1-22-2010

Reviewing the Role of Systems Analysis in Data Networks and the Possible Role for System Theories going Forward

Grant Kirby
Portland State University

EXPLORING NEW NETWORK DEPLOYMENT METHODOLOGIES

HIGHLIGHTS

- Relentless march of network technologies
  - Faster, smaller, cheaper
  - Taking over all forms of communications, computations, data storage, data presentations
  - Driving networks from centralized to scale free
  - Changing interactions between humans
  - Primary change agent in modernization
  - Driving greater economies of scale & scope
- Scale free connectivity > Scale free communications
- SA methodologies will be inadequate in the Web 2.0 future

HISTORY OF COMPUTER NETWORKS

- **Central Computing** 1960's-1980's
  - Dominated by Mainframes
    - Highly purposed
    - Batch computing
    - Compute intensive business/military applications
    - Integer math
    - Data sorting
  - 1:Many relationships

- Constraints
  - **Applications**
  - **Memory**
  - **Storage**
  - **Processing**
  - **Bandwidth**
  - **I/O devices**
  - **$**
  - **Knowledge**
- Drivers
  - **Military apps**
  - **Business apps**
  - **Eco of Scope**
  - **Scientific Apps**
- Key technologies
  - **Operating Systems**
  - **Procedural Prog languages**
  - **Proprietary comm channels**

HISTORY OF COMPUTER NETWORKS

- **Distributed Computing** late 1980's-1990's
  - Dominated by personal computing
    - Office automation applications
    - Personal productivity applications
    - Rapid technification of population
  - Moore's Law: # of transistors in chips 2x every two years
  - Development of high speed LAN technology
    - Ethernet 10 Mb/s ++
    - Network adapter: Performance ↑ Price ↓
  - 1:1 computing

- Constraints
  - **Memory**
  - **Storage**
  - **Processing**
  - **Bandwidth**
  - **I/O devices**
  - **Specialized skills**
- Drivers
  - **Business apps**
  - **Economy of Scale**
  - **Scientific Apps**
  - **Relational DBs**
  - **Multi-user apps**
  - **Shared resources**
  - **price of computers**
- Key Components
  - **Operating Systems**
  - **Object-Oriented Prog**
  -

HISTORY OF COMPUTER NETWORKS

- **Client-Server Computing** late 1990's-2000's
  - Dominated by personal computing & Low cost servers
    - Core business applications
    - massively shared resources
    - Large productivity gains in programming output
  - Introduction of the Internet as a mainstream technology
  - WAN technologies emerged as mainstream
    - Wide area communication infrastructure accelerated
    - Mostly using Telco comm standards
    - Fiber Optic cable deployment explodes on the scene
  - Many:Many computing

- Constraints
  - **Memory**
  - **Storage**
  - **Bandwidth**
  - **Economic ROI**
- Drivers
  - **Business apps**
  - **Digital signal Proc**
  - **Internet applications**
  - **ExtraNet apps**
  - **distributed processing**
  - **Distribute storage**
  - **Competitive pressures**
  - **Rapid decline $torage**
- Key Technologies
  - **OS Capabilities**
  - **Reduced cost of bandwidth**
  - **Object oriented programming**
  - **Dramatic > in CPU power**
  - **High speed LAN connectivity**

HISTORY OF COMPUTER NETWORKS

- **Internet Computing** late 2000's-Now
  - Dominated by Internet Apps & Automated Services
  - Wide use of public IP networks to Push/Pull business apps
  - E-Commerce, B2C, B2B change how we work with data
  - Data warehousing, data mining, and massive storage arrays

- Massive impact on fundamentals of business
  - Marketing/MarComm changing rapidly
  - Customers and Supply Chain demanding immediate information
  - Merchandizing/Service deployment
  - Cheap/High Speed bandwidth

