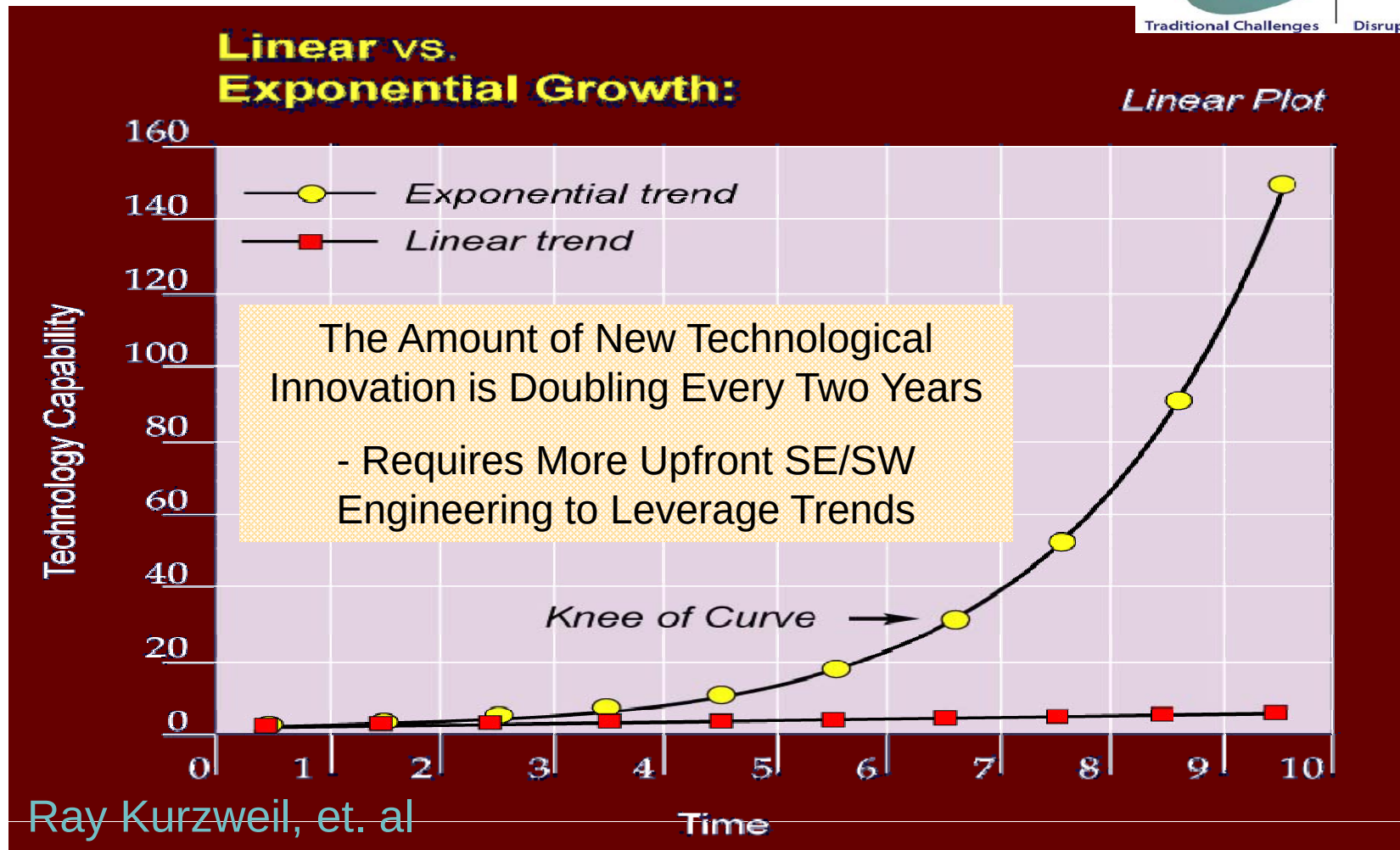
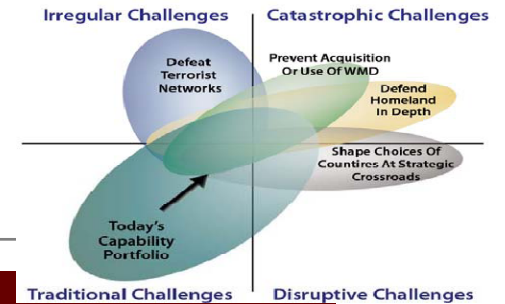
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The Acceleration of Innovation in the 21st Century: - Impacting Both Defense and Society



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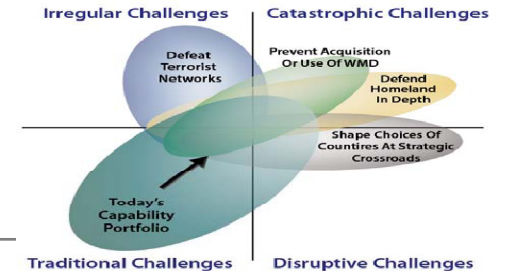
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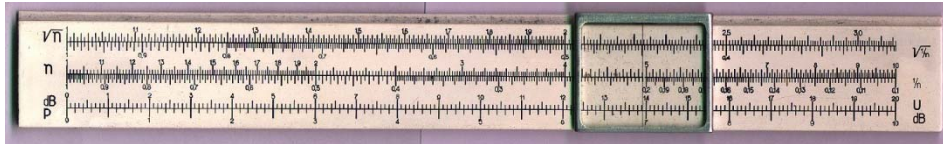
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Augustine's Law: Growth of Software - Order of Magnitude Every 10 Years



In The Beginning



1960's



**F-4A
1000
LOC**



1970's



**F-15A
50,000
LOC**



1980's



**F-16C
300K
LOC**



1990's



**F-22
1.7M
LOC**



2000+



**F-35
>6M
LOC**



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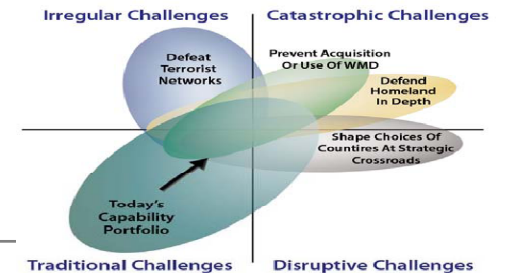
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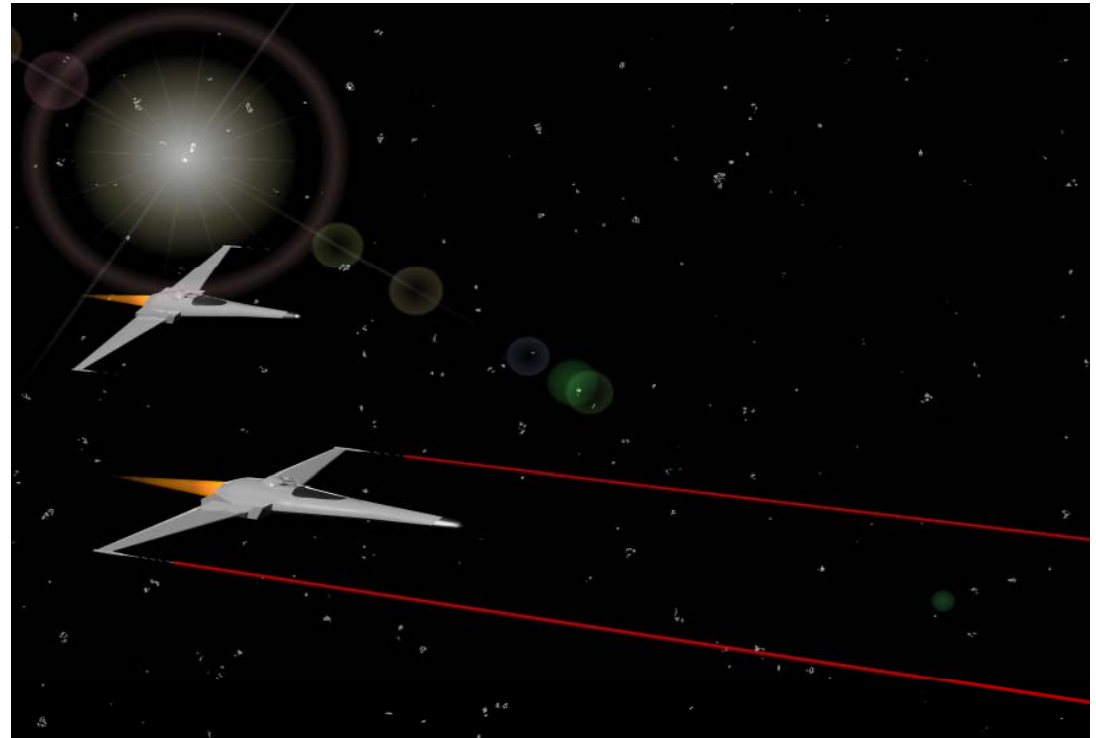
Trend & Implications: Augustine's Law Will Hold



2080?



