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

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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 \$storage**

● **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

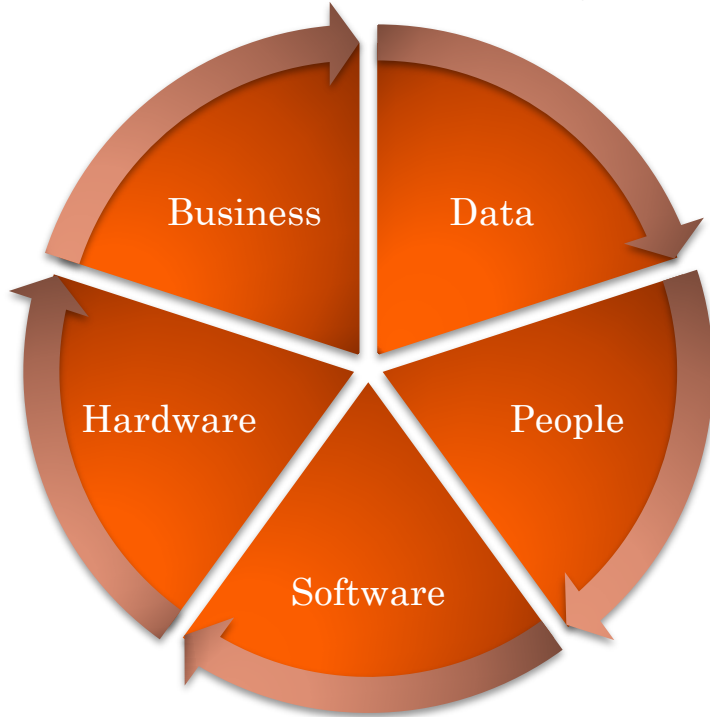
- **Web 2.x** and beyond
 - Web apps promote bottom-up data sources and computing
 - Social Networking hitting mainstream
 - E-Commerce becoming the core
 - MarComm Makeover
- **Computing Virtualization and Cloud Computing**
 - Virtual/mobile computing resources: not constrained to computer or location
 - 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