  - Many:Many computing

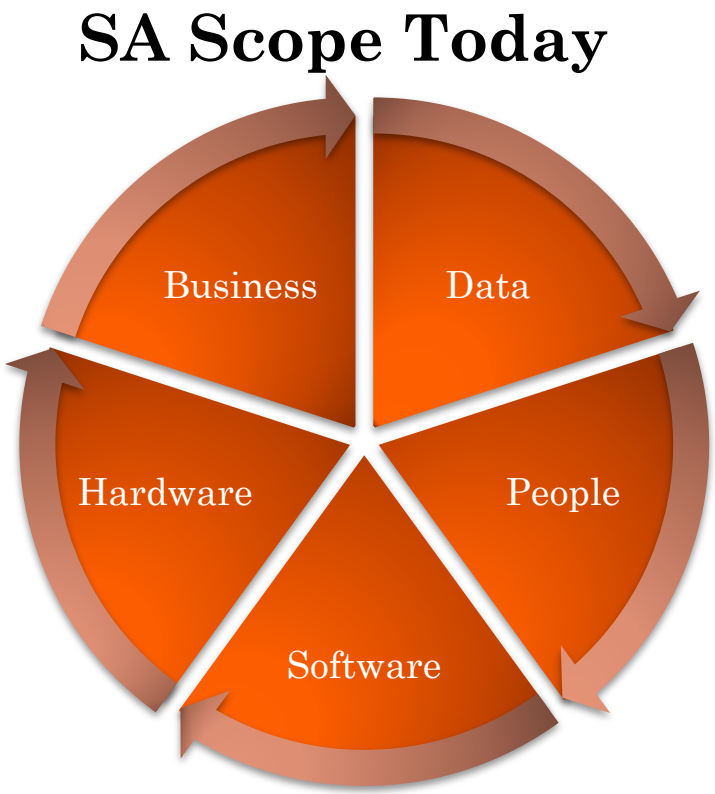
- Constraints
  - **Internal skills**
  - **Ability to respond**
  - **Economic climate**
  - **Security**
  - **IT $/Space/Heat**
- Drivers
  - **Wireless Devices**
  - **Hand held computing**
  - **Internet applications**
  - **ExtraNet apps**
  - **Distributed Applications**
  - **Distributed storage**
  - **Public Comm resources**
- Key technologies
  - **Ubiquitous Broadband**
  - **Telecommuting**
  - **Wireless**
  - **Low voltage/power chips**
  - **Battery power/life**
  - **Displays/Printer technology**

FUTURE OF COMPUTER NETWORKS

- **Web 2.x** and beyond
  - Web apps promote bottom-up data sources and computing
  - Social Networking hitting mainstream
  - E-Commerce becoming the core
  - MarComm Makeover
- **Computing Virtualization and Cloud Computing**
  - Virtual/mobile computing resources: not constrained to computer or location
  - Cloud computing moves applications/storage/services out of the datacenter
  - New tech skills required
  - More management of the network controlled by software
  - Security management unable to keep up with the change
- **Number and type of I/O devices growing exponentially**

- Constraints
  - **Cultural barriers**
  - **Data filtering skills**
  - **Mgt understanding**
  - **Security**
- Drivers
  - **Customer demands**
  - **Hand held computing**
  - **Internet applications**
  - **ExtraNet apps**
  - **Display, battery and memory advances**
  - **Economic climate**
  - **Need to compete**