F-50 - 4.7B Lines of Code



Need for increased functionality will be a forcing function to bring the fields of software and systems engineering closer together



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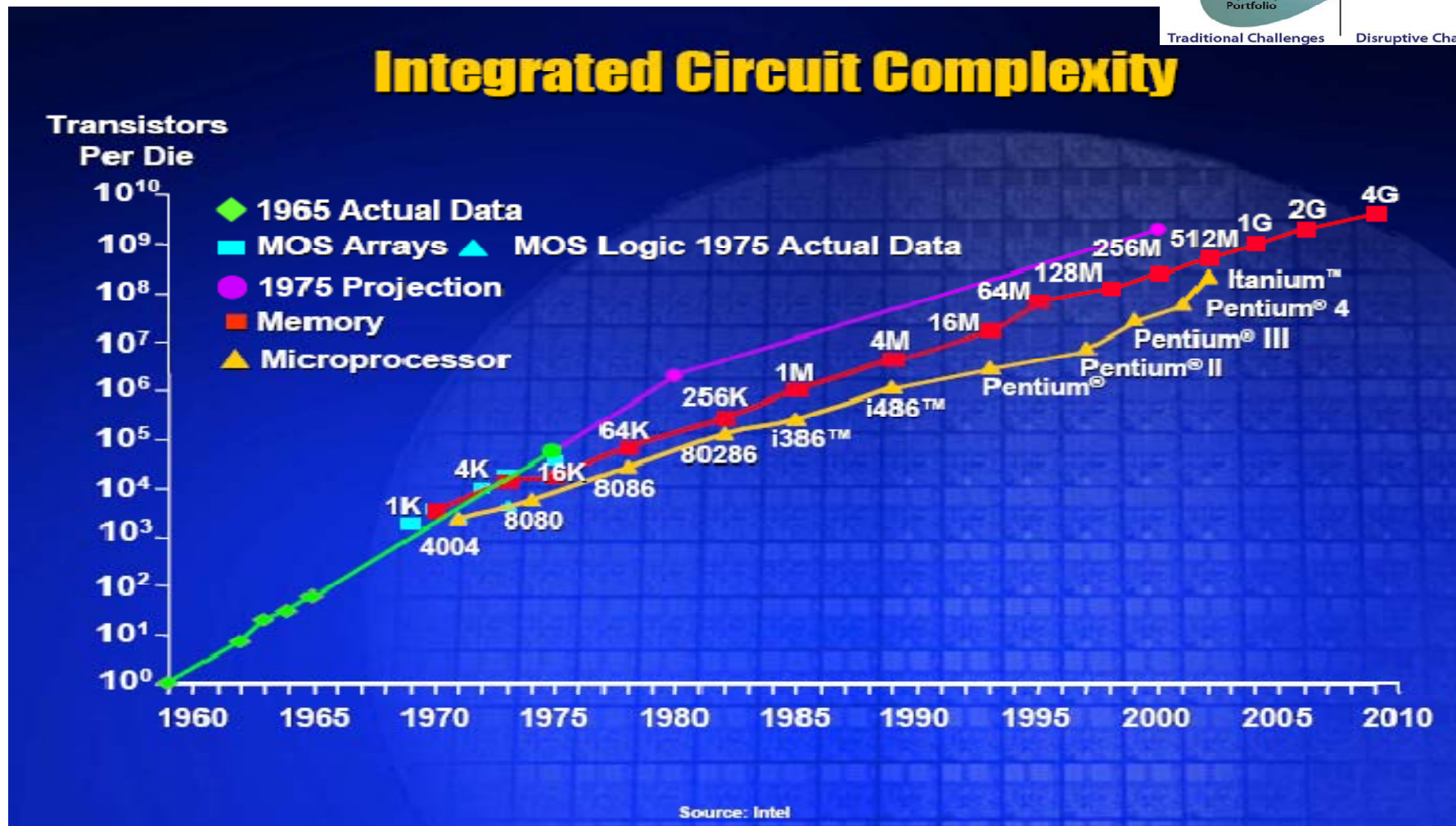
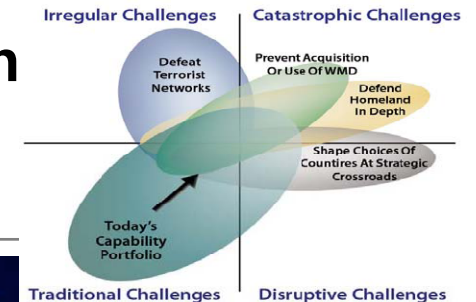
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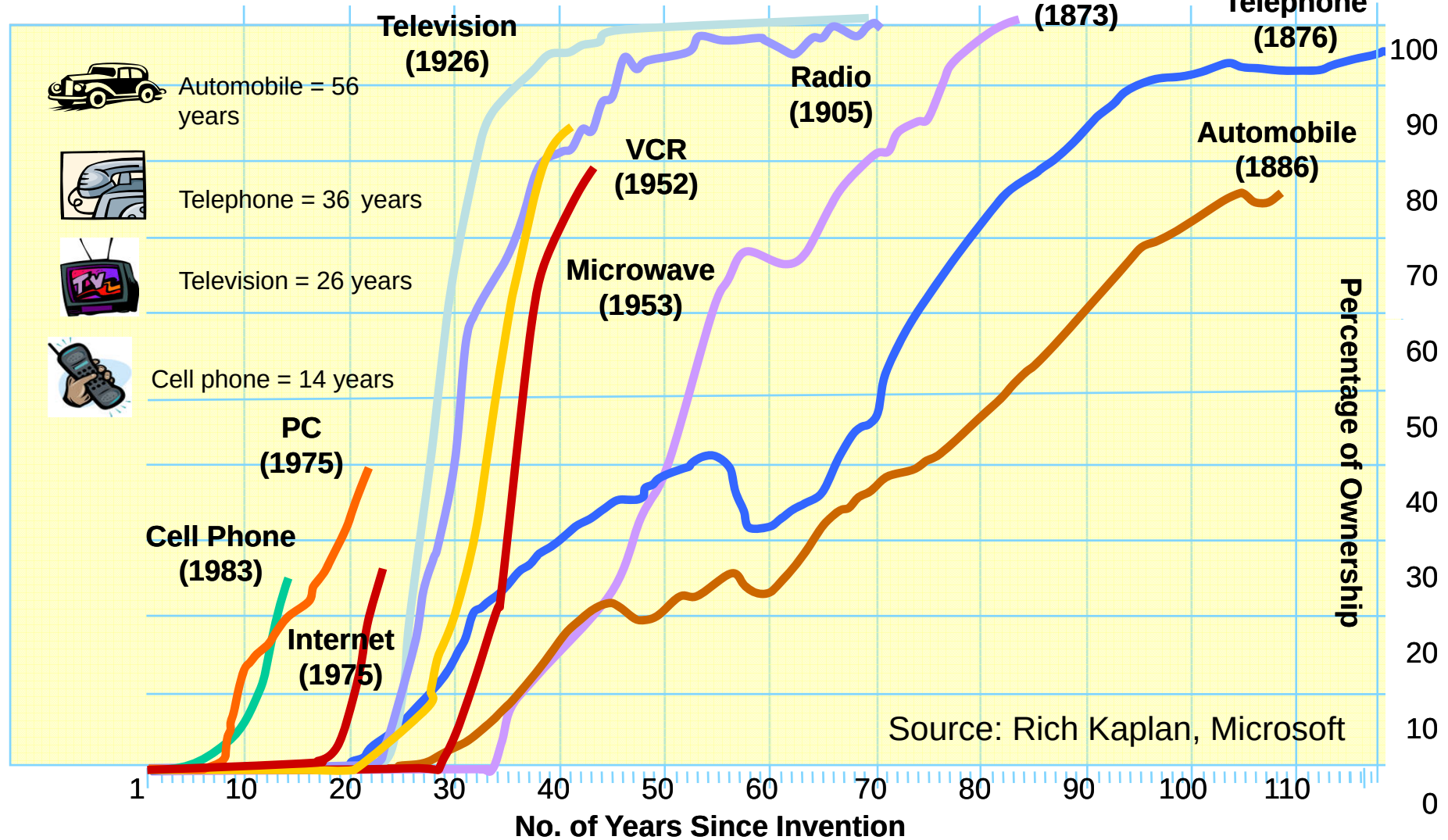
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Moore's Law: The Number of Transistors That Can Placed on an Integrated Circuit is Doubling Approximately Every Two Years





