

Immersion into the Ubiquitous Computing Grid: the next evolutionary increment toward operational viability in the era of **Global Information Warfare**



Leadership Conference on Transformation

Charles Ostman

VP, Electronics & Photonics Forum Chair – NanoSig

Senior Consultant – Silicon Valley NanoVentures

Senior Fellow - Institute for Global Futures

510 549 0129 charles000@aol.com

<http://www.technofutures.com/charles1.htm>

<http://www.nanosig.org/nanoelectronics.htm>



3/4/2019



**SILICON VALLEY
NANO VENTURES**

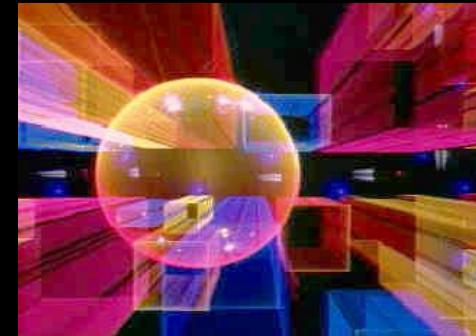
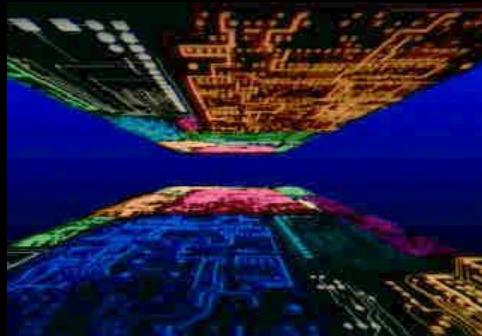


**Nano Electronics
& Photonics Forum**

Enhancing the Present, Probing the Future – Emergent Trends, Evolutionary Drivers

“Being blinded by the beauty of Information Technology
is probably the worst threat that IT faces”

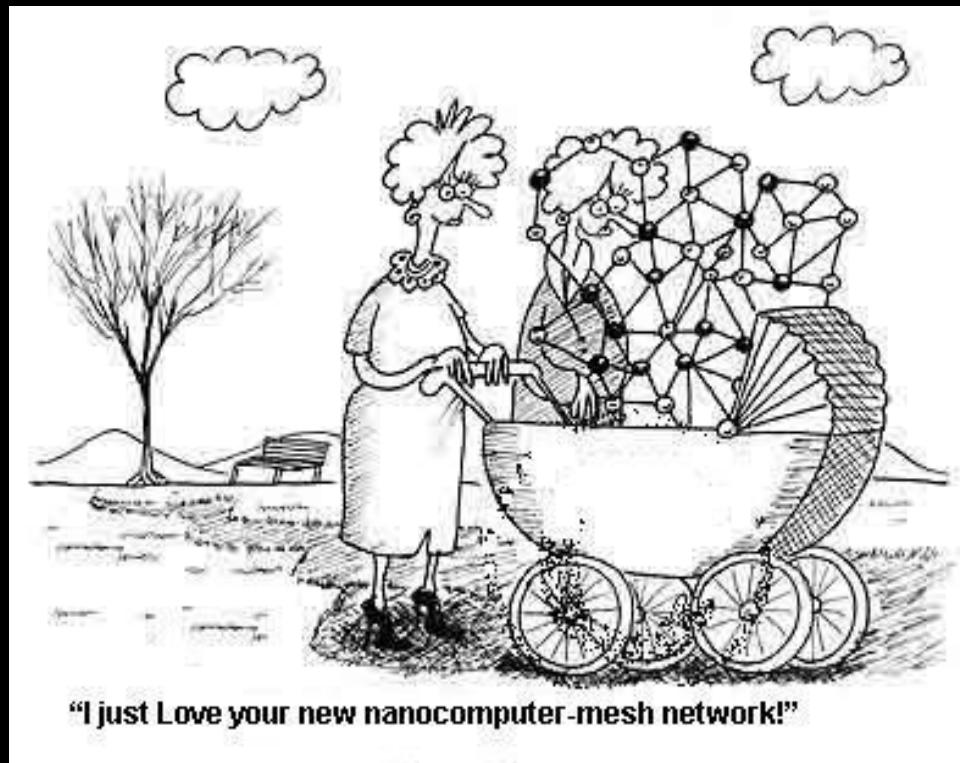
Tony Cordesman – Center for Strategic and International Studies, Wash DC



Enhancing the Present, Probing the Future – Emergent Trends, Evolutionary Drivers

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Enhancing the Present, Probing the Future – Emergent Trends, Evolutionary Drivers

“Instinctive Strategy: Organic Organizations Rule”

Richard W. Oliver – Journal of Business Strategy, American Graduate School of Management

“If it isn’t Connected, it isn’t Real”

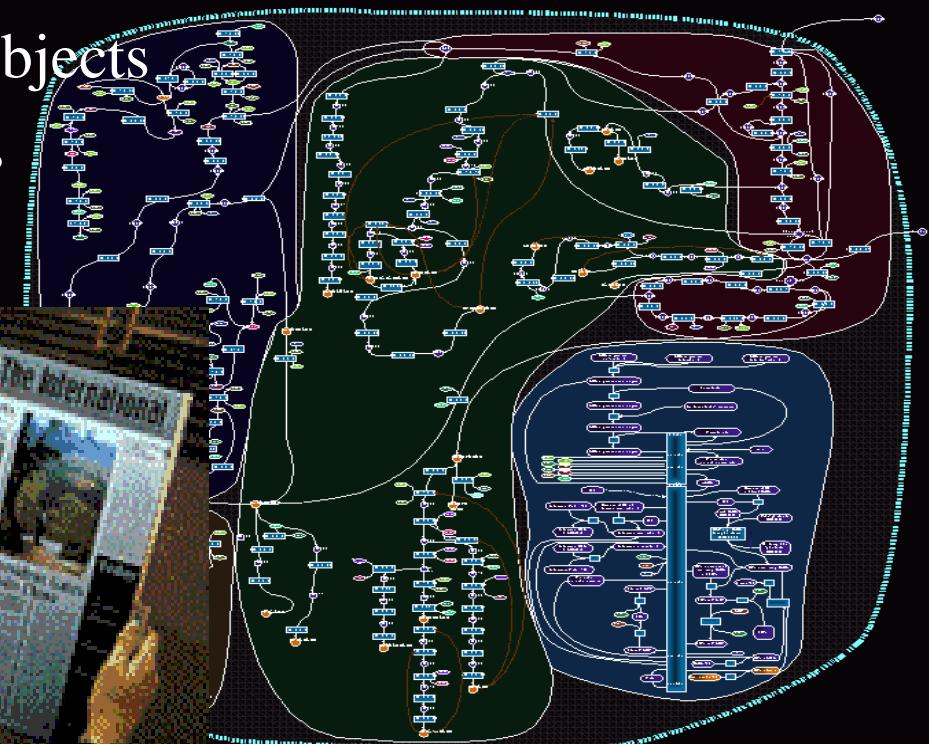
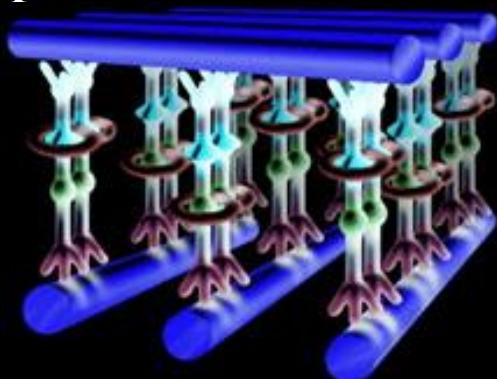
Charles Ostman – Ubiquitous Computing Forum, World Internet Center, Palo Alto CA



“Digital DNA . . . Linking Ubiquity & Biology “
Biomorphic System Substrates
Biological Metaphors in Computing
Evolutionary Computing, Networks
Self Healing Networks, Architectures

Connecting the Dots . . . not just surviving, but flourishing in the Age of Information Warfare

- Artificial Life, Evolutionary Systems, Biological Metaphors in Computing > Ubiquitous Computing Operational Ecology
- Self organizing / self healing / aggressively defensive networks
- Distributed Intelligence – from Smart Dust to Synthetic Sentience
- Autonomous Entities, Persistent Objects
- Process Brokeraging Architectures
- Ubiquitous Process Immersion
- Applied Nanotechnology



The “traditional” Digital DNA Paradigm -

- DNA is the identity platform of the entire organism
- DNA is the engine of replication