SA Scope Today



- **Roots in Operational Research**
- **Sys Life Cycle Methodology**

- Planning
- Analysis
- Design
- Implementation
- Maintenance
- Review
- Iterate

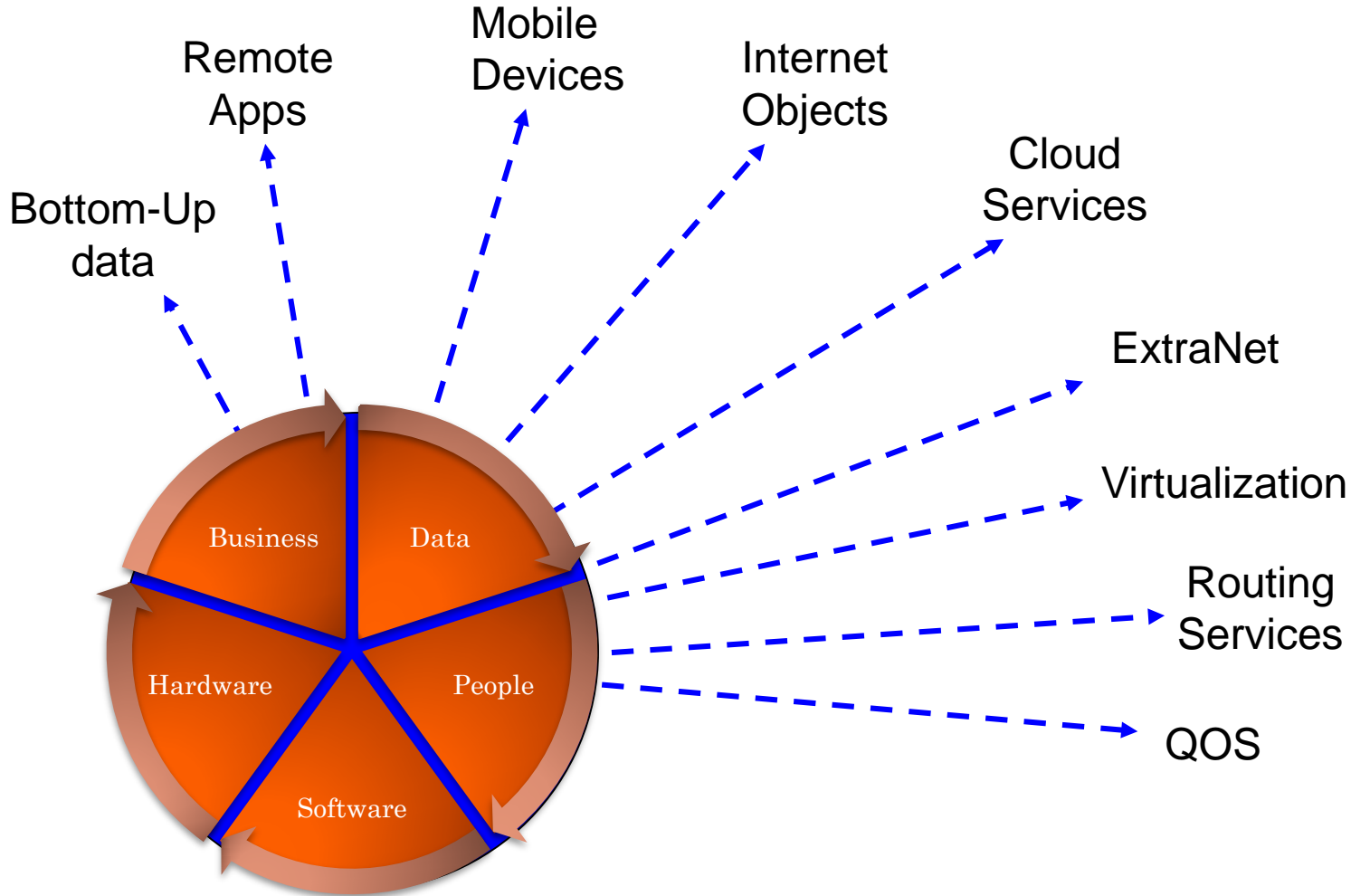
- **Melds Past, Present & Future**

- Lags behind software models
 - Waterfall
 - Prototyping
 - Throw-away prototyping
 - Rapid App Dev
 - Agile
 - Scrum
 - Extreme
 - ?



