New Concepts and Trends

- How Future Trends in Systems and Software Technology Bode Well for Enabling Improved Acquisition and Performance in Defense Systems

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San Diego, CA
Theme: Technology – Tipping the Balance

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The Software Engineering Institute - Improving the Practice of Engineering: Create, Apply and Amplify

Federally Funded Research and Development Center

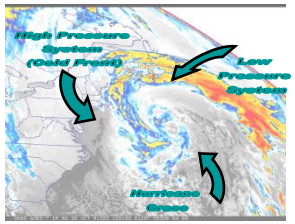
Created in 1984

Sponsored by the U.S. Department of Defense

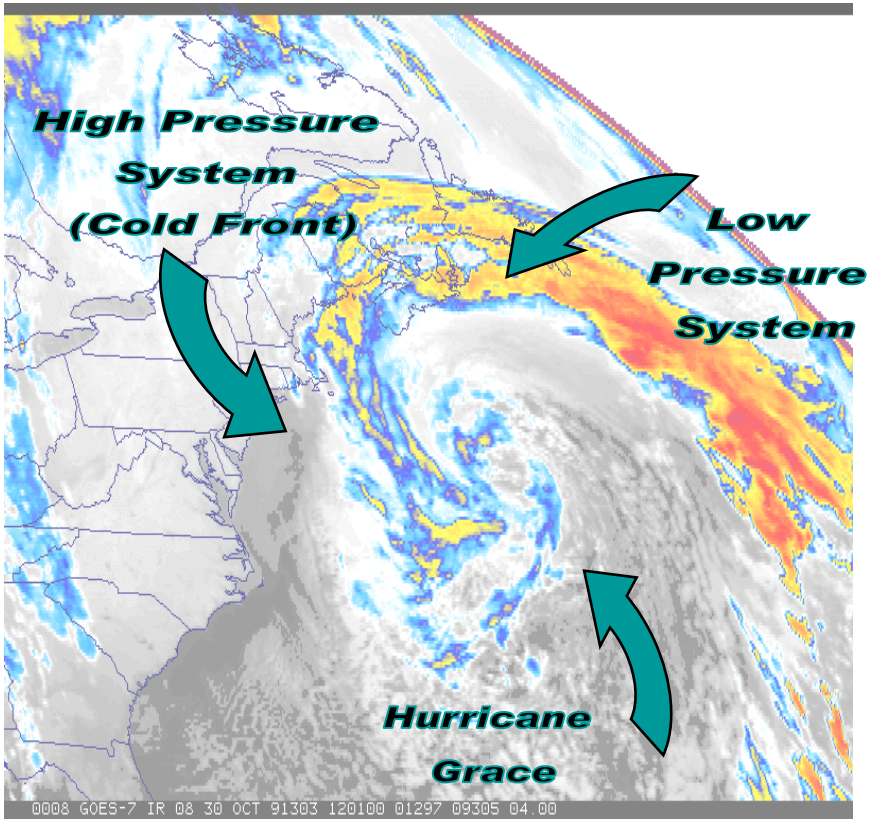
Locations in Pittsburgh, PA; Washington, DC; Frankfurt, Germany

Operated by Carnegie Mellon University

Overview

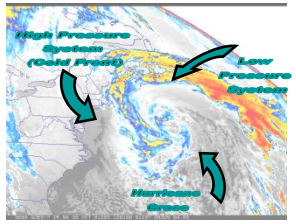


- **Transformational Trends**
  - Development
  - Acquisition
  - Human Element
  - Risk Management
  - Communications
- **Ten Future Trends**
- **Wrap-up**



"Perfect Storm" Event, October 1991
National Oceanic & Atmospheric Administration

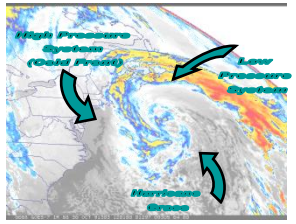
Development: Need for Space, Air, Ground, Water, Underwater Software-Intensive Systems that are Interconnected