The enterprise genome - metadata

**Organism, Organs, Cells < >
Enterprise, Architectures, Objects**

The “emergent Evolutionary” Paradigm -

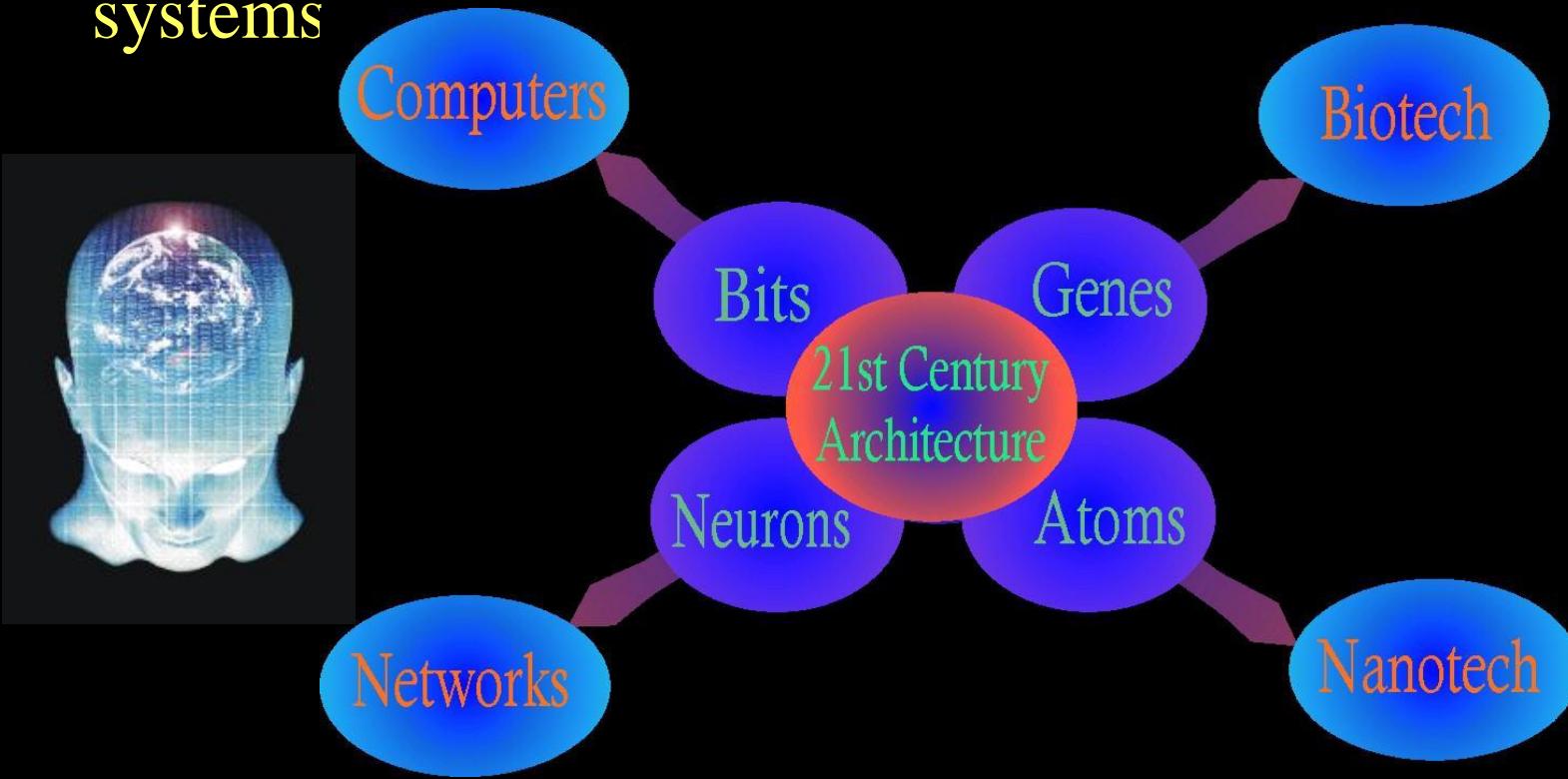
- Evolution is the engine of autonomous self organization, optimization
- Evolution enables adaptation to contiguous environmental morphology - *biomorphology*

Adaptive response to evolutionary challenge

Proactive, pre-emptive strategic mutation

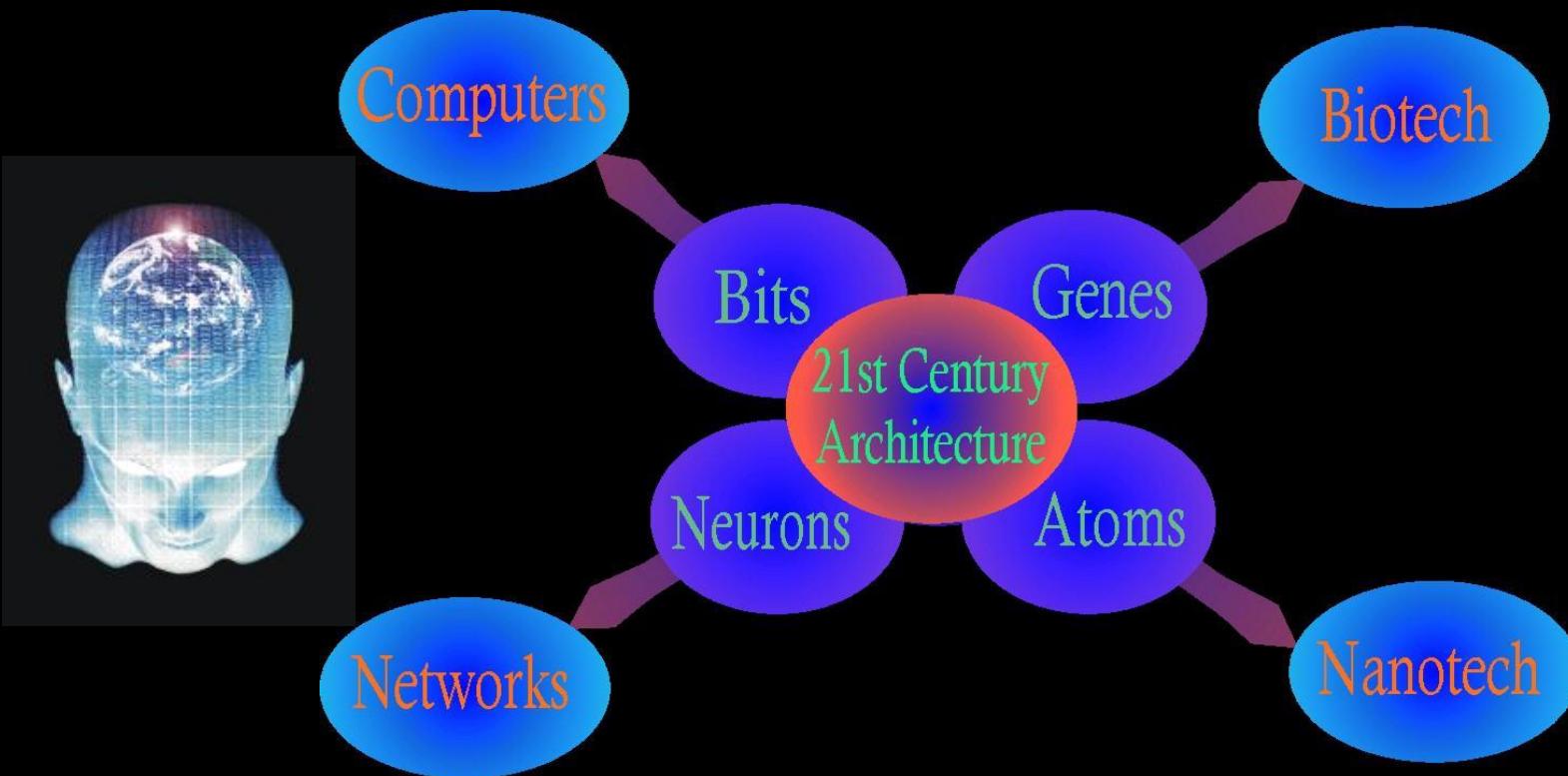
The enterprise of digital genomics is entering a new era

- Emergent knowledge domains are an evolving architecture of interrelated disciplines, technologies, organizational systems

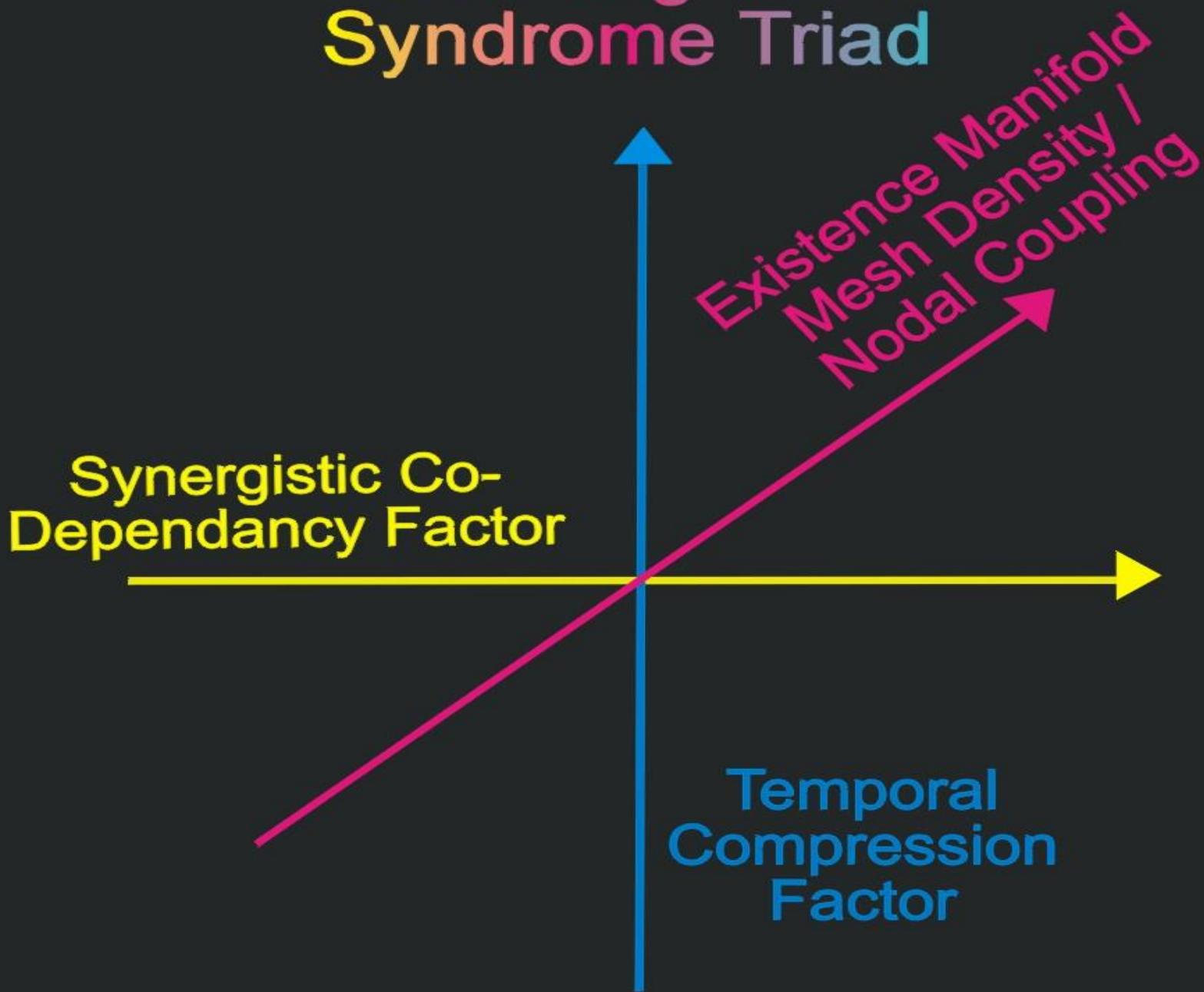


The enterprise of threat perception is entering a new era

- Emergent threat domains are an evolving architecture of interrelated disciplines, technologies, organizational systems