Increased Technological Rate of Adoption



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Relationship Between Complexity and Acquisition Success Improving and More Improvements are on the Way

Software is Growing in Complexity

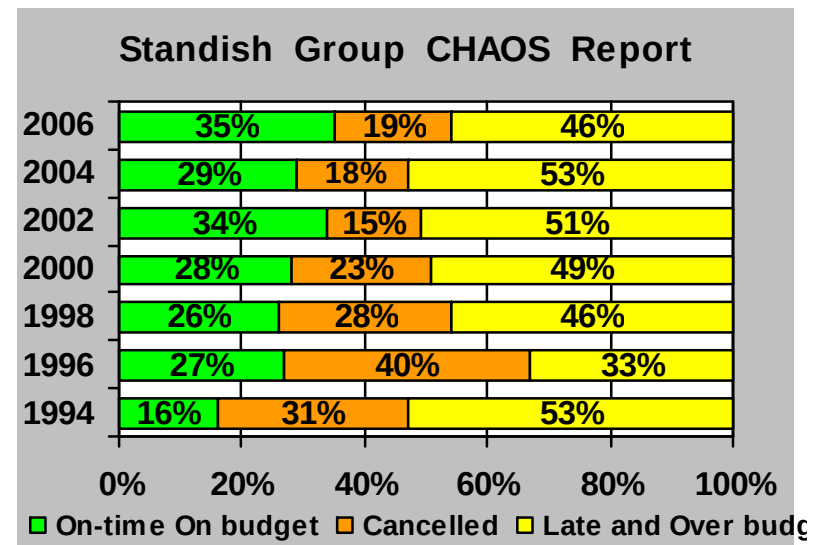
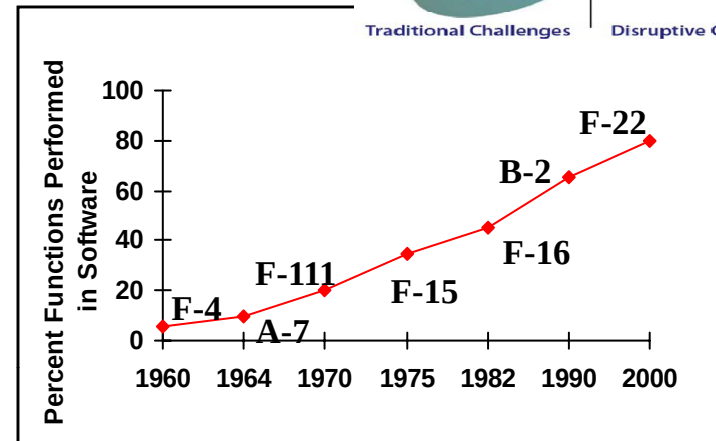
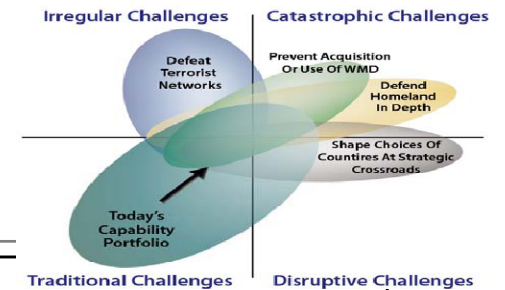
- 80% of some weapon system functionality is dependent upon software
- Consequences of software failure can be catastrophic

Software Acquisition is Difficult

- 46% are over-budget (by an average of 47%) or late (by an average of 72%)
- “Successful projects” have 68% of specified features

Software is Pervasive

- IT Systems, C4ISR, Weapons, etc



On-going Changes to the Acquisition Process Targeted at Correcting this Issue



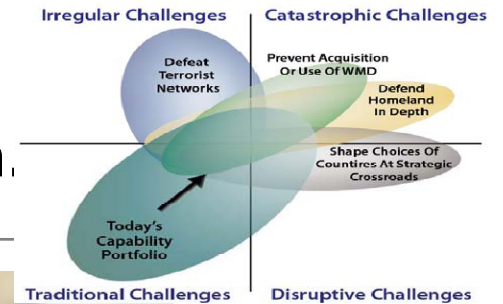
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Acquisition: Life of a Program Manager in a System of Systems and/or Net-Centric Operation.



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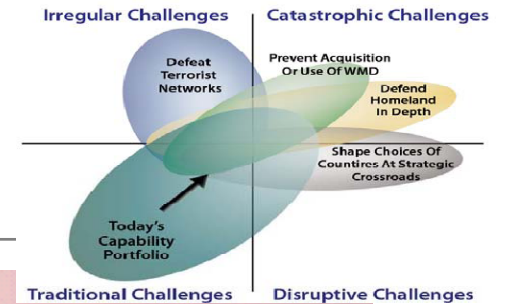
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Acquisition: Effectively Managing Risk



A Key Challenge is How to Obtain a Better Alignment of Risk Among the Relevant Stakeholders



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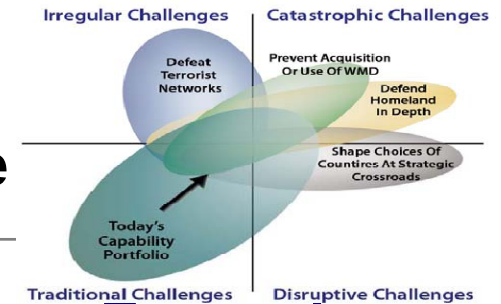
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Acquisition Challenges: Some Drivers That Increase the Risk of Acquiring Software-Intensive



Platform → **Enterprise**
Customer Emphasis

Requirements → **Objectives/ Capabilities**
Acquisition Model

Dominant Prime → **Strategic Teaming**
Program Execution

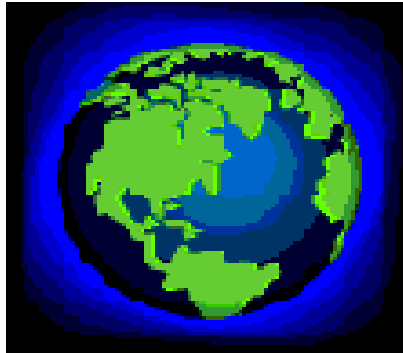
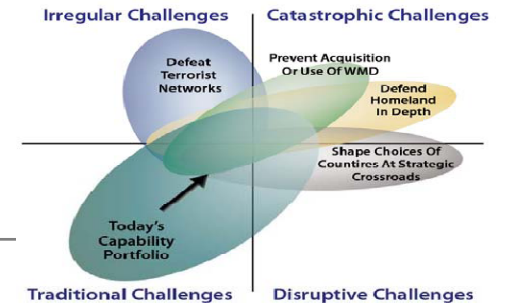
“Boxes” → **“Layers & Stacks”**
Integration Challenge