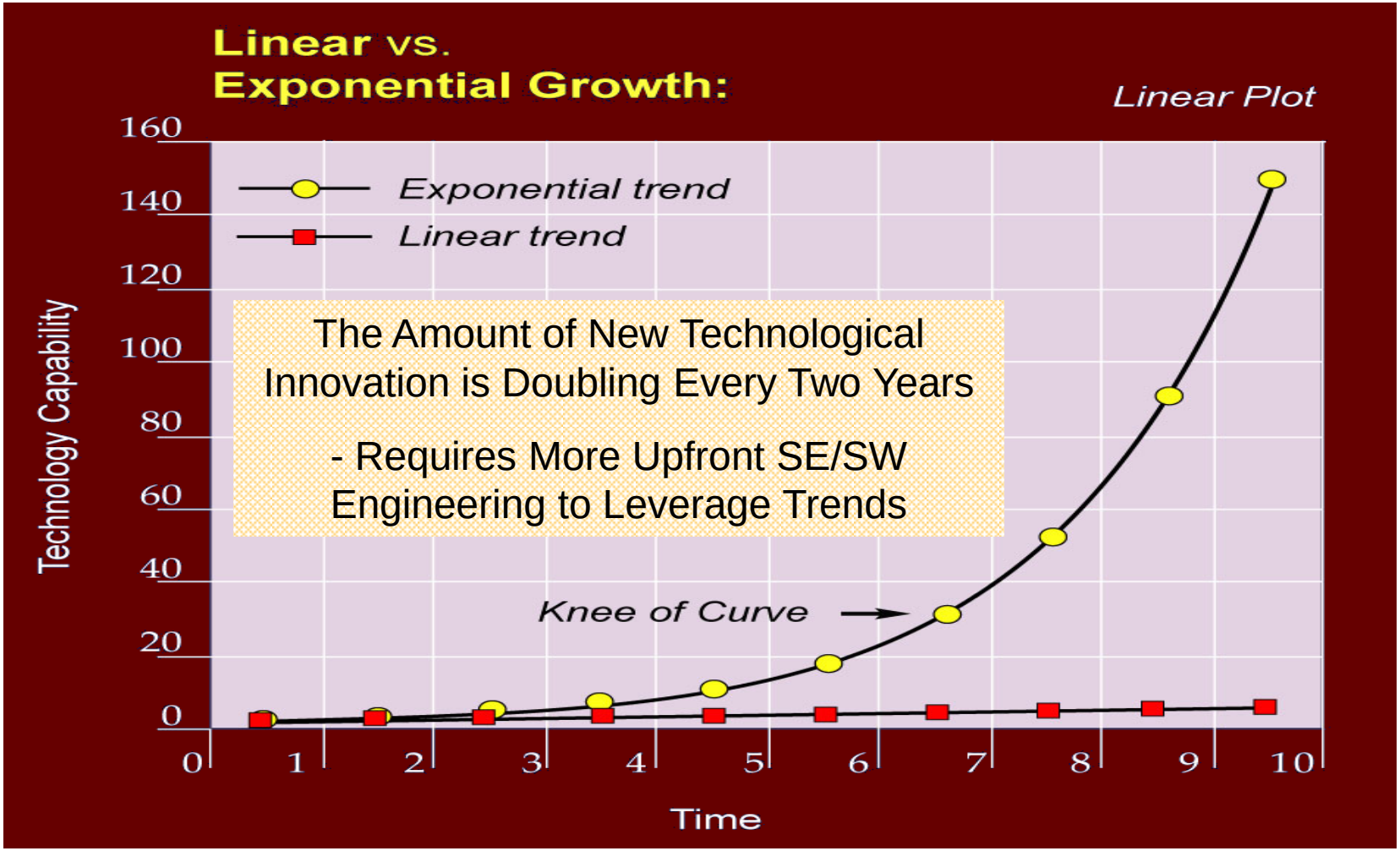


- Several million SLOC programs; “Hybrid” systems combining legacy re-use, COTS, new development
- Multi-contractor teams using different processes; dispersed engineering, development & operational locations
- New technologies create opportunities/challenges; products change/evolve, corporations mutate
- 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

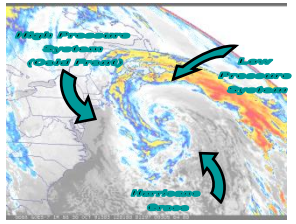
Development Complexity of Software-Intensive Systems is Increasing