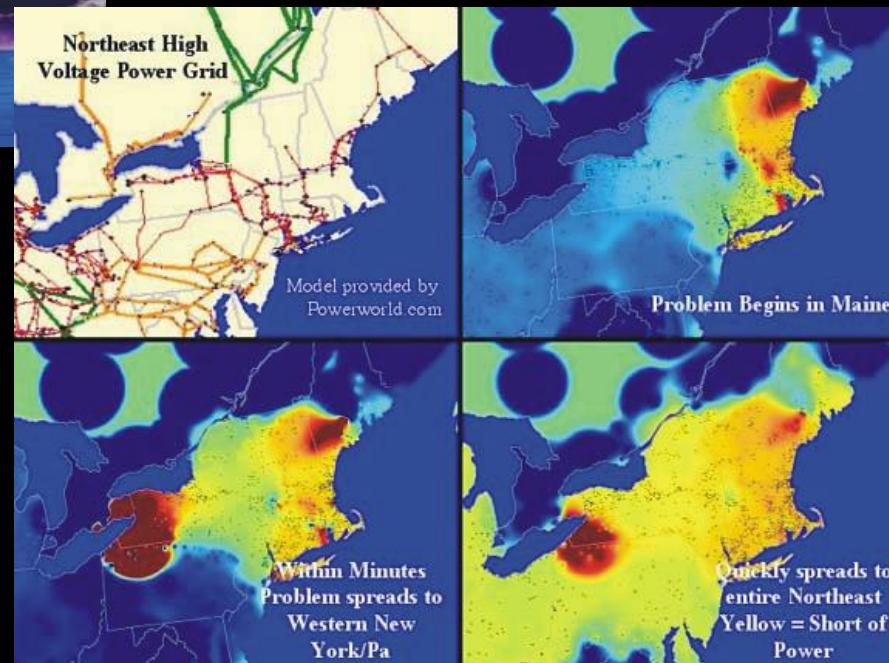
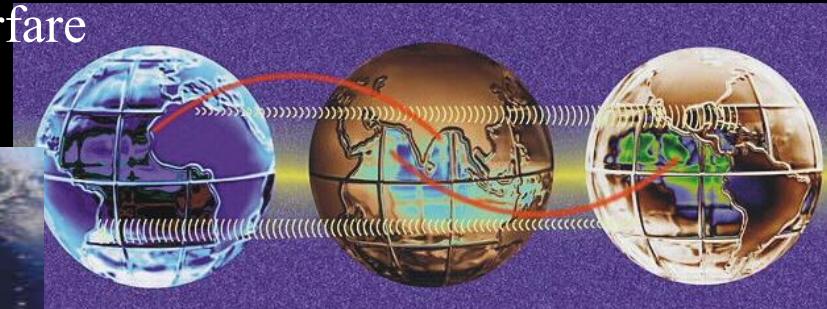
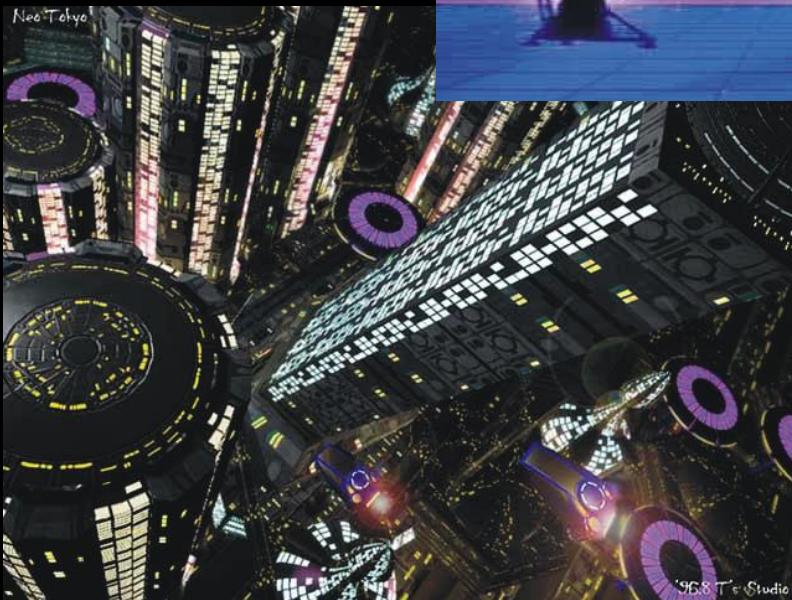


Convergence Syndrome Triad



Define “Threat” - Emergent Integrated Solution Platforms for Strategic Intervention

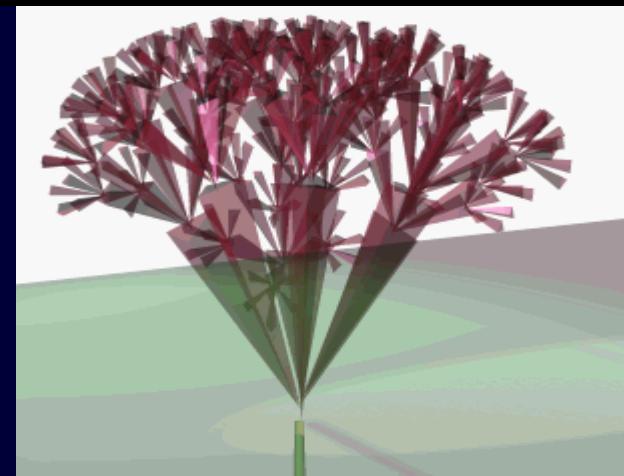
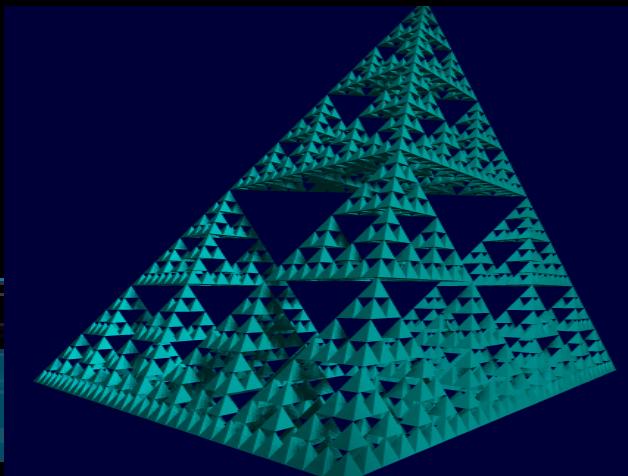
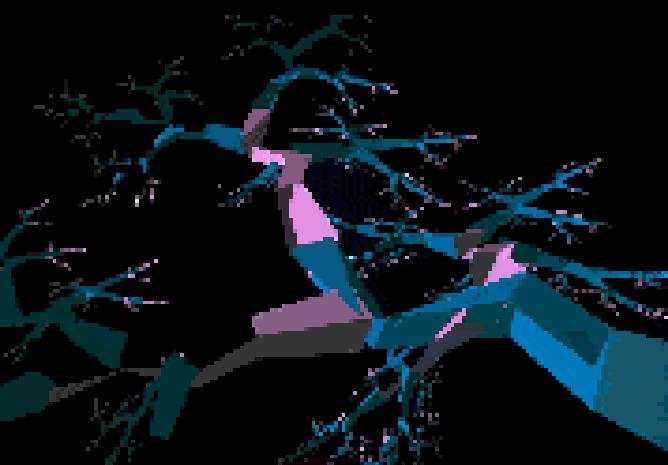
- “Virtual” and “Hard” battlefields and threat domains
- Unconventional threats / “granular” urban warfare
- Autonomous realtime threat exposure
- Decentralized defense theaters



Fitting Security in the Ubiquitous Computing Paradigm > Define “Security”

- Threat Domains > Internal vs. External
- System Porosity > “Leakage” Control
- Complexity Management vs. Compartmentalization
- Autonomous Stealth > Contiguous Realtime Awareness

Evolution toward system sentience



Fitting Security in the Ubiquitous Immersion Paradigm >

Define “Security”

- Threat Domains > Internal vs. External
- System Porosity > “Leakage” Control
- Complexity Management vs. Compartmentalization
- Autonomous Stealth > Contiguous Realtime Awareness
- Hypervirulent, self propagating destructive pseudo-organisms and self replicating virtual pathogens require hypervirulent pro-active adaptive responses
- The ultimate security protocol = every element, every node, every process domain, (human and non-human) is dynamically linked at all times
- All activity transactions are dynamically registered as contiguous “existence transactions” in an n-dimensional operational ecology > if it isn’t connected, it isn’t real