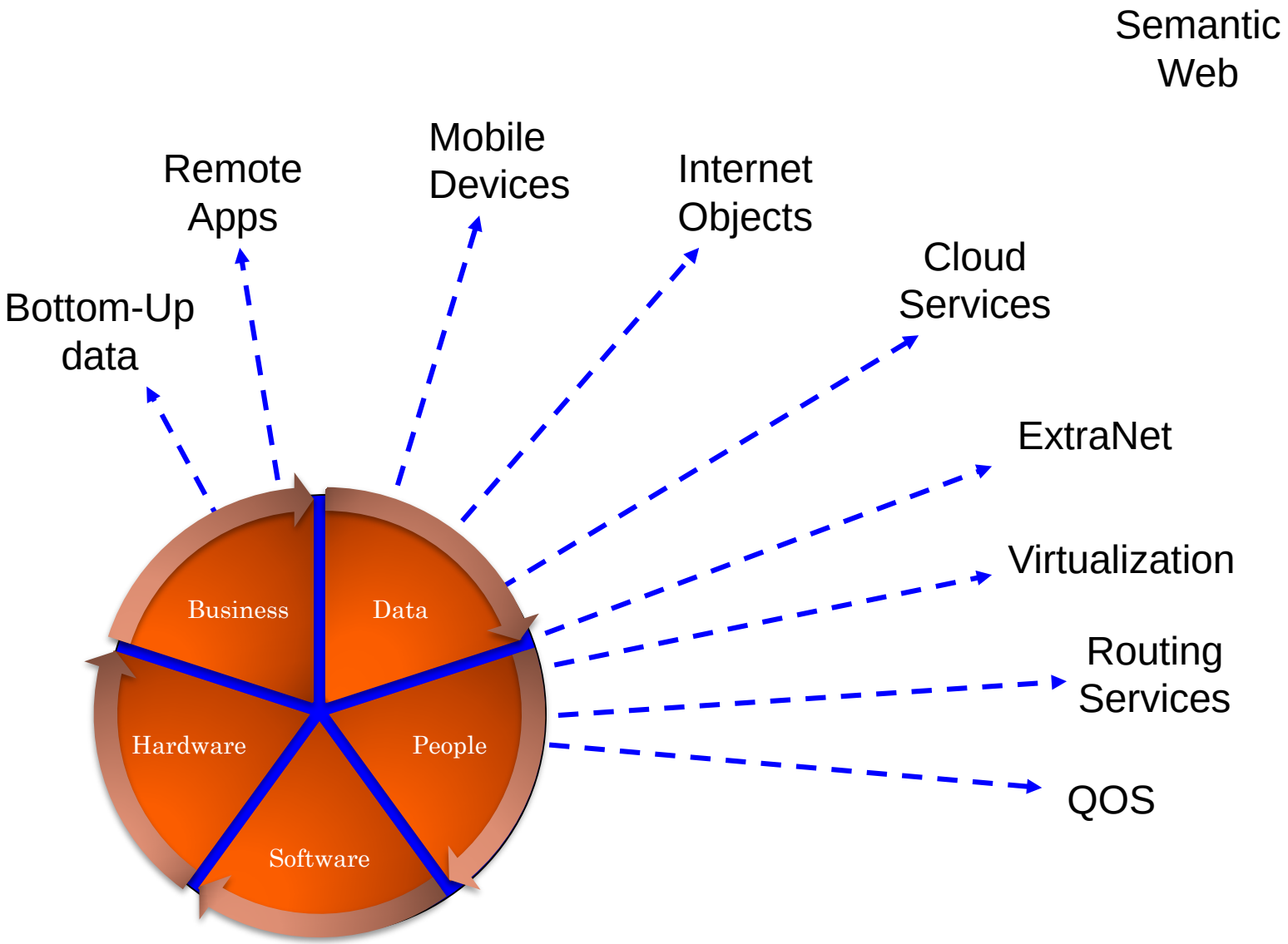
THE COMING WAVE



Network System Analysis

- **Roots in Operational Research**
- **Sys Life Cycle Methodology**
  - Planning
  - Analysis
  - Design
  - Implementation
  - Maintenance
  - Review
  - Iterate
- **Melds Past, Present & Future**
  - Lags behind software models
    - Waterfall
    - Prototyping
    - Throw-away prototyping
    - Rapid App Dev
    - Agile
    - Scrum
    - Extreme
    - ?