THE COMING WAVE

Semantic
Web



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

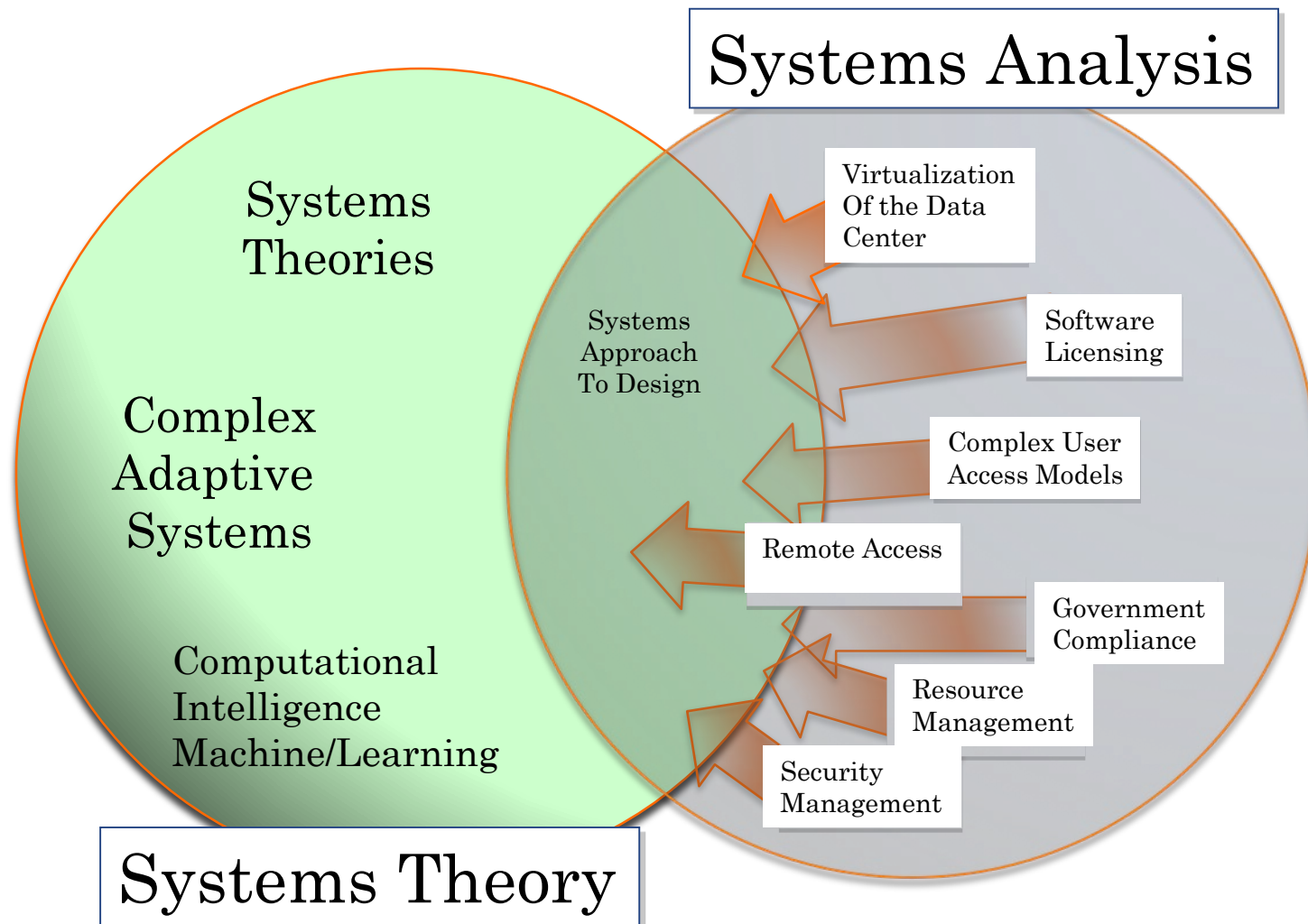


Dodo-ification of Hardware-Centric Networking

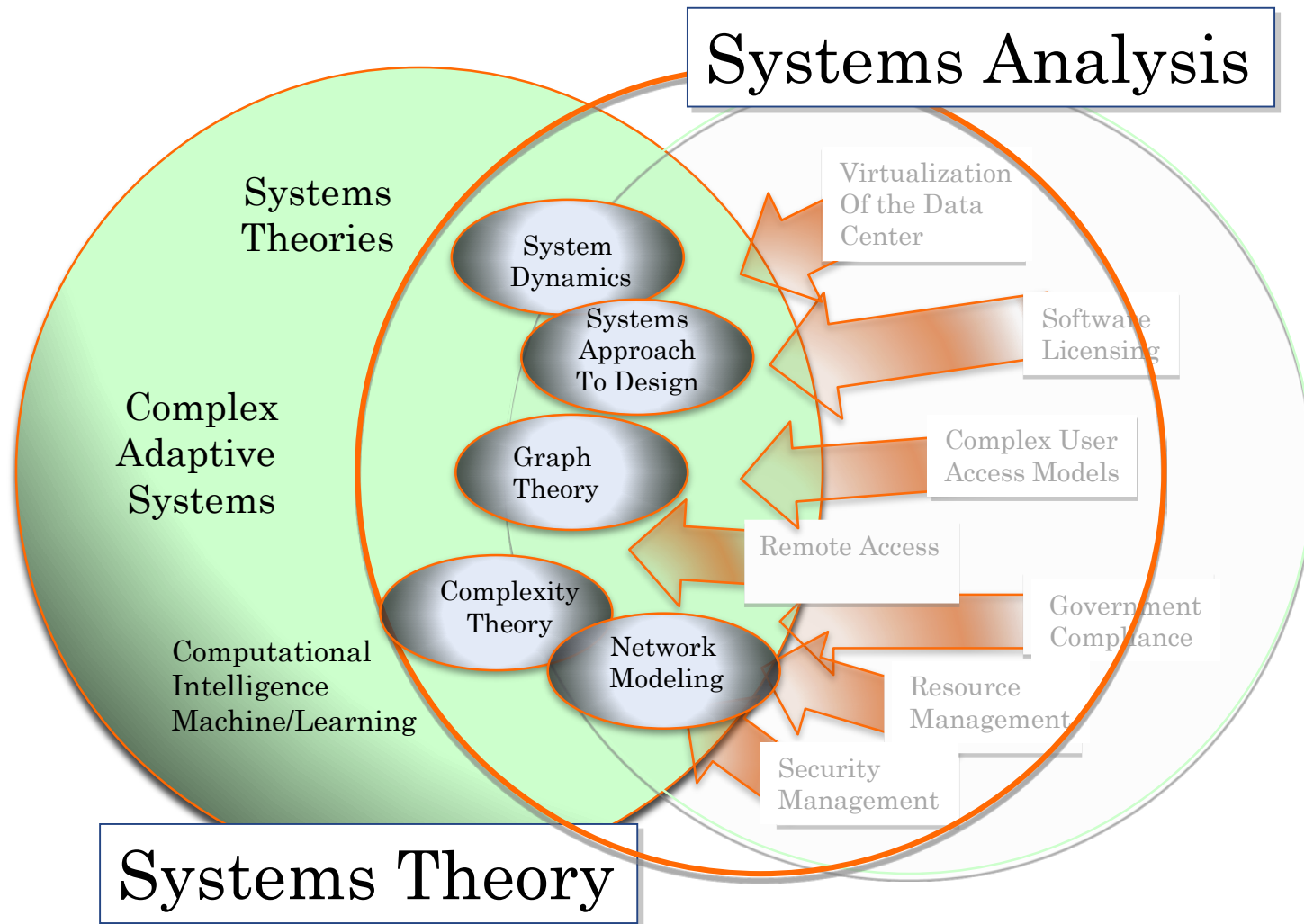
- Organizational networks are becoming scale free [2]
 - Pressure to add layers of small networked devices
 - Adding wireless & Internet technologies
 - Virtualization of resources pushes system boundaries
 - Tradeoff between Manageability/Security and Availability/Usability
- Policy-based management 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?**



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