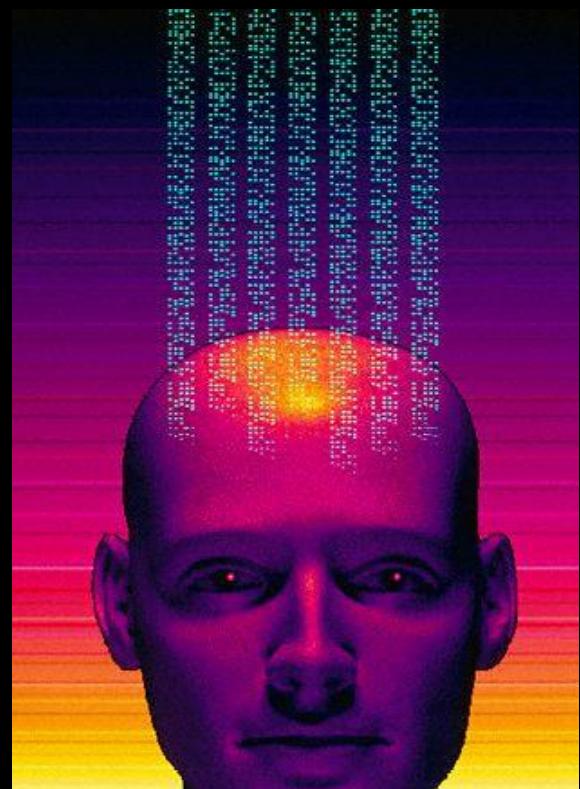
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Collaboration vs. Control

- Technology Convergence
- Cultural Paradigms
- Economic Drivers
- Belief Systems



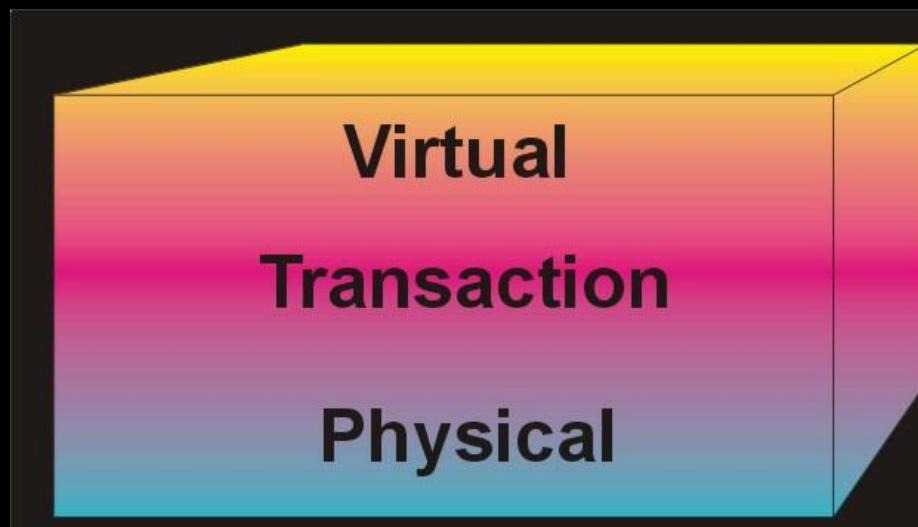
Evolution in the age of Information Warfare - Virtual Battlefield Event Dynamics

- **Intrusion** – point of impact process disruption, hidden “trojan horse” system performance sabotage agendas
- **Infection** – distributed surveillance, stealth data mining, self modifying avoidance strategies
- **Destruction** – sabotage of mission critical process domains, catastrophic manifestation of system failure

Process Elements of Ubiquitous Computing

Think Different > Think *Holographic*

- Behavioral Biometrics
- Ubiquitous Existence Transacting
- Distributed Sensing / Computing
- Integrated Cognition Platforms

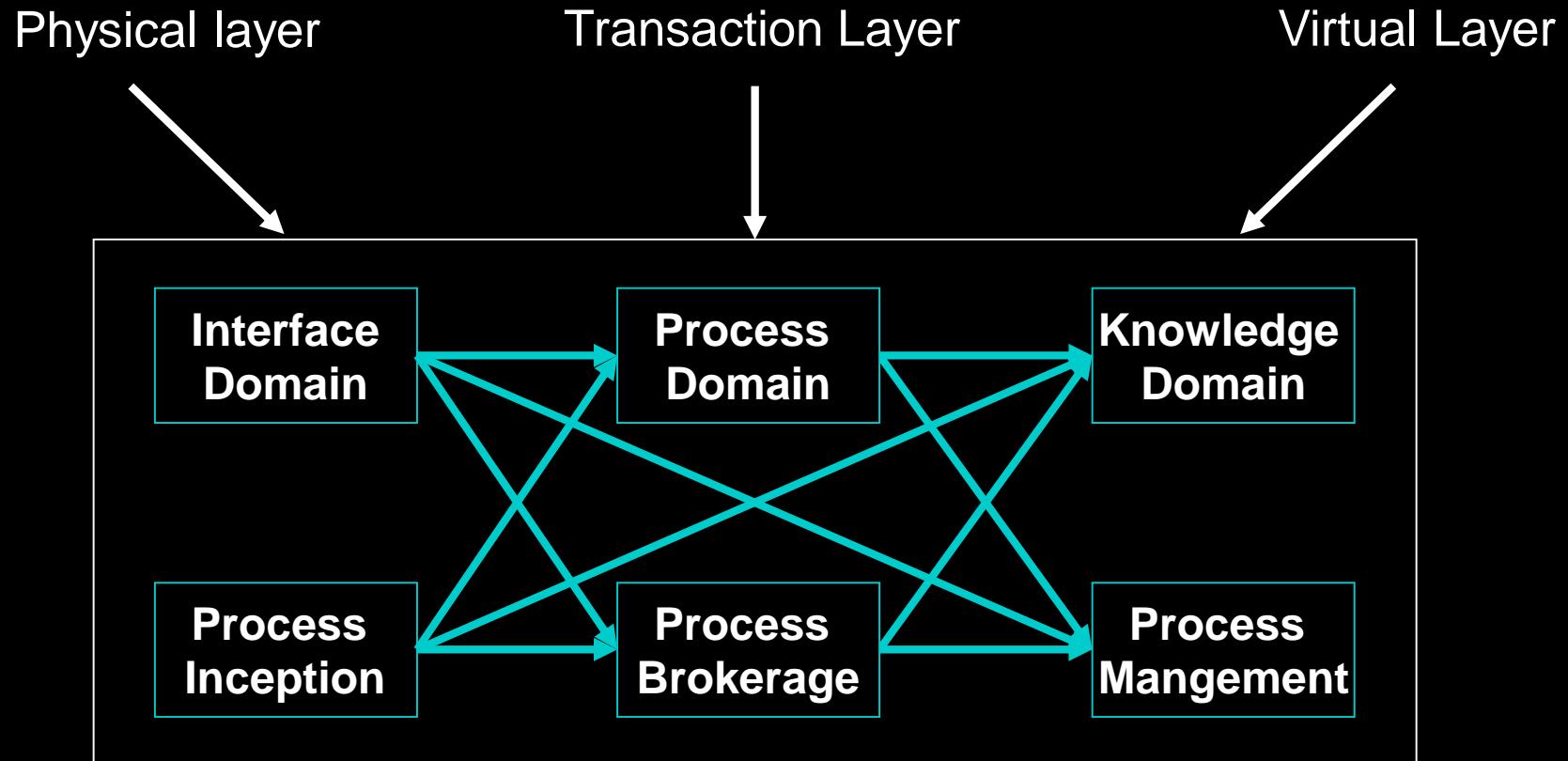


Knowledge domains, system objects, data repository, core applications, process management

Process domains, acceptance and verification, data flow mechanisms, transaction management

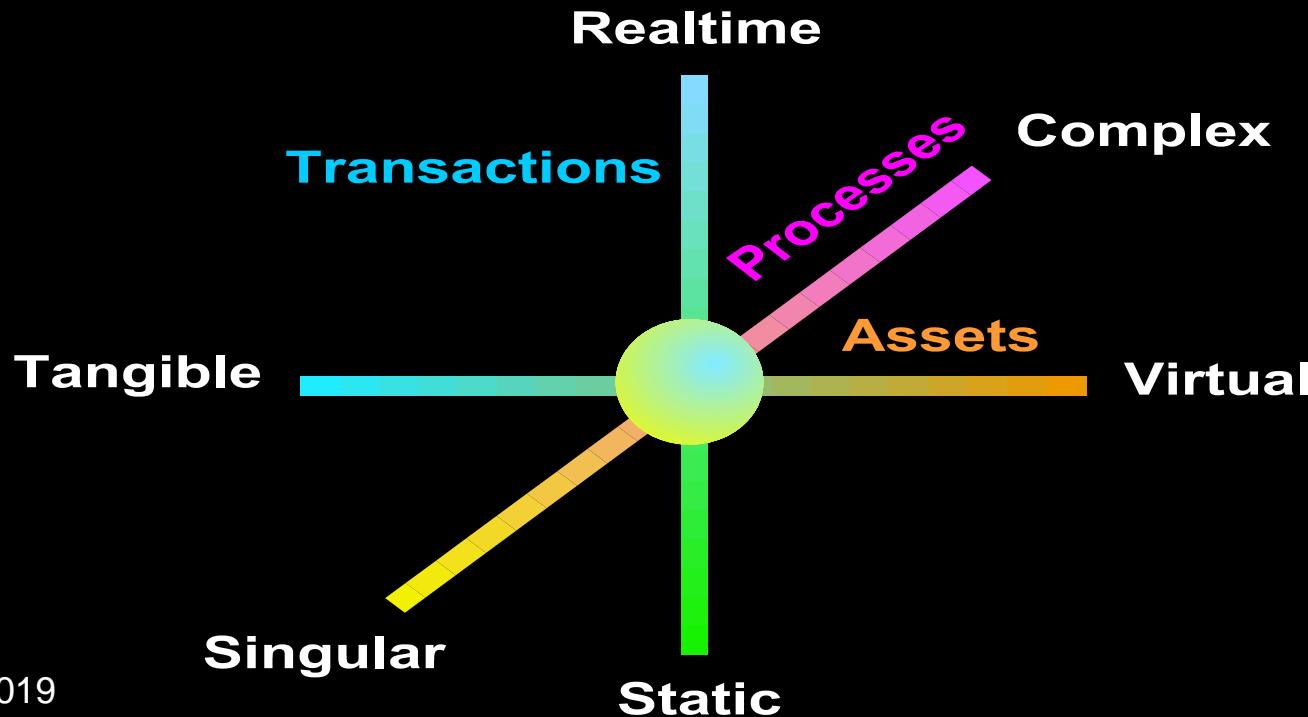
Presence domains, documentation, sense and data acquisition, portable data vessels, existence management