THE COMING WAVE



PROJECT COMPLEXITY

- Remington/Zolin: measure of network complexity [1]
  - **Interconnectedness:** people and devices
  - **Non-linearities:** outcomes
  - **Adaptiveness:** fail-over, load balancing, fault tolerance
  - **Emergence**: Impacting core business goals

    - Scalability [3]
    - Availability
    - Network Performance
    - Effective throughput
    - Accuracy of received data
    - Efficiency: effectiveness/cost, energy, time to implement
    - Security
    - Manageability
    - Usability
    - Adaptability
    - Affordability

TYPES OF PROJECT COMPLEXITY

- Structural [1]
  - Non-linear, emergent behavior
  - Separation of cause and effect in space & time
- Technical
  - Unknown, untried technology
  - Unintended consequences of use
- Directional
  - Goals/project paths not well understood
  - Legacy islands of computing persist
  - Sections of network advance faster than others
- Temporal
  - Volatility varies over time
  - Negative momentum shows up later

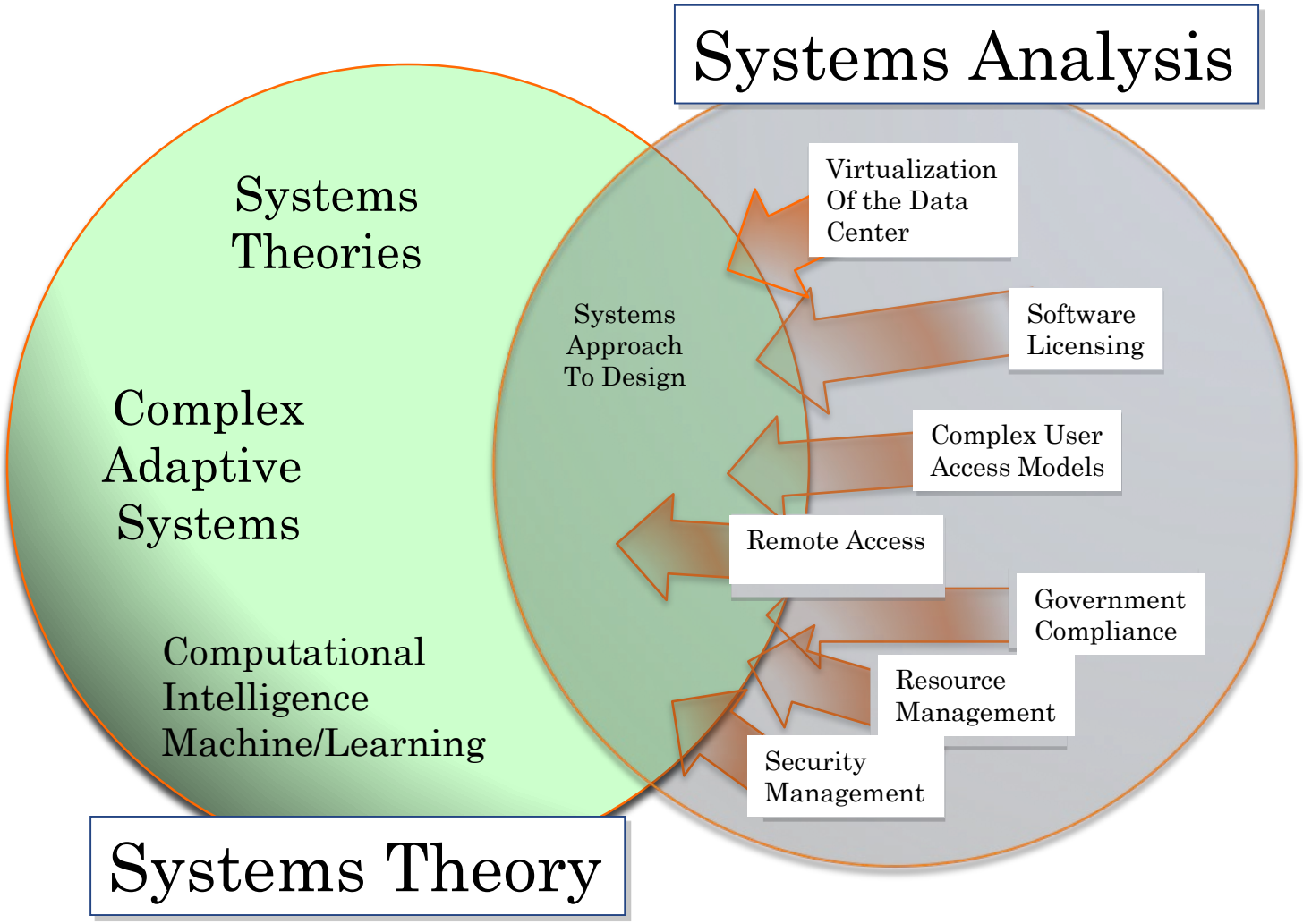
Organizational Dynamics

- Breadth & depth of experience at all levels
- Project organizational structure
- Communication barriers between stakeholders
- Cultural norms that unequally affect project components

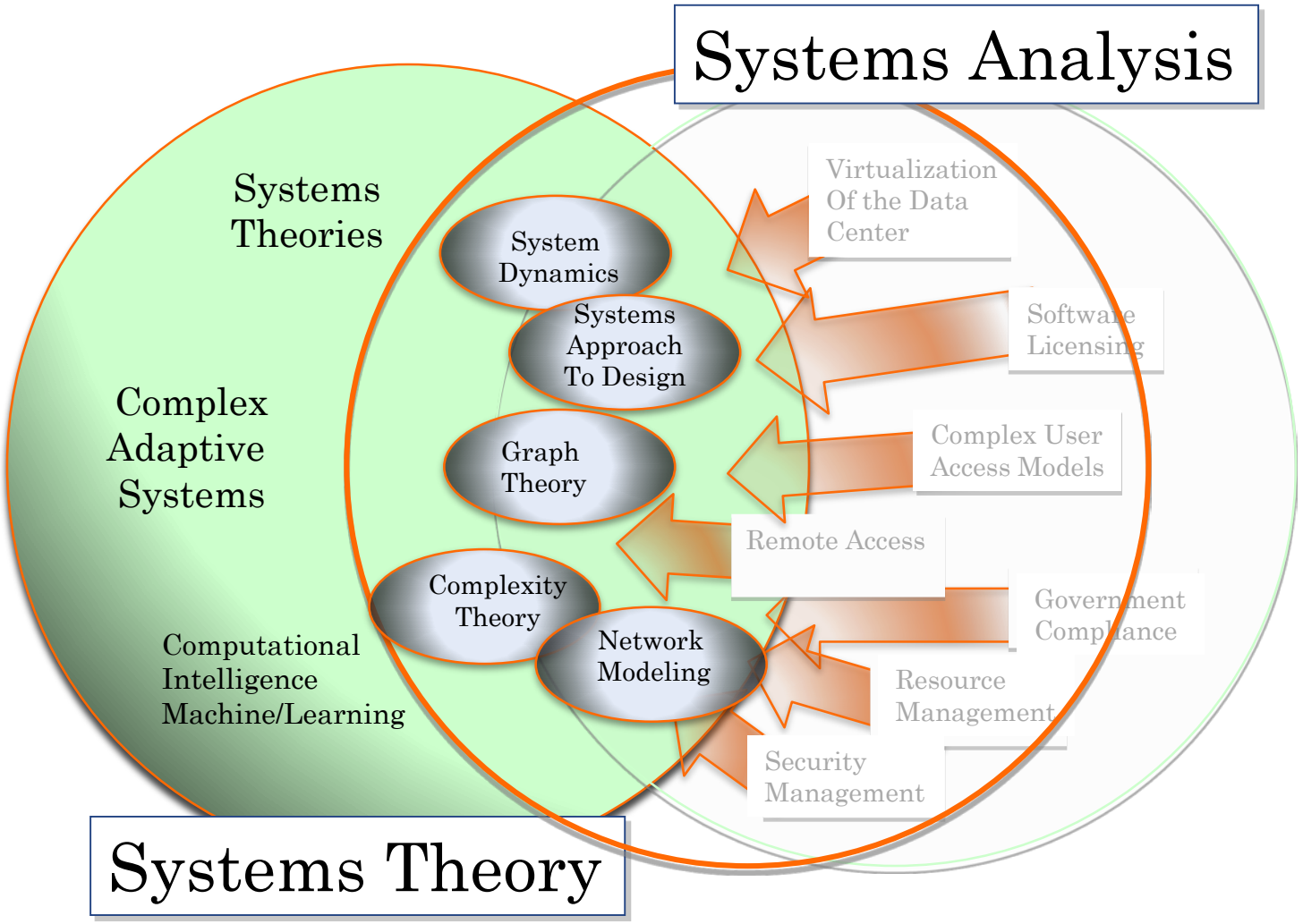
Dodo-ification of Hardware-Centric Networking