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

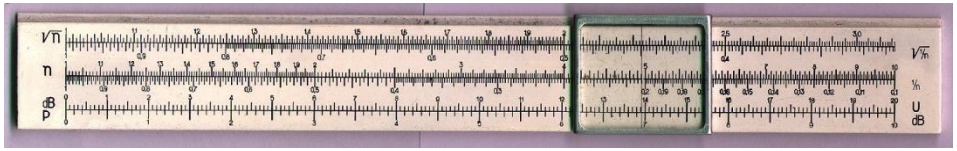


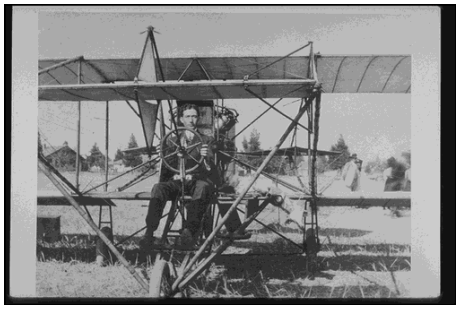


Augustine's Law: Growth of Software - Order of Magnitude Every 10 Years



In The Beginning





1960's

F-4A
1000
LOC

1970's

F-15A
50,000
LOC

1980's

F-16C
300K
LOC

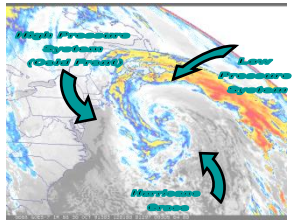
1990's

F-22
1.7M
LOC

2000+

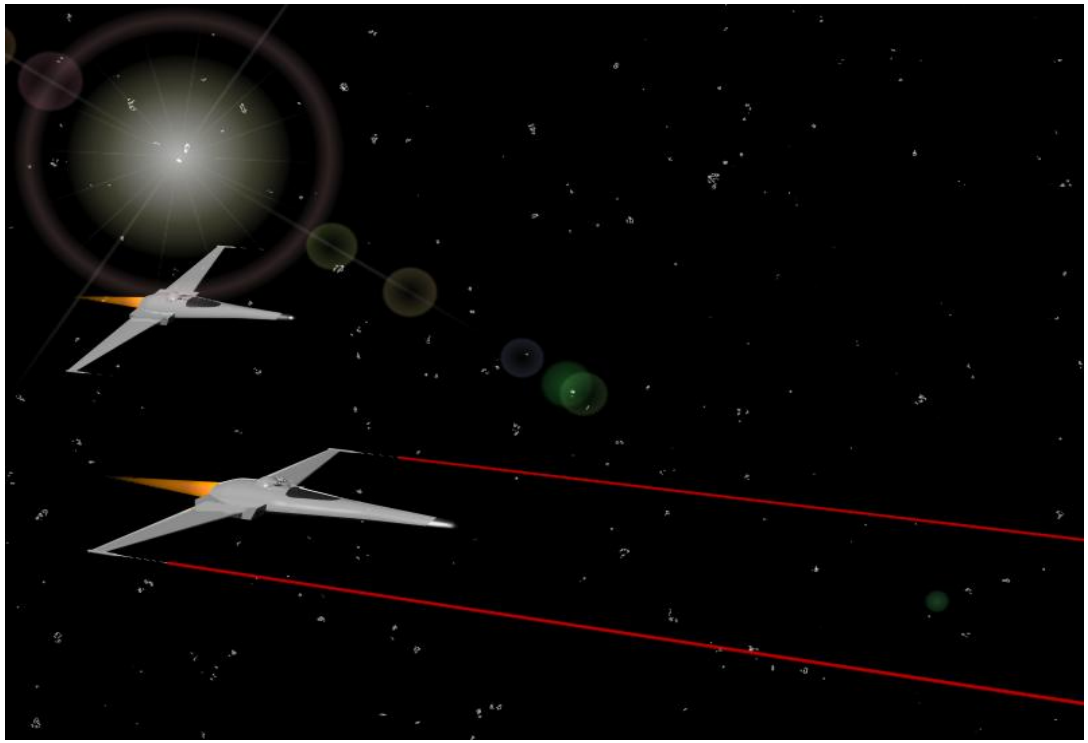
F-35
>6M
LOC

Trend & Implications: Augustine's Law Will Hold



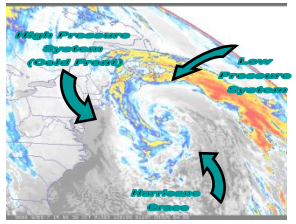
2080?

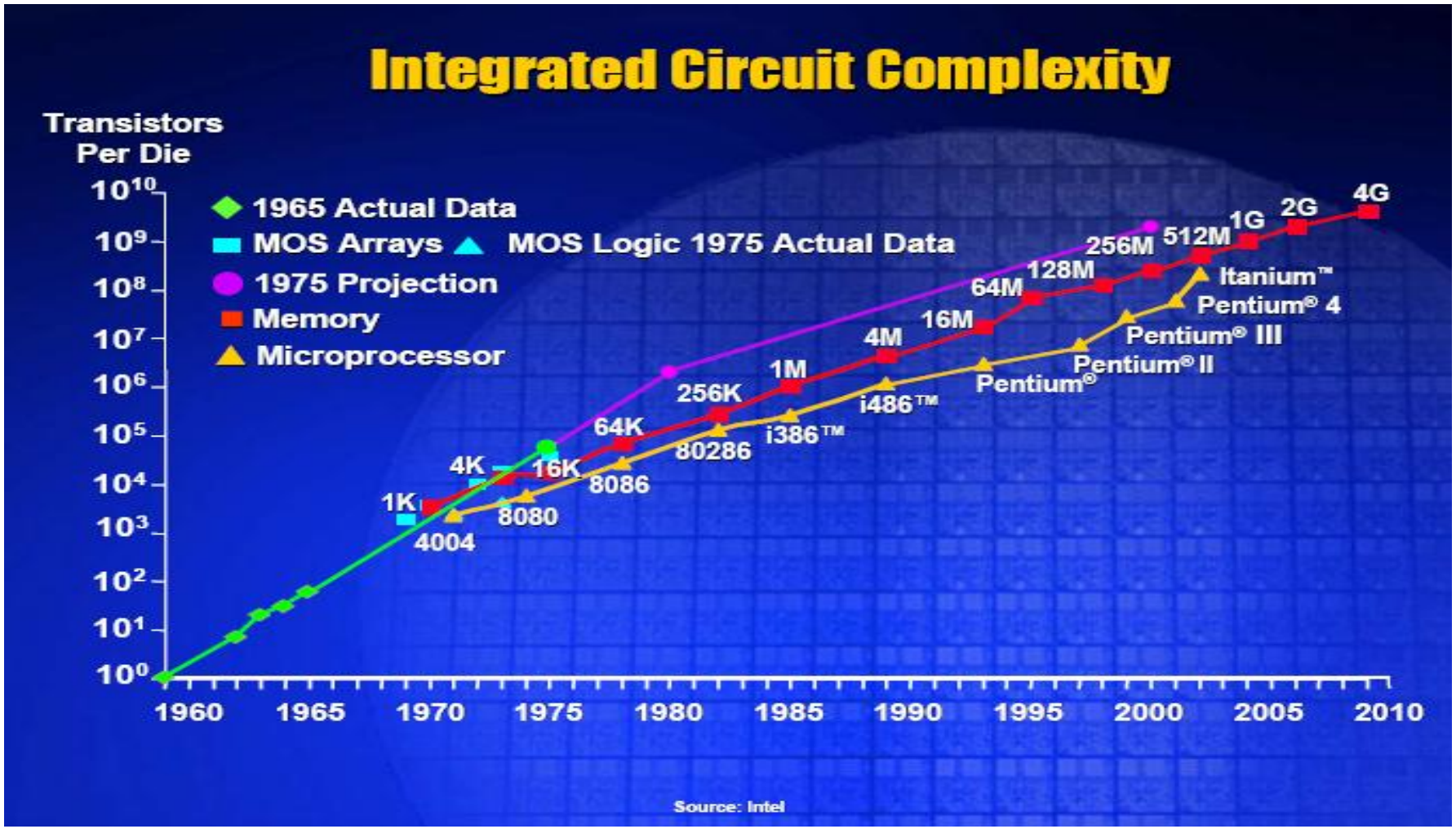
F-50 - 4.7B Lines of Code



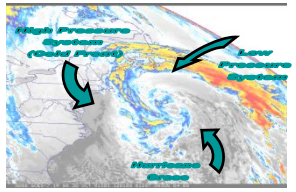
Need for increased functionality will be a forcing function to bring the fields of software and systems engineering closer together

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

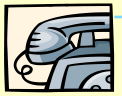




Increased Technological Rate of Adoption



Automobile = 56 years



Telephone = 36 years

Television = 26 years

Cell phone = 14 years

Television (1926)

Electricity (1873)

Telephone (1876)

Radio (1905)

Automobile (1886)

VCR (1952)

Microwave (1953)

PC (1975)

Cell Phone (1983)

Internet (1975)