Ubiquitous Computing Paradigm



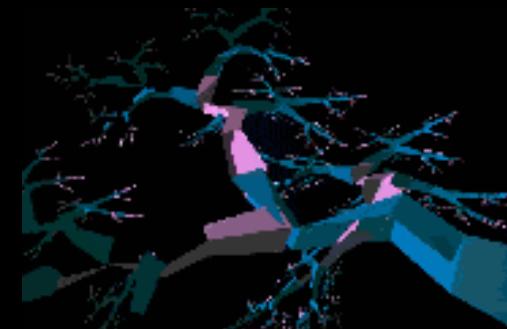
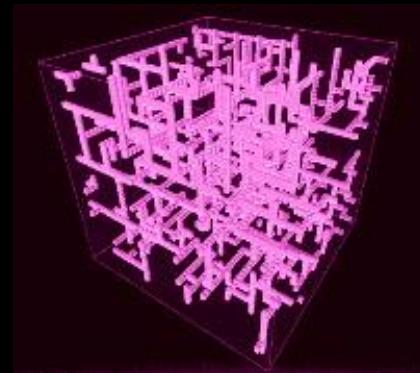
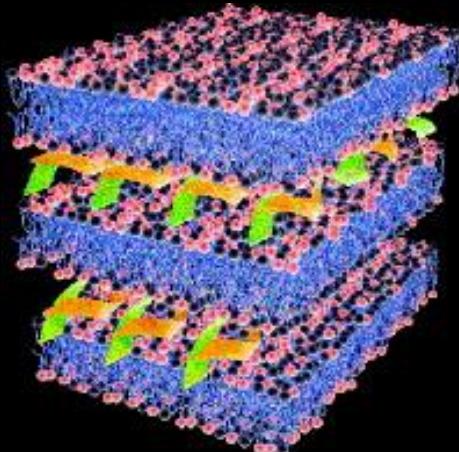
Major Economic Drivers

- Tangible Assets > Virtual Assets
- Technology Vectors > Complex Value Chains
- Intellectual Property > Sovereign Knowledge Domains



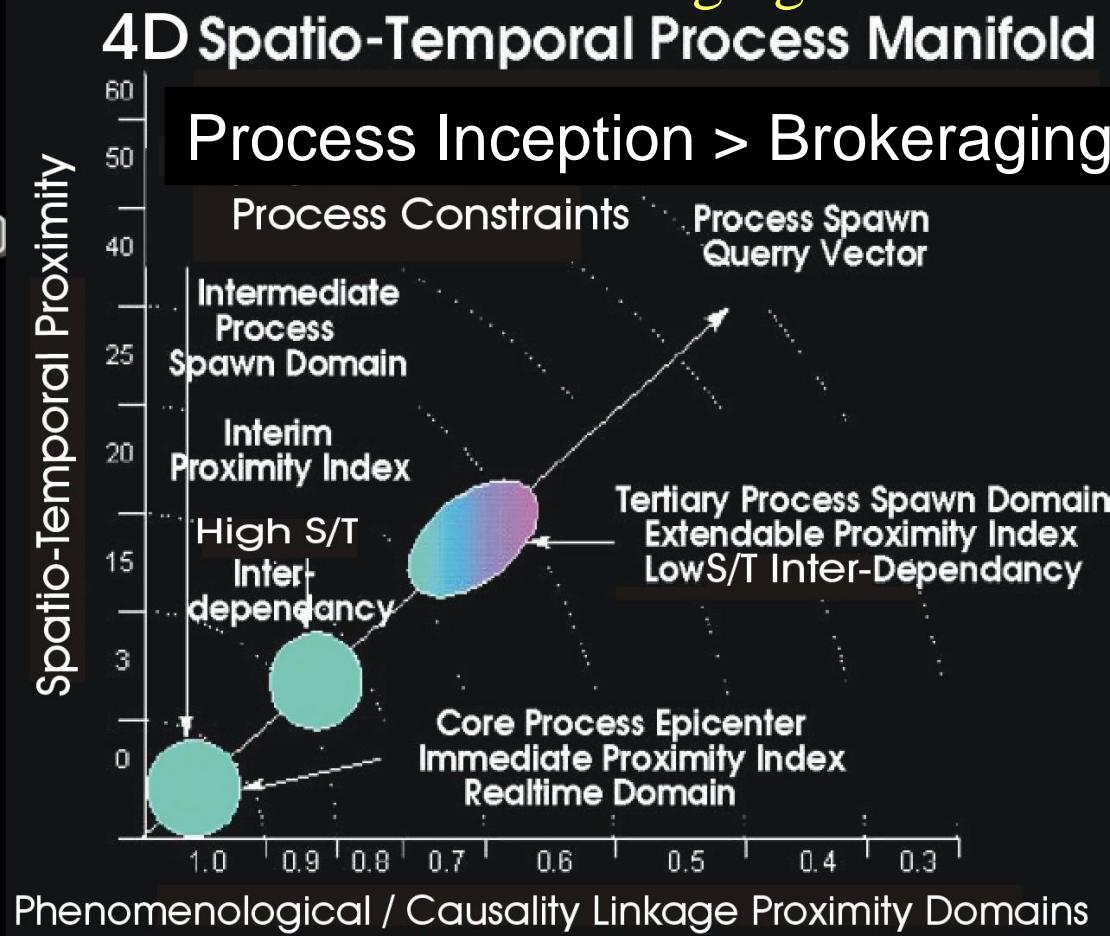
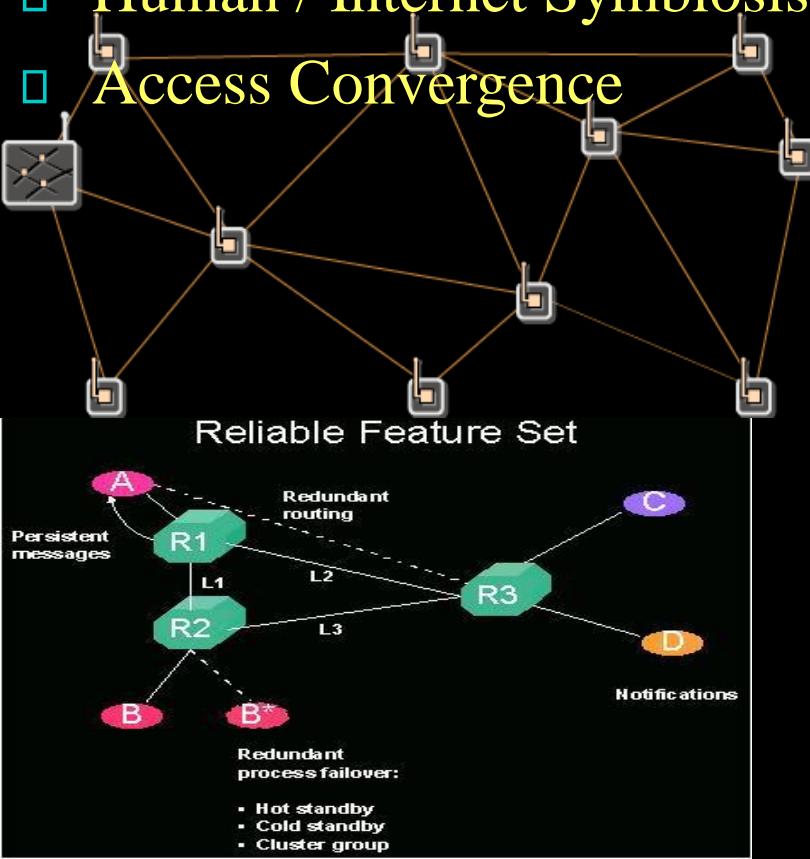
The Operational Ecology - Artifacts and Technologies

- Ubiquitous Immersion / Existence Transaction
- “Smart” Networks / Evolvable Systems
- Virtual “Autonomous Entities”
- Intelligent Agents and Agent Colonies
- Synthetic Sentience as a Strategic Resource

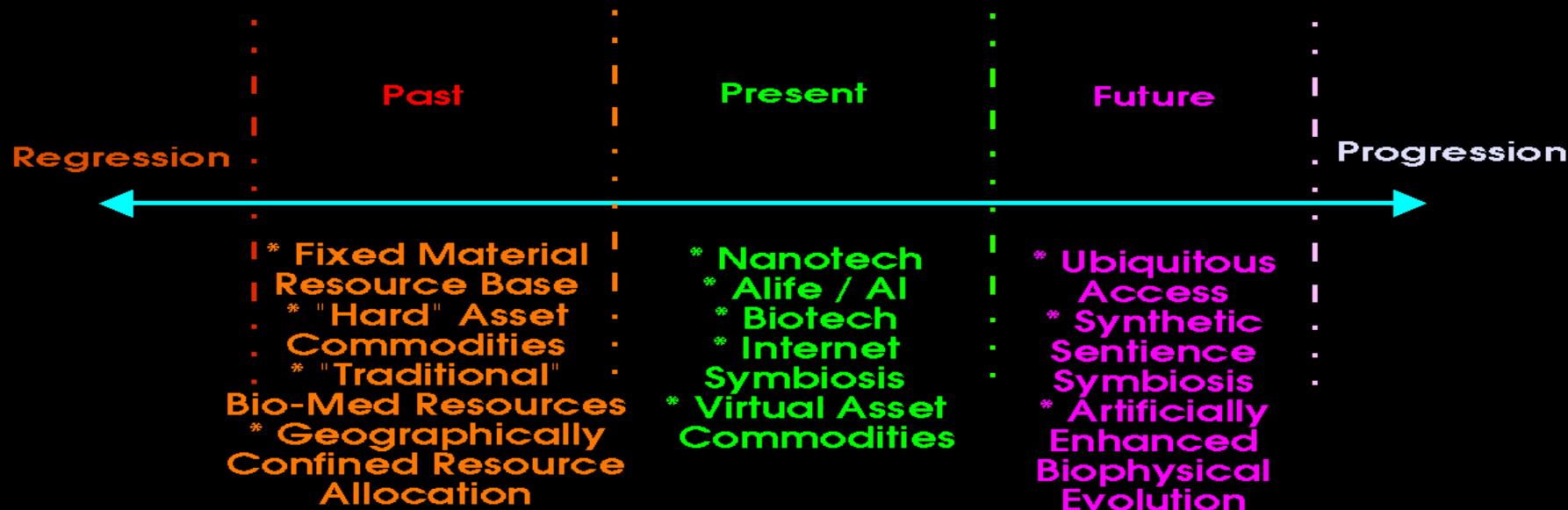


Key Elements of the Emergent Operational Ecology

- Sovereign Knowledge Domains
- Ubiquitous Computing “Fabrics” - Access and Brokeraging
- Human / Internet Symbiosis
- Access Convergence