Proprietary → **Plug & Play**
Architectures and Standards

Need Exists to Address Both Sides, and Do So with Compressed Delivery Schedules via Improvements in Systems/Software Engineering



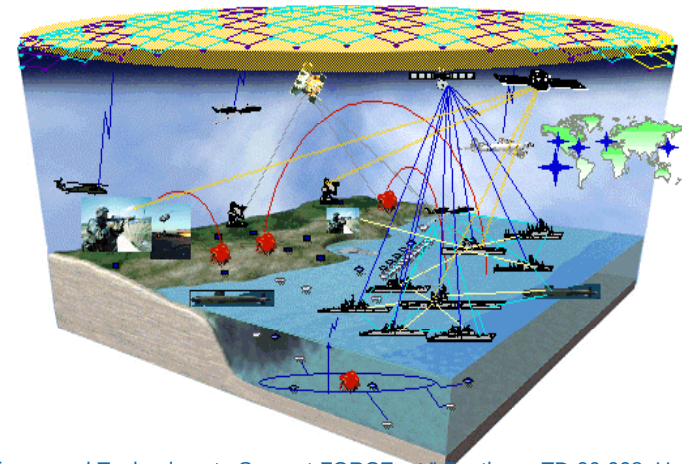
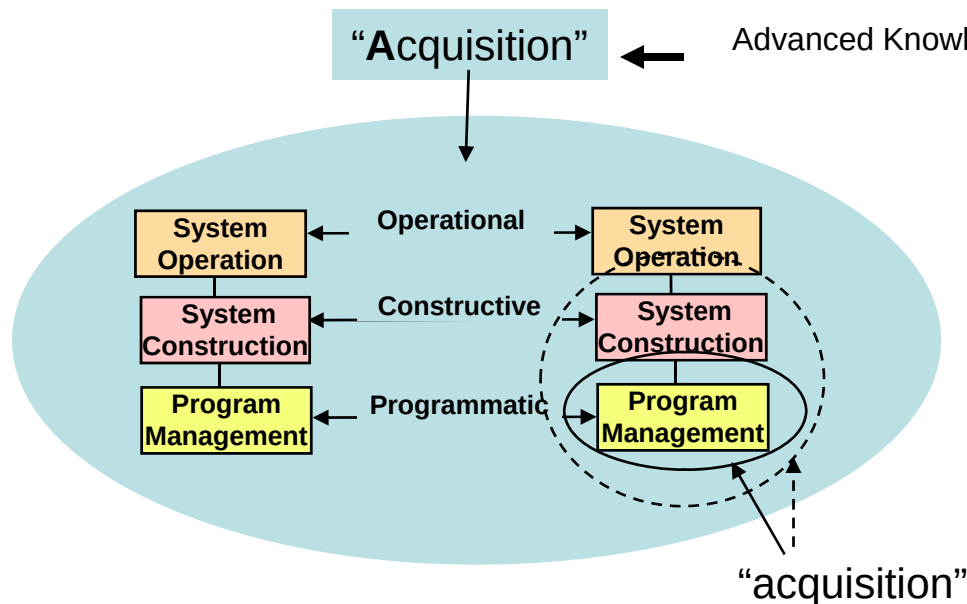
Acquisition Performance – Flexible Boundary-Crossing Acquisition Structure



2005 study confirmed*:

- In advanced knowledge-based organizations, management's desire for the flow of knowledge is greater than the desire to control boundaries
- Unlike the matrix organization, there is less impact on the dynamics of formal power and control
- **Important to measure the system in terms of user performance**

* Using Communities of Practice to Drive Organizational Performance and Innovation, 2005, APQ study



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Ref: Jim Smith, (703) 908-8221, jds@sei.cmu.edu