Source: Rich Kaplan, Microsoft

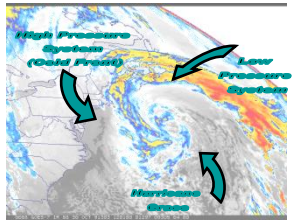
Percentage of Ownership

0 10 20 30 40 50 60 70 80 90 100

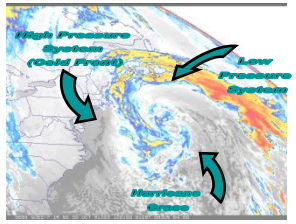
1 10 20 30 40 50 60 70 80 90 100 110

No. of Years Since Invention

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

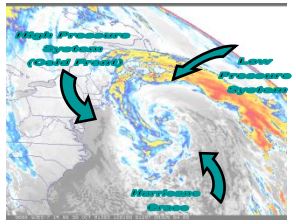


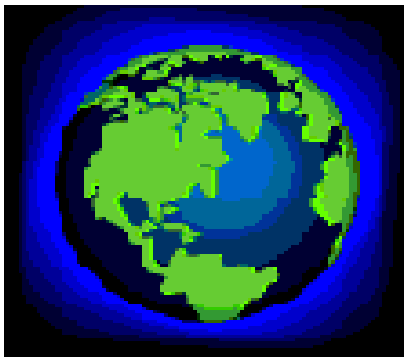
Acquisition: Effectively Managing Risk



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

Acquisition Performance – Flexible Boundary-Crossing Acquisition Structure

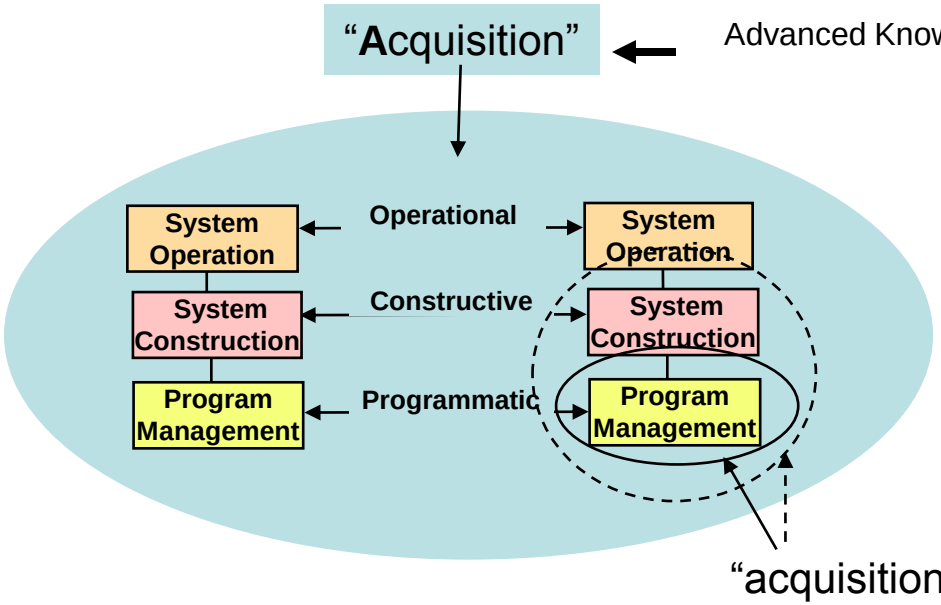


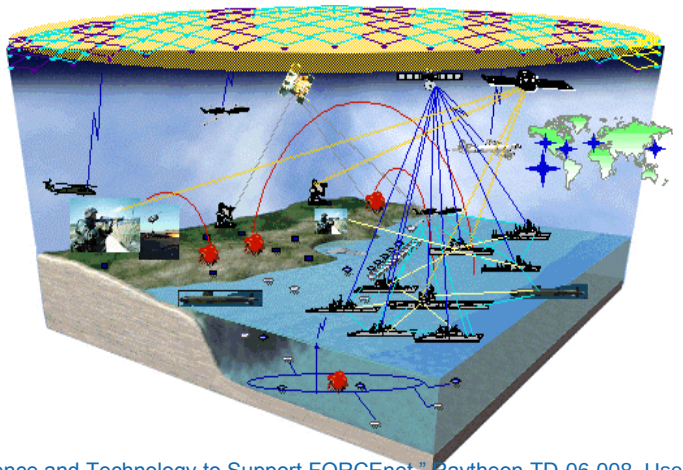


2005 study confirmed*:

- 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

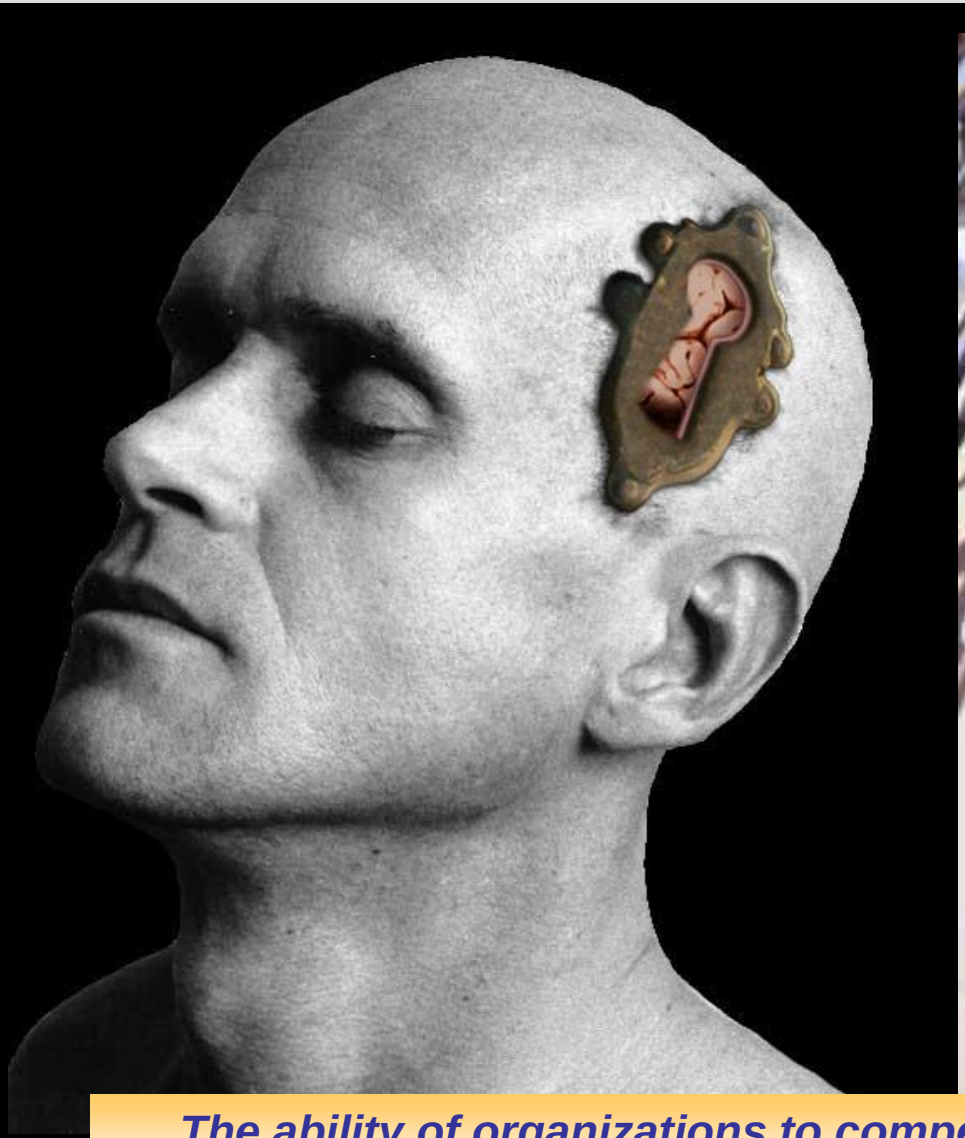




From "Science and Technology to Support FORCEnet," Raytheon TD-06-008. Used by permission.

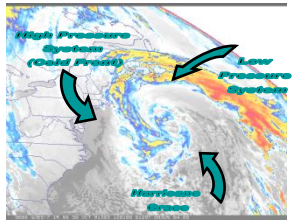
Ref: Jim Smith, (703) 908-8221,jds@sei.cmu.edu

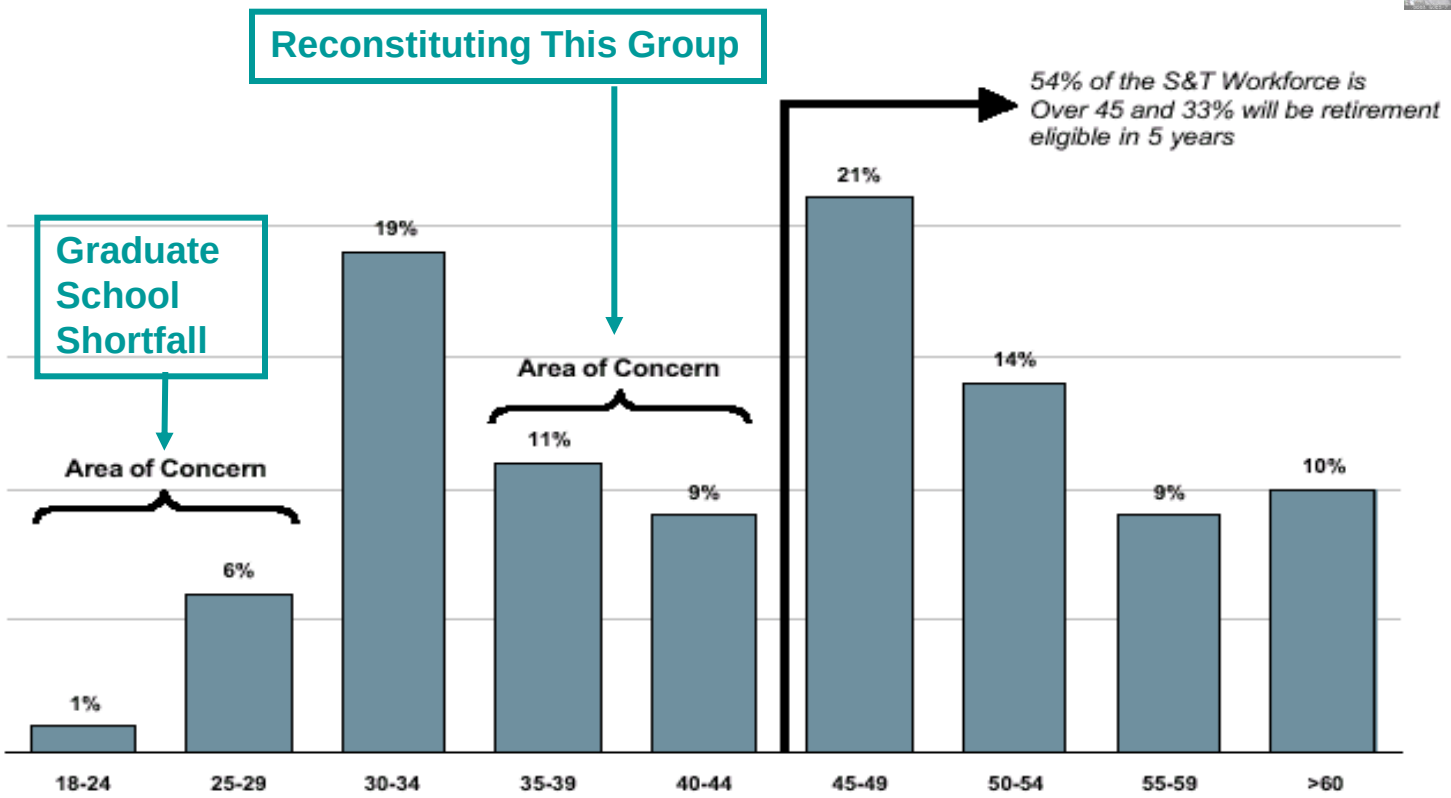
Human Element



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

Society Drivers: Bimodal Demographics (Space Industry)