Technology Driven Socio-Anthropological Evolutionary Threshold Domains



Evolutionary Eventstream Seminal Markers



Complexity Quotient

Temporal Compreſion Index

System Viability

Compounding Multiplier Effect

Synthetic Sentience Symbiosis Threshold

Value Chain as Composite Aggregate of Hard and Virtual Assets –

Compliancy mapping across n-dimensional operational ecologies

- Knowledge / Resource / Distribution Value Chain
- Interdependancy Factors
- Compliance Consistency
- Distribution Topology
- Asset Tracking
- Pathology Event Containment and Exposure Control
- System “DNA” / Digital Genomics
- Adaptive System Integrity

Value Chain as Composite Aggregate of Hard and Virtual Assets –

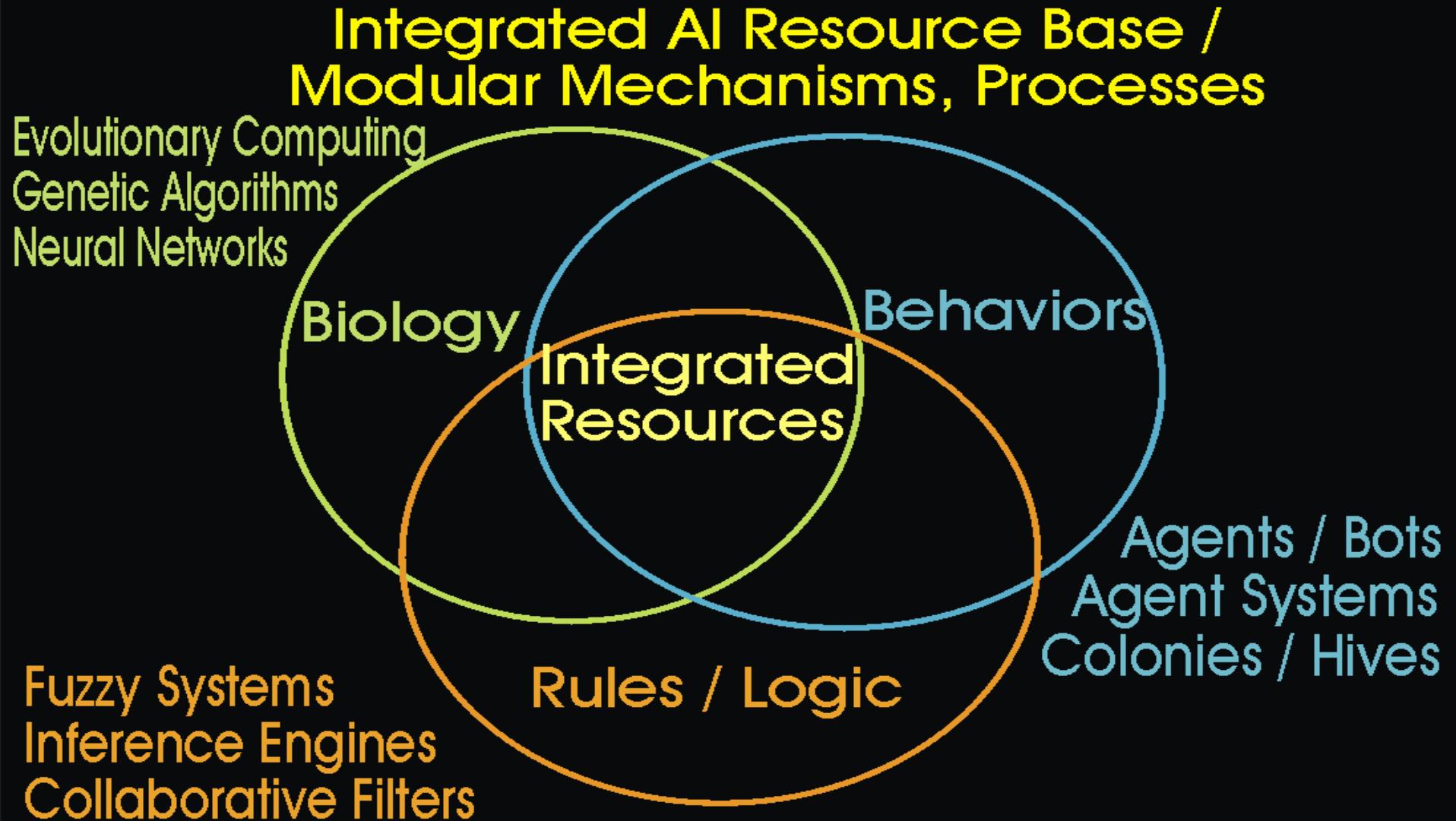
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Toward System Autonomy – Self Optimizing, Pro-Actively Defensive

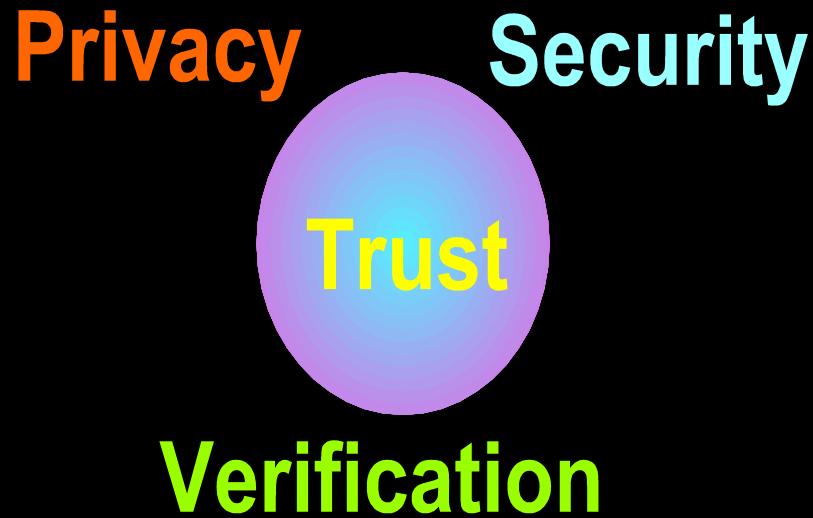
- Integration with scalable, interoperable intelligences, processes, engines, objects
- Hierarchical, dynamically adaptive knowledge domains
- Aggregate evolutionary & biologically inspired system / network attributes
- Virtual antibodies, immune system

Biological Metaphors in Computing

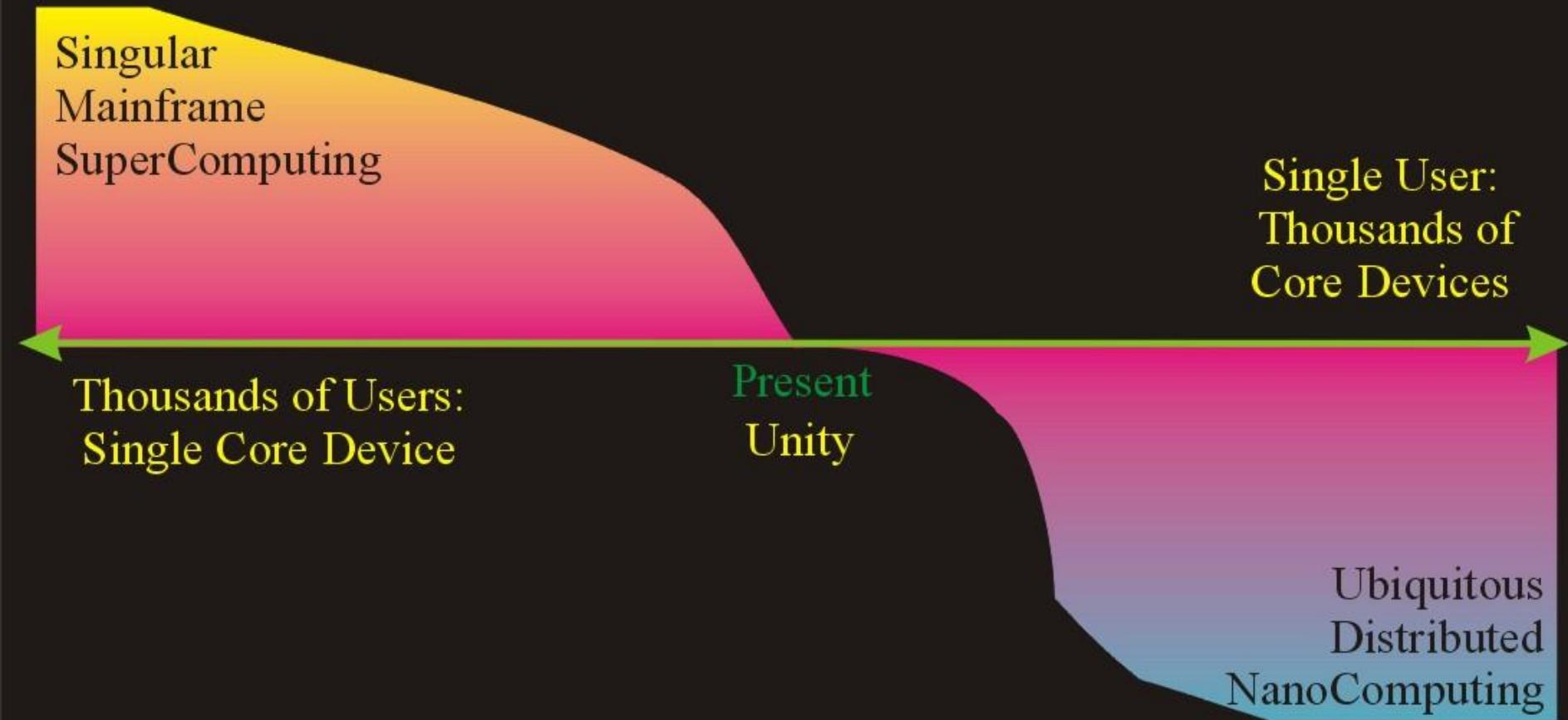


Cultural Imperatives

- Embedded Intelligences
- Integrated Existence Management
- Ubiquitous Interactive Process Environment