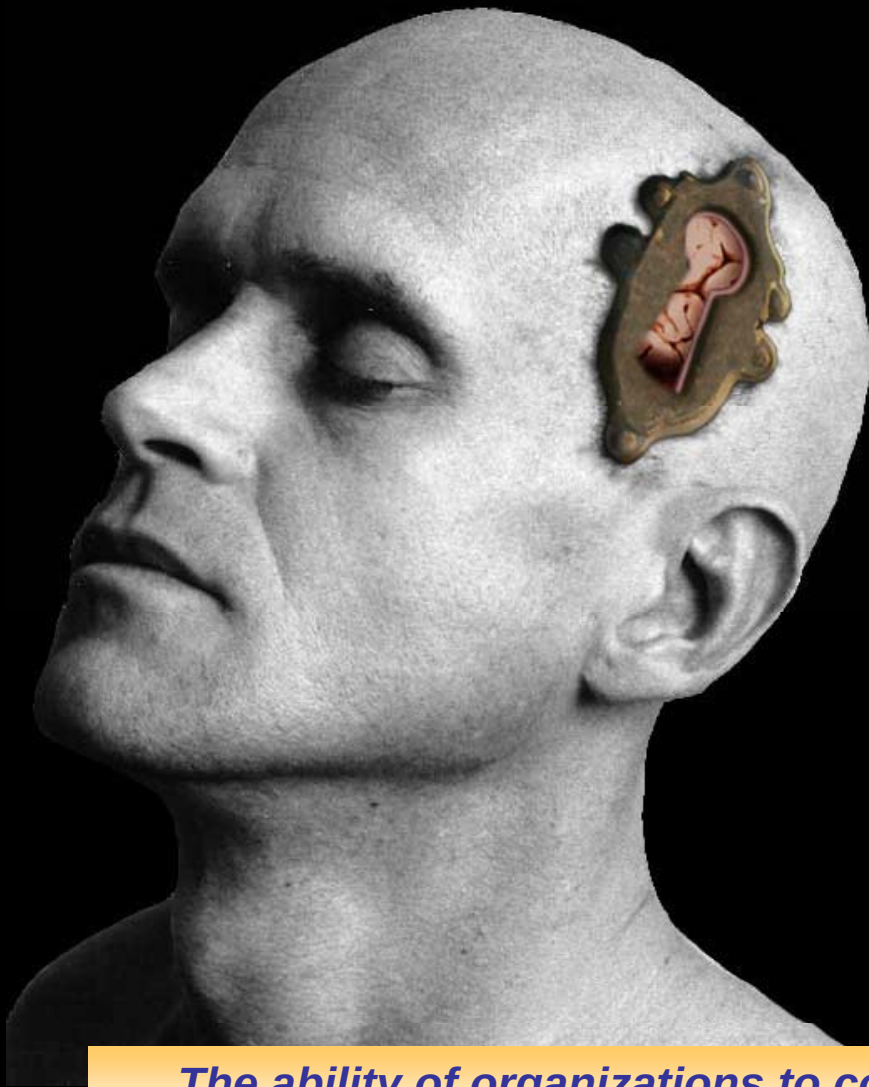


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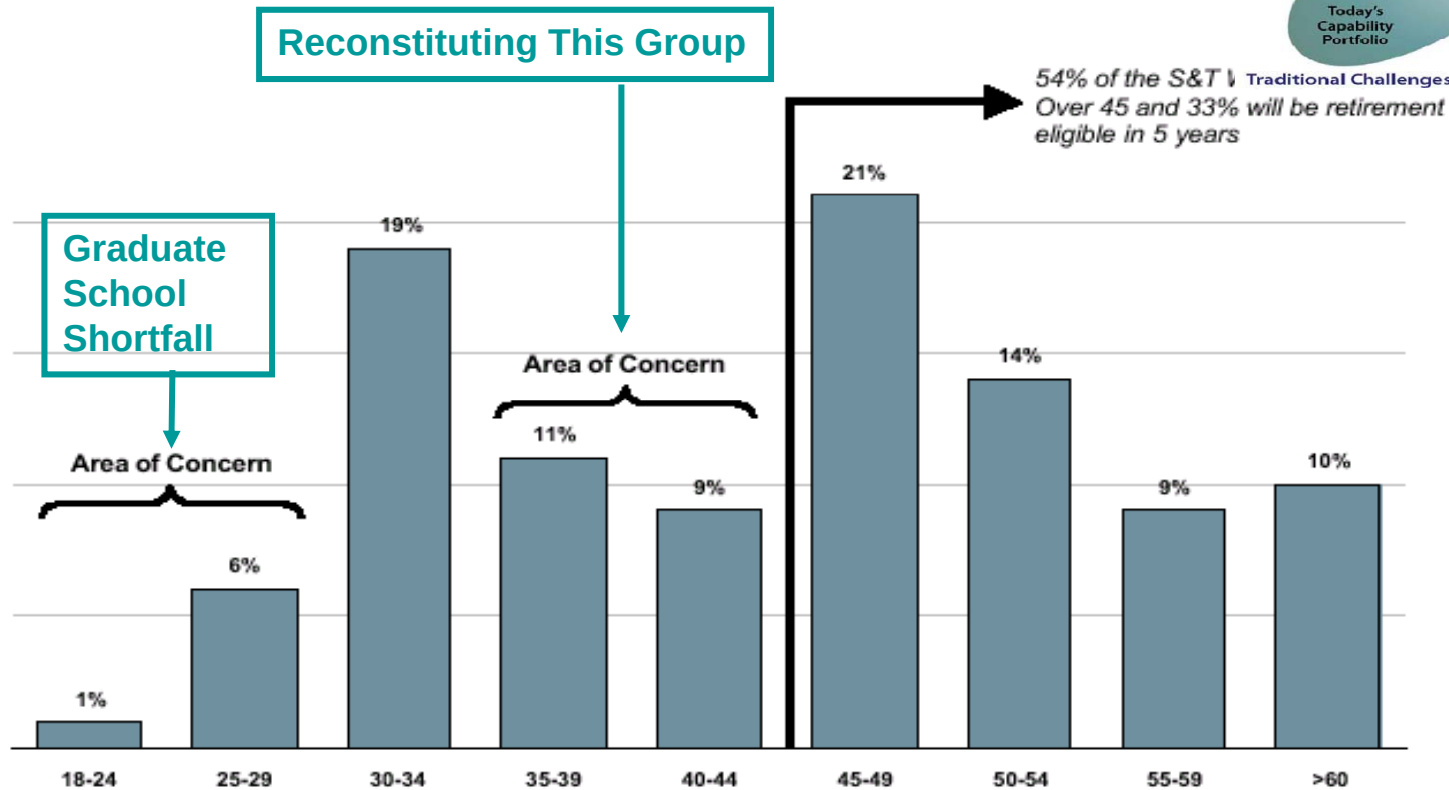
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Human Element



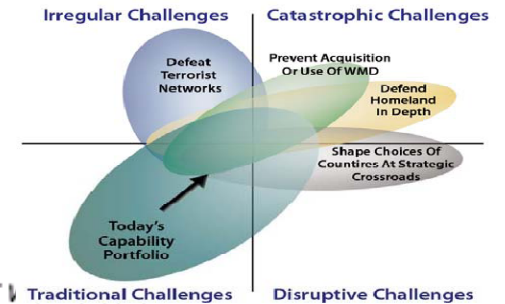
The ability of organizations to compete will increasingly depend on the innovation of the human element

Society Drivers: Bimodal Demographics (Space Industry)



Average Space Industry S&E Workforce Age Distribution

Trend: Industry/Gov't Will Increasingly Focus on Attracting, Training and Retaining Systems Engineering Talent

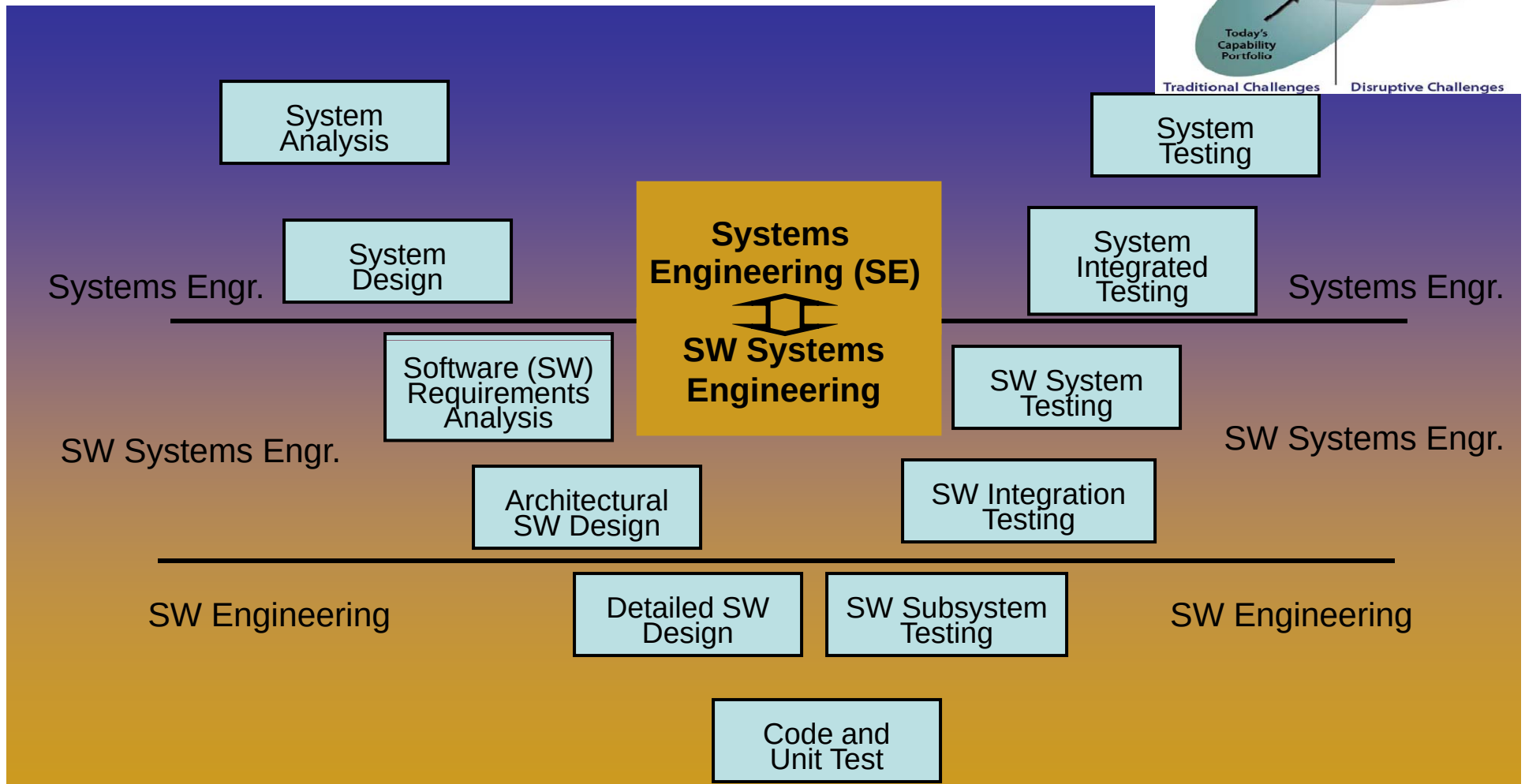
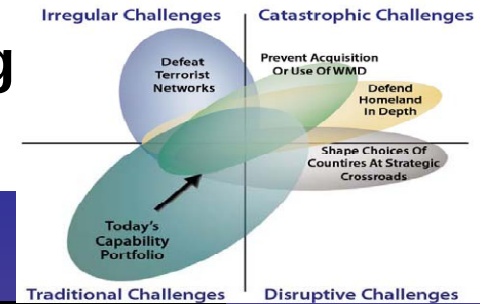