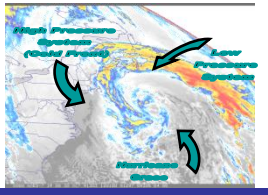


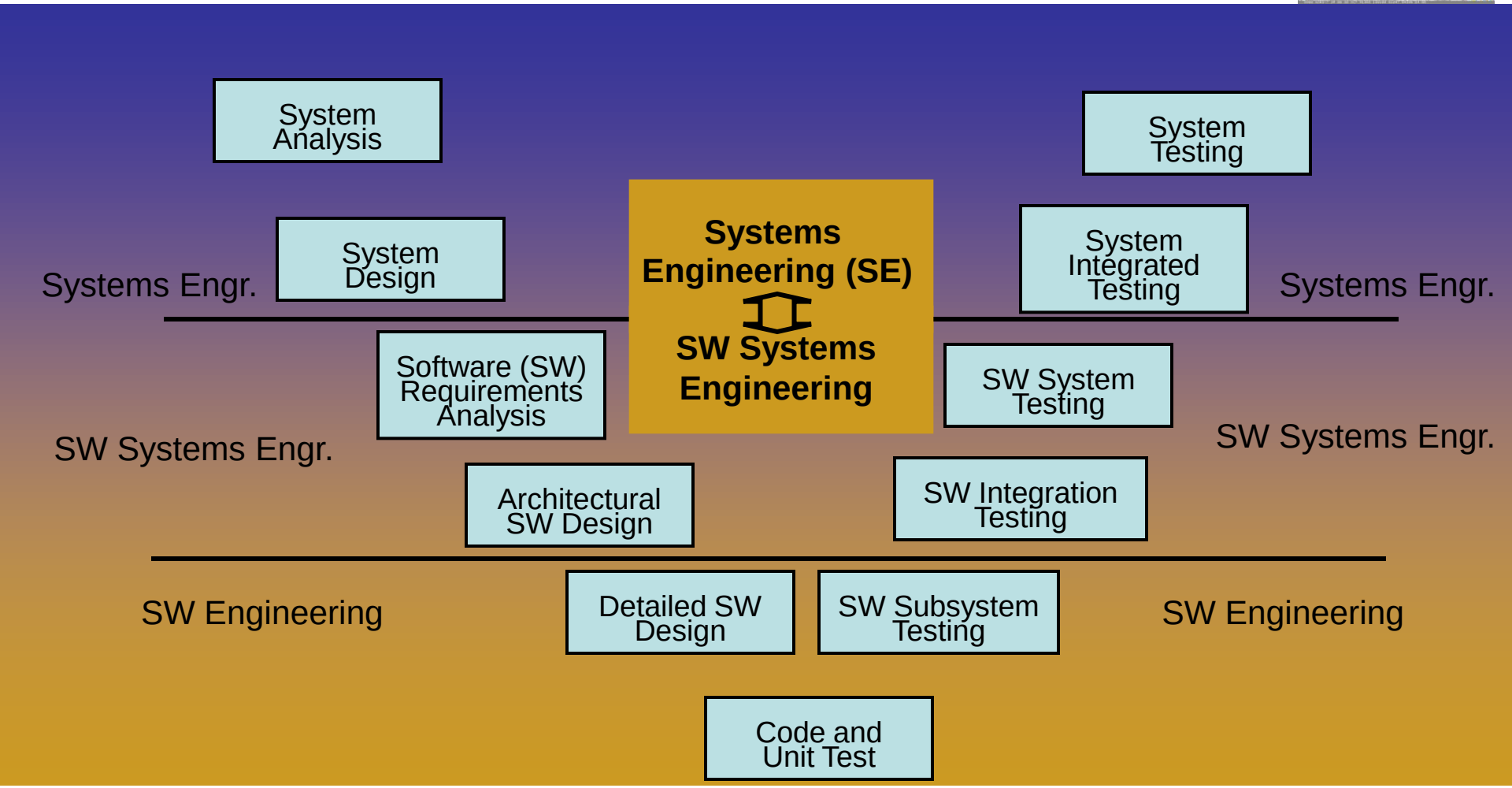
Average Space Industry S&E Workforce Age Distribution

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

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

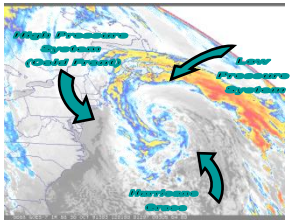
Objective is for Software and Systems Engineering to Become More Integrated Versus Separated