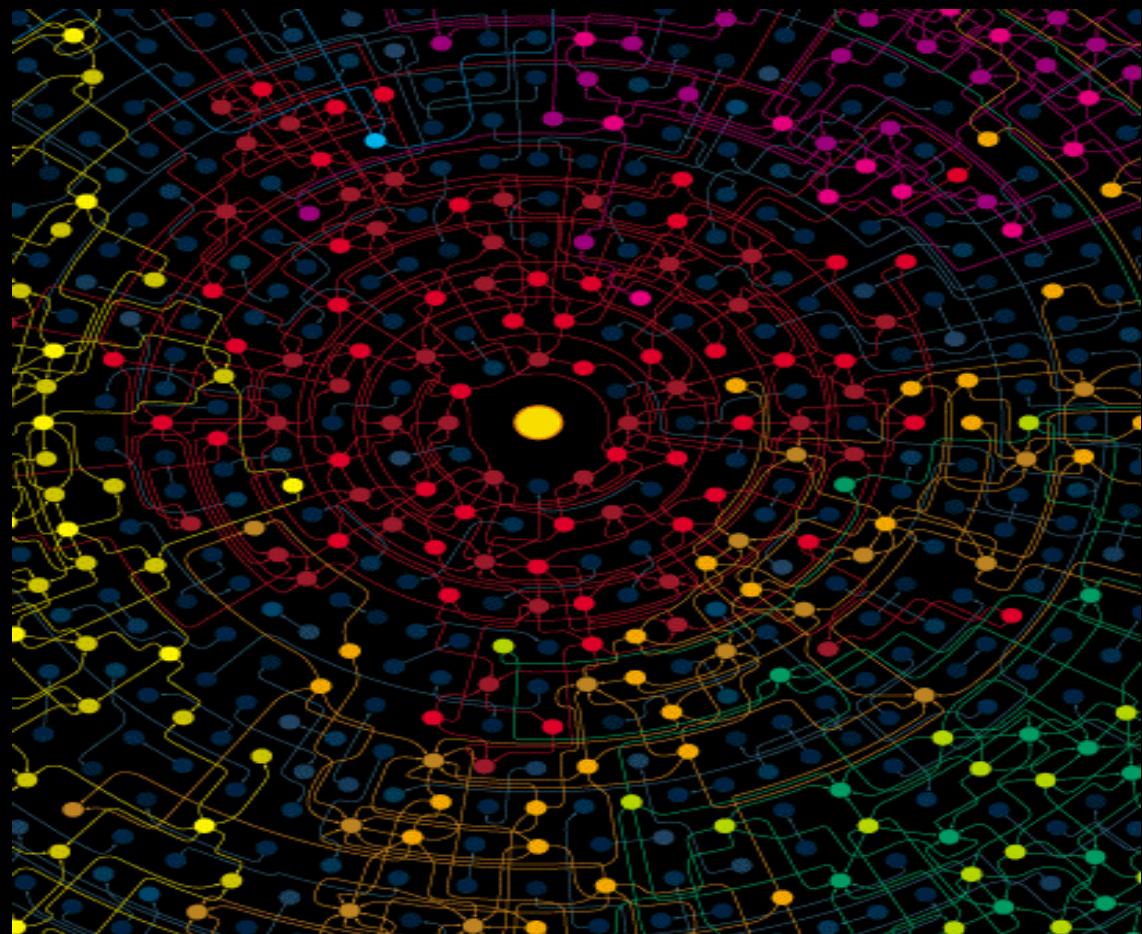


NanoComputing - Integration of Sensing, Cognition, Computing, Communication



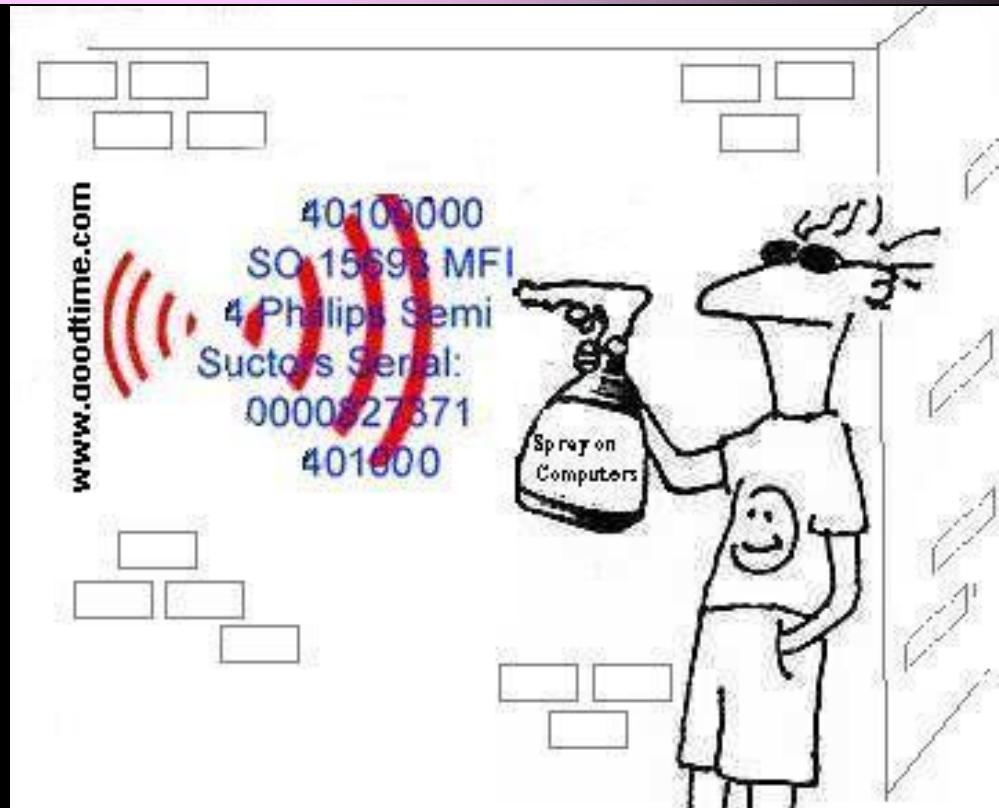
Digital Convergence > Process Convergence

- Architectures
- Domains
- Objects
- Elements
- Integration
- Transparency
- System Health



NanoComputing - Integration of Sensing, Cognition, Computing, Communication

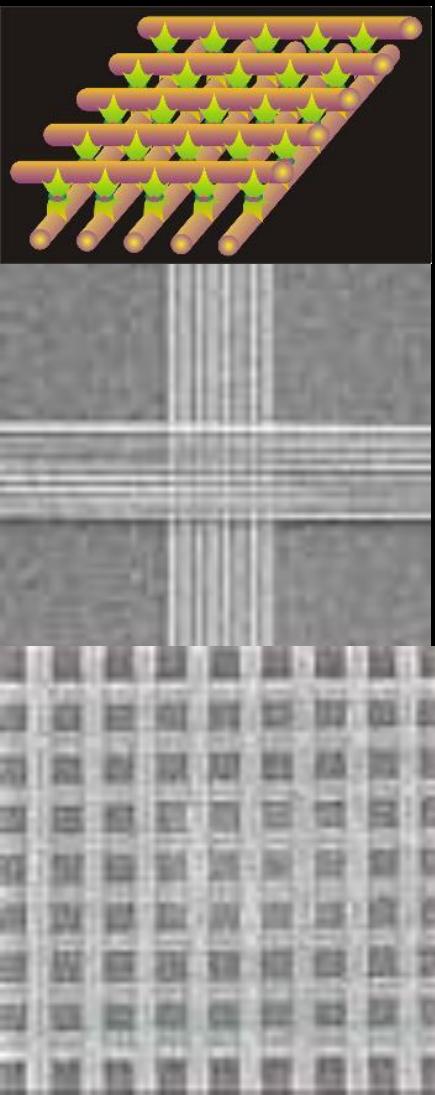
- NanoBarcodes
- “Spray on” Computers
- Smart Dust / RFID
- Intelligent documents
- Nano sensors, fabrics



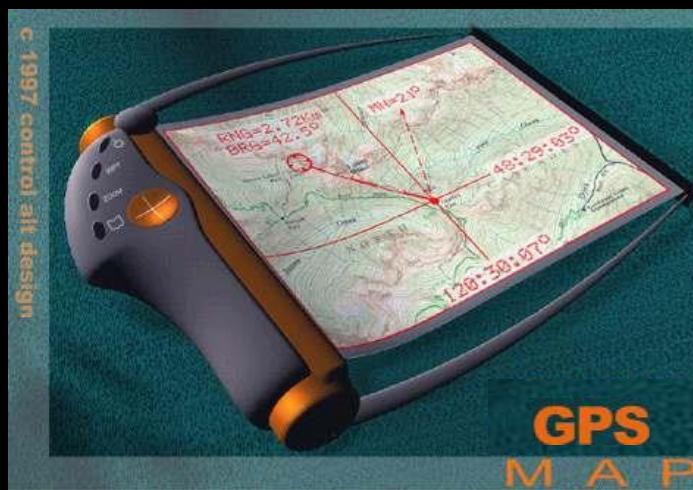
Gang-Graffiti of the future! “Spray on active tagging!”