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Source: Lockheed Martin (0004305-001: AIAA SE Workforce Data. Frank Cappuccio VP & GM Skunk Works)

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Objective is for Software and Systems Engineering to Become More Integrated Versus Separated



OSD Initiative: Integrated Software and Systems Engineering Curriculum



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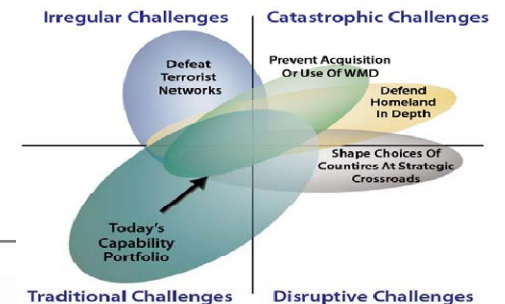
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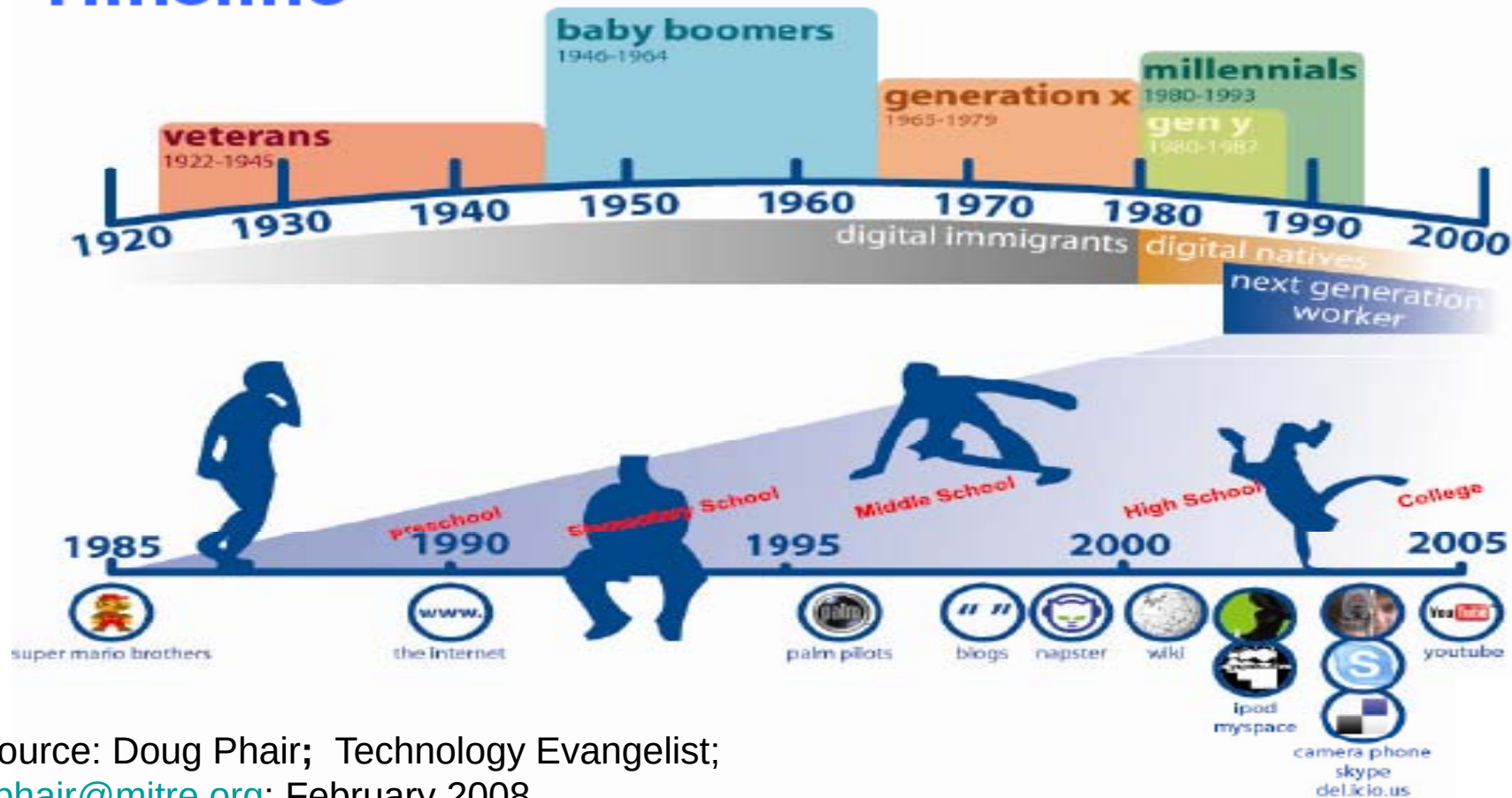
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Human Element in the Work-Space Environment



Timeline



Source: Doug Phair; Technology Evangelist;
dphair@mitre.org; February 2008



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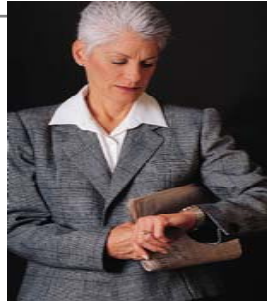
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Managing Multiple Generations: Cultural Differences



Traditionalist
1928-1945

- Hard worker
- Respects authority
- Work is an obligation
- Communicates formally & in person
- Organizational loyalty
- Work & family don't mix



Baby-Boomer
1946 - 1964

- Workaholic
- Questions authority
- Works efficiently
- Competitive
- No news is good news
- Work to live, little balance between work/family



Generation X
1965 - 1980

- Technically savvy
- Prefer informality
- Learns quickly
- Communicates directly & immediately
- Wants structure & direction
- Seek work/life balance

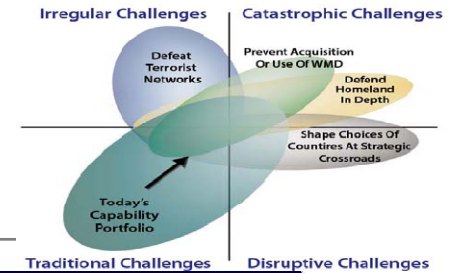


Generation Y
1980 - 2000

- Prefer informality
- Learn quickly
- Embrace diversity
- Requires supervision
- Indirect communication: email & texting
- Seek "demand" work/life balance



Trends Affecting the Workforce



From

To

Doers differ from thinkers → Doers must be thinkers

Assets are things → Assets are people

Labor is an expense → People are an investment

Lifetime employment → Lifetime employability

Top down control → Decentralized decisions

Localized work → Networked problems solved

Measure for results → Measure for improvements

Pfeffer (1994)