- Organizational networks are becoming scale free [2]
  - Pressure to add layers of small networked devices
  - Adding wireless & Internet technologies
  - Virtualization of resources pushes system boundaries
  - Tradeoff between Manageability/Security and Availability/Usability
- Policy-based management replacing technologist [4]
- Profile-centric computing blurs location of leaf objects
- QOS pushed to the edge [3]
  - Centralized, intelligent routers bottlenecks replaced by network aware leaf objects
  - QOS on demand
- Virtualization/Cloud computing models blurs sense of place & ownership

THE COMING WAVE



THE COMING WAVE



Data Networks ➔ Complex Networks

- Self-org characteristics follow large-scale properties of complex, scale-free networks [6,7]
- Growth and preferential attachment
  - Eliminates Random Network Model
  - Common to business networks/social networks
  - Vertex connections follows power law distribution [6,7]
- Web – 100s of Millions of vertices
  - Added as extensions of LAN/WANs
  - Edges and vertices constantly changing
  - Complexity at many levels
    - Data routing
    - Infrastructure connectivity
    - Object linking
    - User Communications
    - Access vs Security/Public vs Private

SUMMARY

- IS dominates the economy
- SA methods inadequate for Web 3.0
- Biz nets ➔scale free (despite common sense)
- Unintended design consequences abound
- IS mgt decisions increasingly made by software
- System Analyst will need 'Systems' training
- Software is King; hardware is invisible
- Business networks ☞ Social networks
- Web 3.0 (the semantic Web): the ultimate scale free network (increasingly mobile hubs)
- New design approach inevitable: **Systems Synthesis**?

BIBLIOGRAPHY

1. Remington, Kaye and Zolin, Roxanne and Turner, Rodney (2009) "*A model of project complexity : distinguishing dimensions of complexity from severity*". In: Proceedings of the 9th International Research Network of Project Management Conference, 11–13 October 2009, Berlin.

- Barabasi, A, Bonabeau, E. ***"Scale Free Networks."*** Scientific American, May 2003, pp. 60-69
- Oppenheimer, P., "Top-Down Network Design", CiscoPress, 2nd E, pp. 5-56
- VMWare:Whitepaper, " *Solving the Desktop Dilemma with User-Centric Desktop Virtualization for the Enterprise*" 2009, http://www.vmware.com/files/pdf/solving_desktop_dilemma_wp.pdf
- Wasserman,S. ; Faust, K., "*Structural Analysis in the Social systems: Social Networks, Methods and Applications*",Cambridge University Press, 1994
- Carrington,P., Scott,J., Wasserman, S., "*Models and Methods in Social Network Analysis*", Cambridge University Press, 2005
- Barabasi, A., Albert, R. " *Emergence of Scaling in Random Networks*", Science 15 October 1999: Vol. 286. no. 5439, pp. 509 - 512 DOI: 10.1126/science.286.5439.509