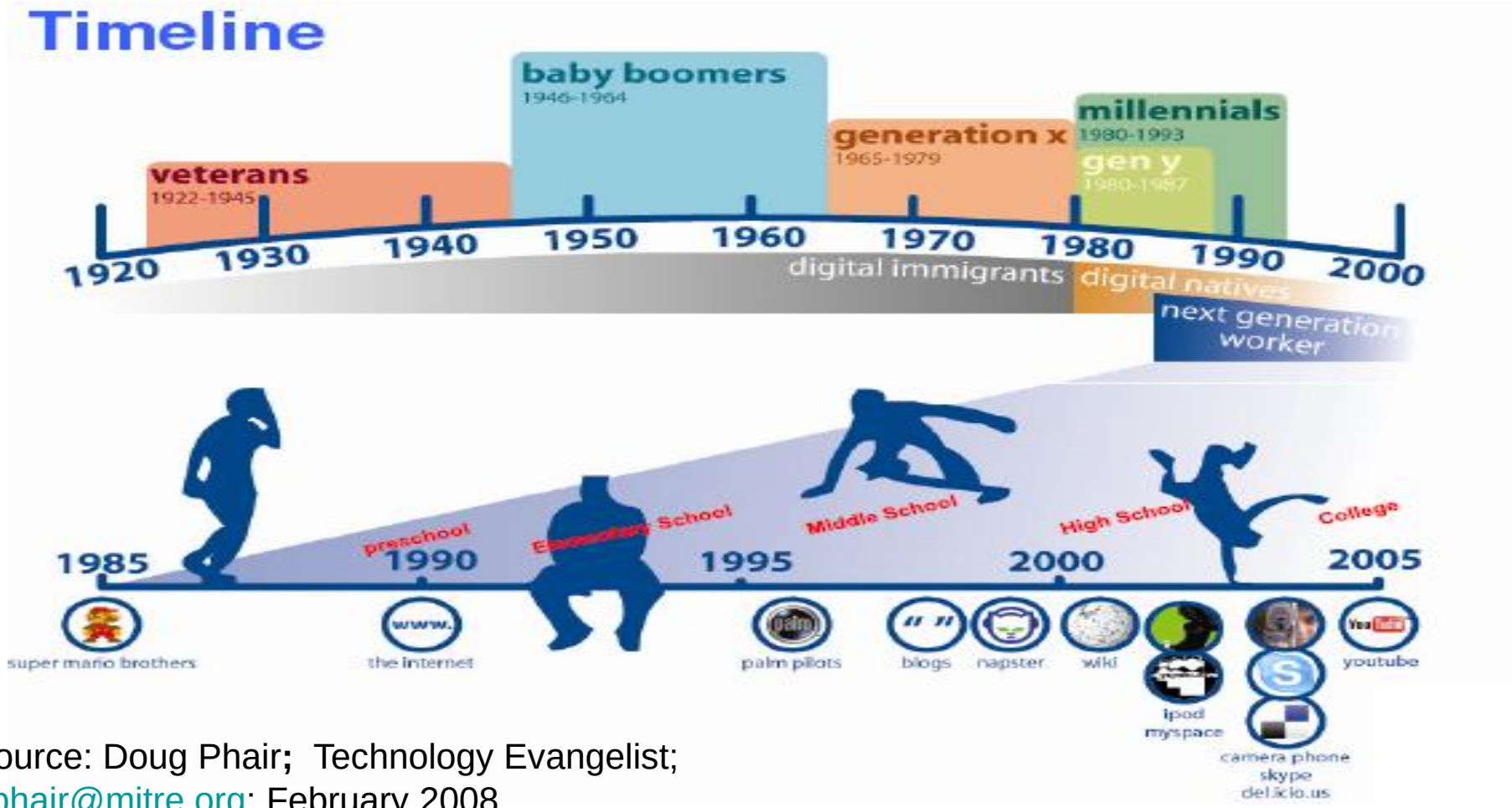




OSD Initiative: Integrated Software and Systems Engineering Curriculum

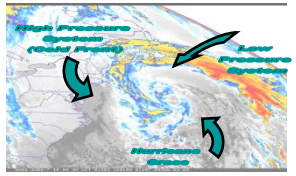
Human Element in the Work-Space Environment