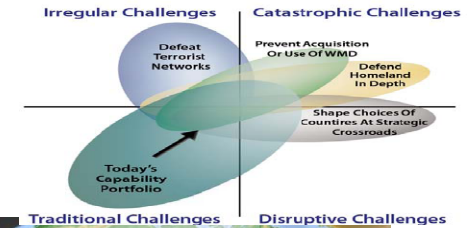
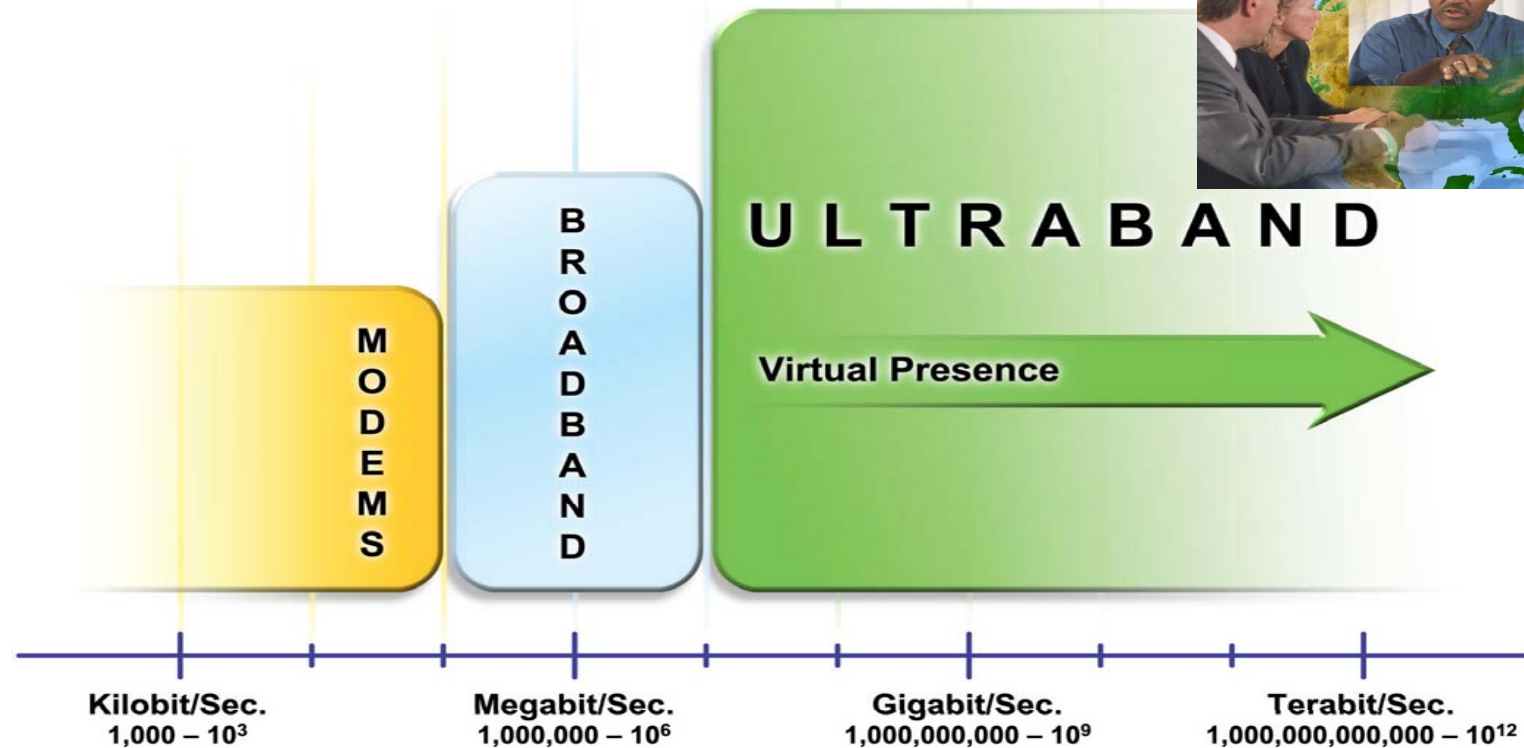
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Communication: Increased Capabilities in the Digital Spectrum Enables Improvements in Communication and Collaboration



Rule #4: The best companies are the best collaborators*

* Friedman, Thomas L. *"The World Is Flat"*, Farrar, Straus and Giroux, 2005



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Irregular Challenges

Catastrophic Challenges

Defeat Terrorist Networks

Prevent Acquisition Or Use Of WMD

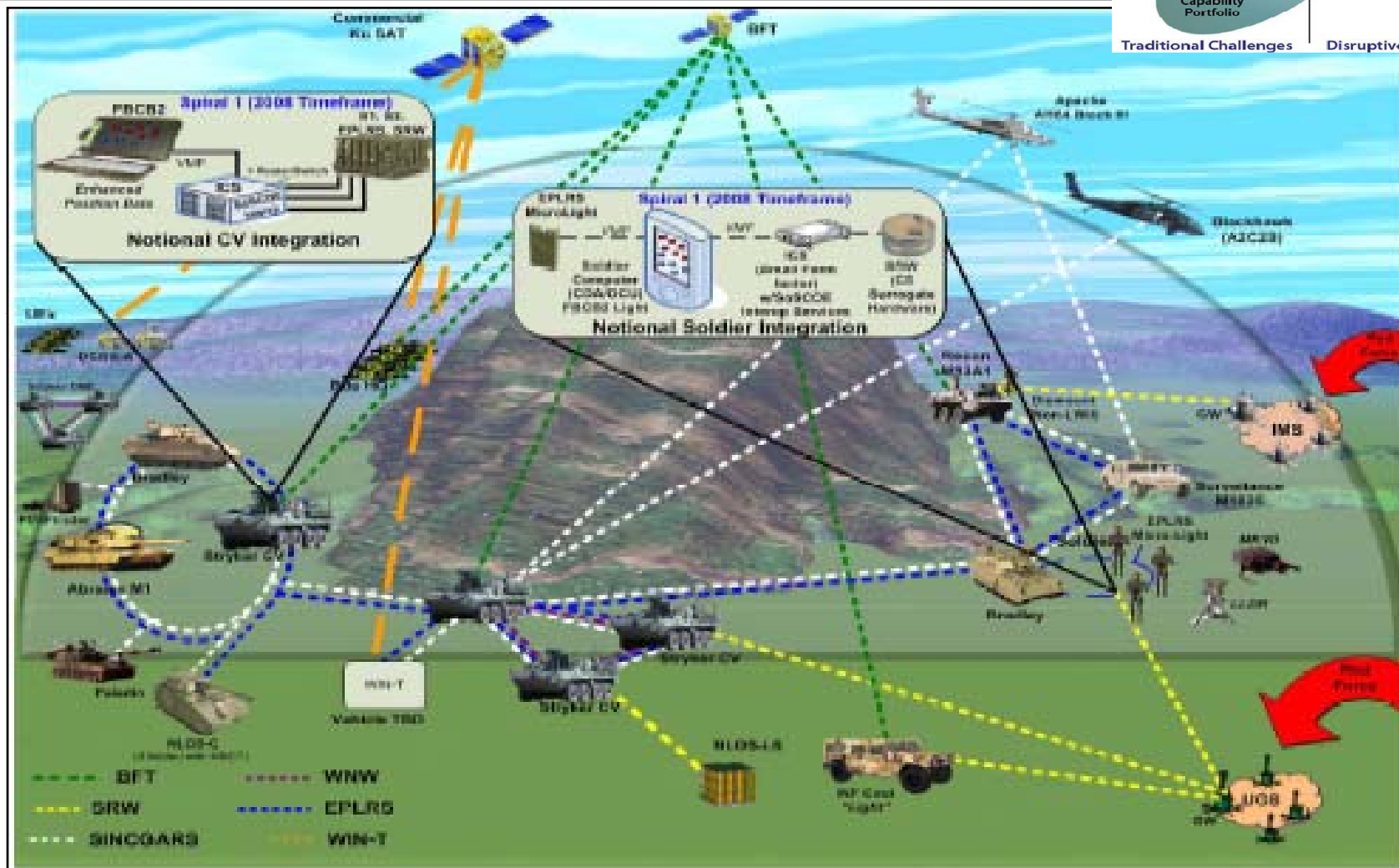
Defend Homeland In Depth

Shape Choices Of Countries At Strategic Crossroads

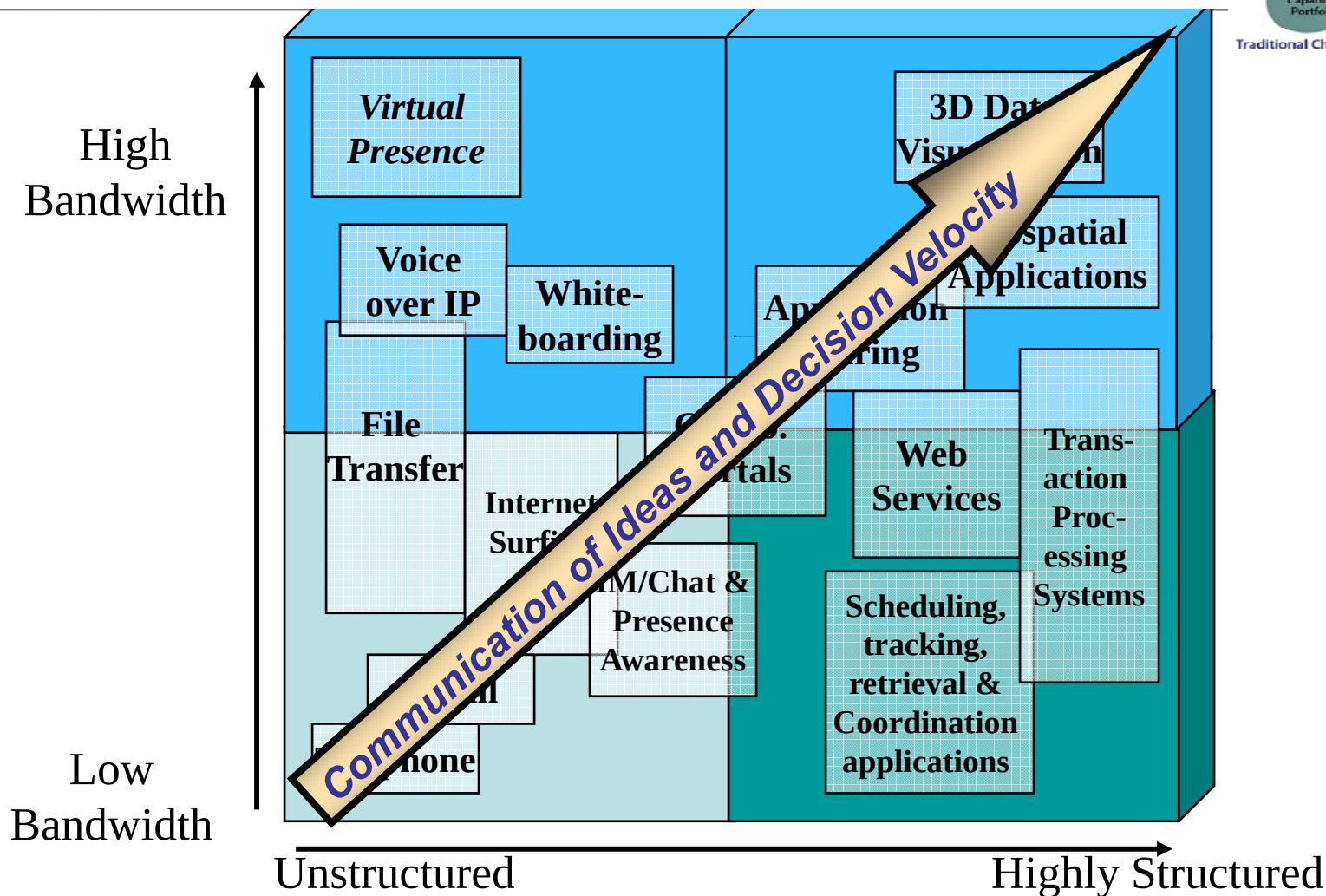
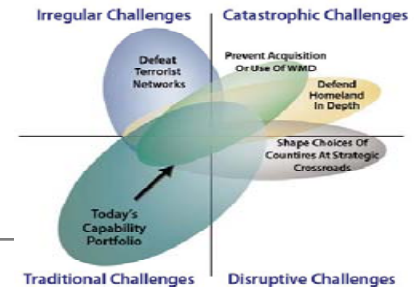
Today's Capability Portfolio

Traditional Challenges

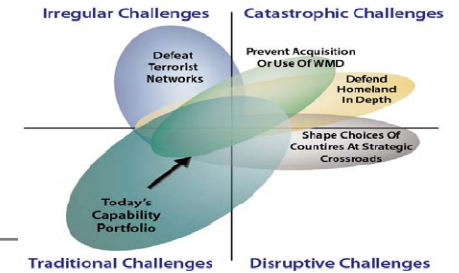
Disruptive Challenges



Implication: Improvements in Collaboration Mechanisms Are Enablers for System and Software Engineering Success



Problem Identification: Ultra-Large-Scale (ULS) Systems – The Software Challenge of the Future

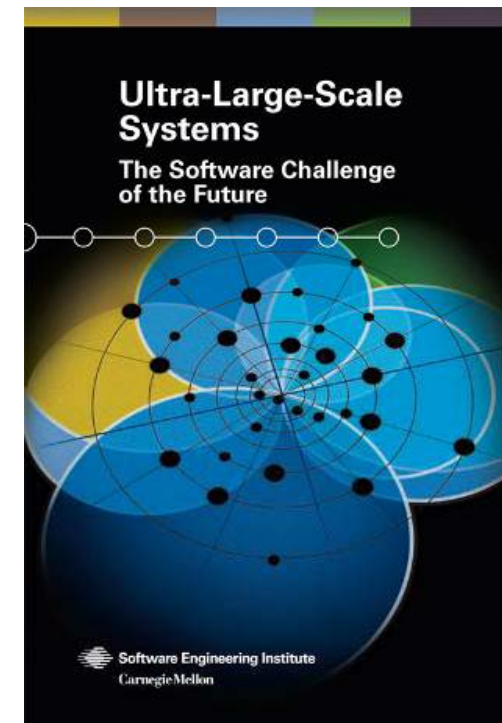


Gather leading experts to study:

- Characteristics of ULS systems
- Challenges and breakthroughs required
- Promising research and approaches

Intended outcomes:

- ULS Systems Research Agenda
- Program proposal
- Collaborative research network



ULS systems study

About the Effort

Funded by the Army (ASA ALT)

Staffing: 9 member SEI team; 13 member expert panel

Study lead – Linda Northrop, SEI

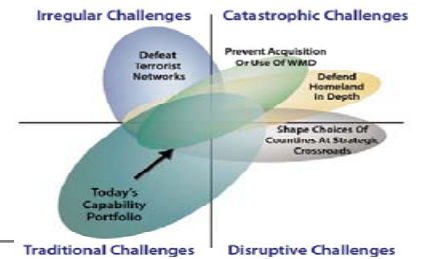


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Systems and Software Engineering: Ten Trends

- *Greater demands on systems and software engineers will stimulate growth in the field – nationally and internationally*
- *Industry/Gov't will increasingly focus on attracting, training and retaining systems and software engineering talent – short and long run – with emphasis on providing a Generation Y work environment*
- *Increased reliance on systems and software engineering processes and technologies to effectively manage the acquisition/"green" space*
- *The laws of Augustine's and Moore will continue to hold and will continue to be a forcing function to bring the fields of software and systems engineering closer together*
- *Improvements in program risk-reduction collaboration mechanisms will be significant enablers for increases in systems and software engineering communication and "decision velocity"*





Systems and Software Engineering: Ten Trends

- *Increased need for a large number of complex systems and systems of systems will lead to investments in research and technology*
- *Systems and software engineers will continually find way to innovative to reduce complexity*
 - *Increased importance of modeling and simulation*
 - *Increased reliance on architectures (top-down and bottoms-up)*
 - *Increased design for continuous evolution and deployment at all levels will occur*
 - *Understanding users and their context will evolve, e.g. leaner system and software engineering process assets on projects*
- *Increased customer requests for system and software engineering support earlier in life cycle*
- *Shift of systems and software engineering focus from the platform to systems of systems*
- *Process improvement will continue to be important*





Recommended Readings



Buckman, Robert H. *Building a Knowledge-Driven Organization*. McGraw-Hill, New York, NY, 2004.

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