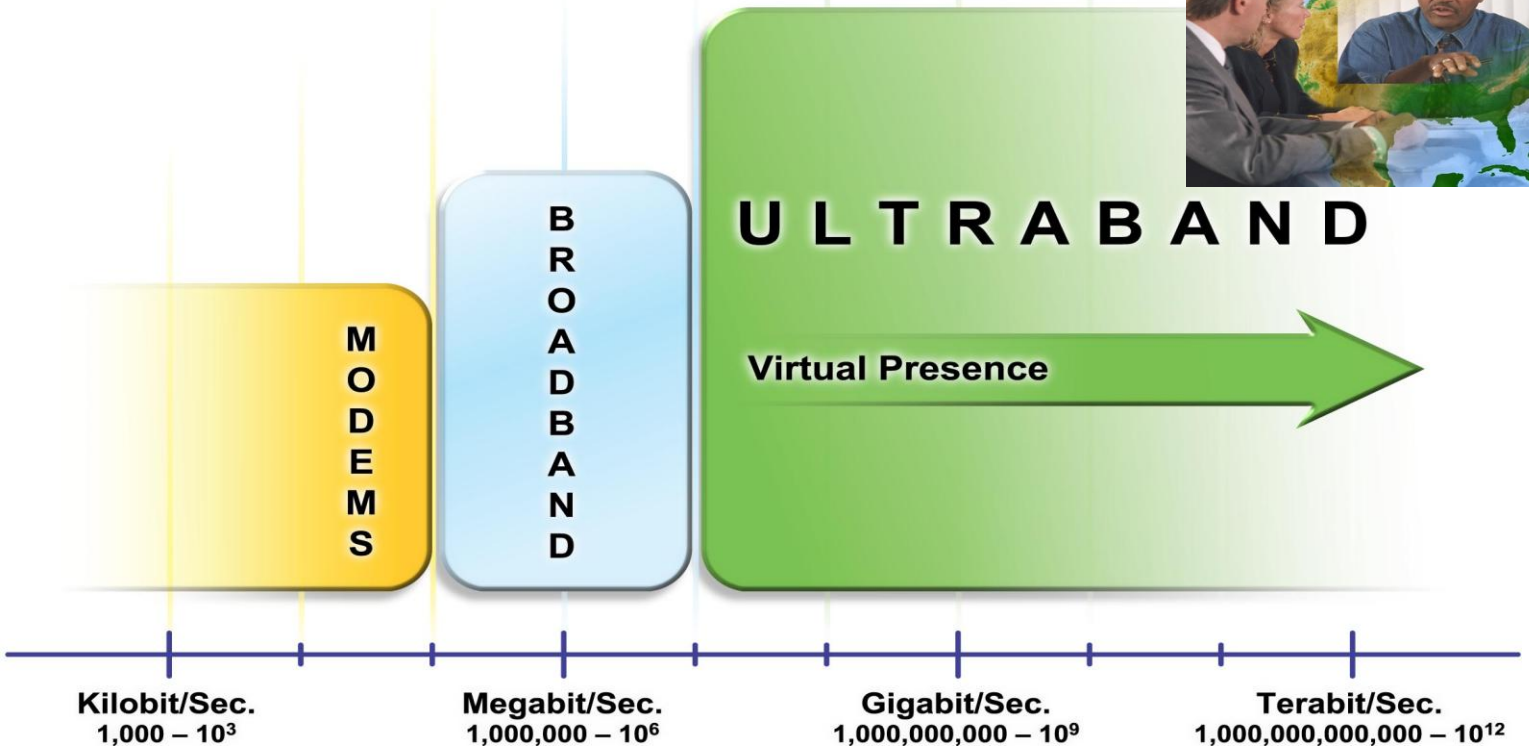




Source: Doug Phair; Technology Evangelist; dphair@mitre.org; February 2008

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

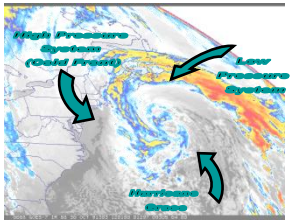




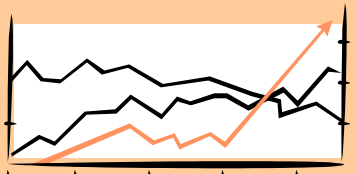
Rule #4: The best companies are the best collaborators*

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

Higher-Maturity Approaches to Process Improvement Are Important and Synergistic Trends

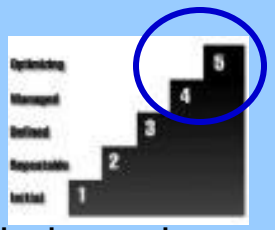


Data-Driven (e.g., Six Sigma, Lean)



Optimizing

Quantitatively Managed



Determine what your processes can do (Voice of Process)

- Statistical Process Control

Clarify what your customer wants (Voice of Customer)

- Critical to Quality (CTQs)

Identify and prioritize improvement opportunities

- Causal analysis of data

Determine where your customers/competitors are going (Voice of Business)

- Design for Six Sigma

Model-Driven (e.g., CMM, CMMI)

Determine the industry best practice

- Benchmarking, models

Compare your current practices to the model

- Appraisal, education

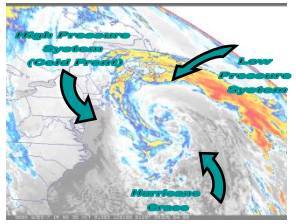
Identify and prioritize improvement opportunities

- Implementation
- Institutionalization

Look for ways to optimize the processes

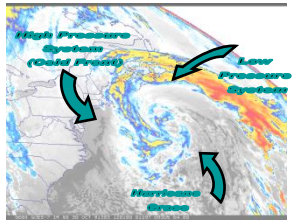
CMMI and Six Sigma,
Siviy, et al, 2007, Addison Wesley

Systems and Software Engineering: Ten Trends



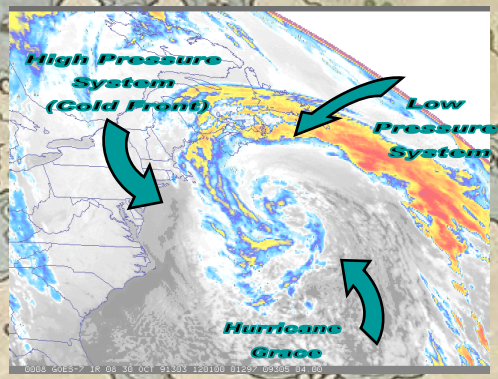
1. *Greater demands on systems and software engineers will stimulate growth in the field – nationally and internationally*
2. *Industry/Gov't will increasingly focus on attracting, training and retaining systems and software engineering talent – short and long run – with emphasis on providing a Generation Y work environment*
3. *Increased reliance on systems and software engineering processes and technologies to effectively manage the acquisition/"green" space*
4. *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*
5. *Improvements 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



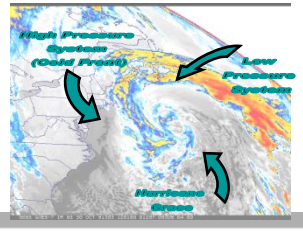
6. *Systems and software engineers will continually find way to innovative to reduce complexity*
7. *Increased importance of modeling and simulation*
8. *Increased customer requests for system and software engineering support will occur earlier in life cycle*
9. *Shift of systems and software engineering focus from the platform to the networks and ground systems*
10. *Process improvement will continue to be important!*

Questions?



THE KNOWN WORLD
Beyond here there be Dragons

Recommended Readings



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

GAO Report: 08-467SP, Defense Acquisitions – Assessment of Selected Weapon Systems, March 2008

Chesbrough, Henry William. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Publishing Corporation, Boston, MA 2003.

Drucker, Peter. *Managing in the Next Society*. Truman Talley Books, New York, NY, 2003.

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

Gates, William H. III "*Business @ The Speed of Thought – Using a Digital Nervous System*", Time Warner Books, 1999

Kurstedt, Harold and Pamela, Systems and Software Engineering Interfaces, Dealing with the Bumpy Roads, Participant Guide, March 2008

Malone, Thomas. *The Future of Work: How the New Order of Business Will Shape Your Organization, Your Management Style and Your Life.* Harvard Business School Publishing, Boston, MA, 2004. See http://ccs.mit.edu/futureofwork/

Nidiffer, Kenneth E. and Doland, Diana "Evolving Distributed Project Management", special issue IEEE Software, Sept/Oct 2005

Northrop, Linda. Ultra-Large-Scale Systems – The Software Challenge of the Future, Software Engineering Institute, June 2006

Rouse, William B. et al, *Understanding R&D Value Creation with Organizational Simulation*, Tennenbaum Institute, H. Milton Stewart School of Industrial & Systems Engineering, Georgia Institute of Technology, Atlanta, GA 30332-0205, Oct 2006

Wladawsky-Berger, Irving. "The Future of IT in an On-Demand World." IBM Server Group, Keynote address at OSBC 2005. Archived at http://www.itconversations.com/shows/detail495.html