Nanoelectronics / Molelectronics

It's not just about “little devices”

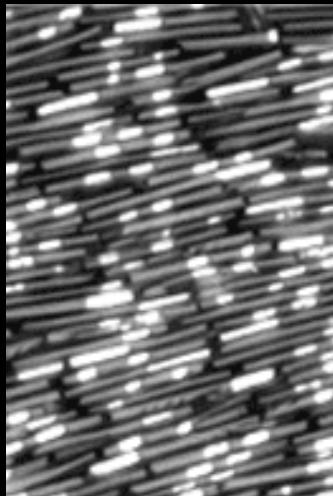


- Extreme high density functionality
- “Printable” electronics on diverse materials
- Reconfigurable logic arrays, memory fabrics
- Low cost, disposable device technology
- Highly adaptable
- Integrated sensors, processing, memory



Ubiquitous Object Interface

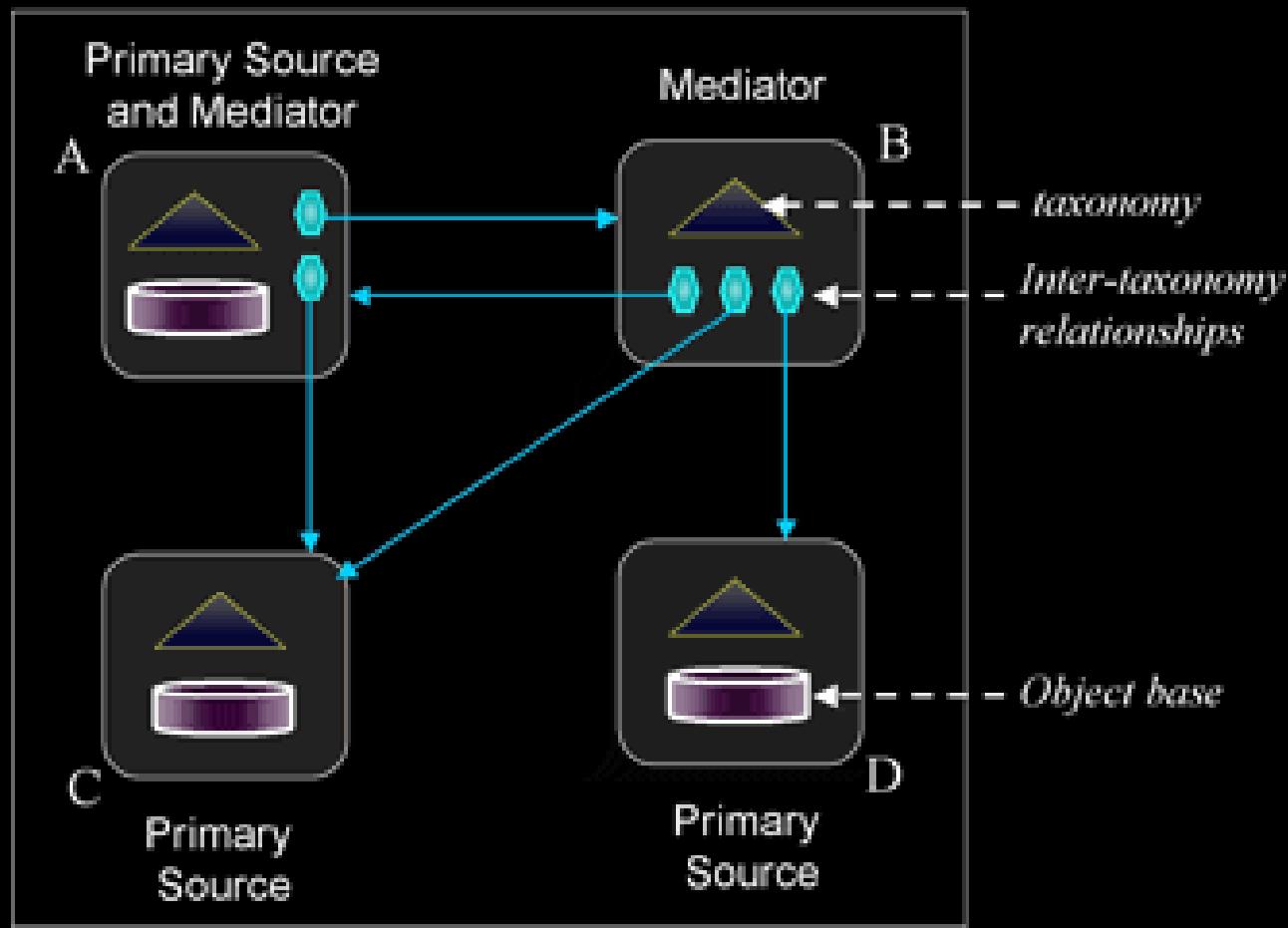
- Nano Bar Codes
- Micro / Nano RFID – OFID devices
- Printable Nano-circuitry



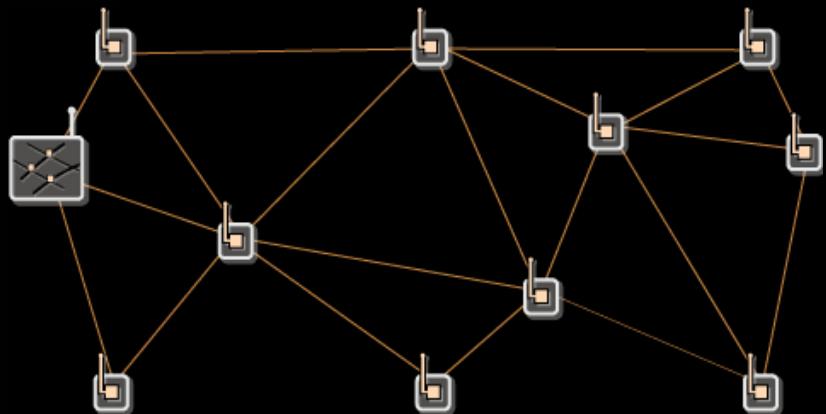
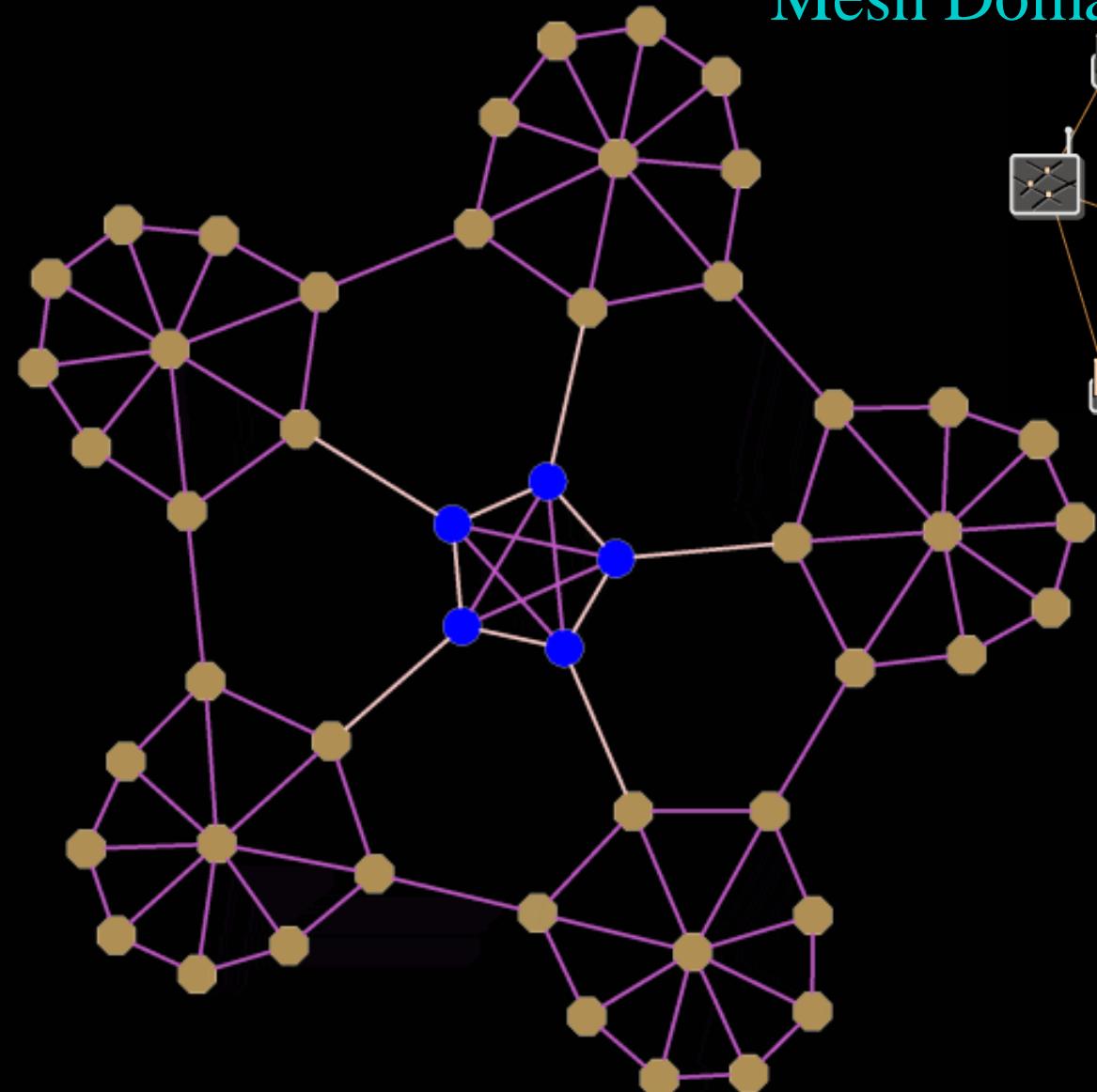
SEM Photograph of
185 Micron NanoBlocks

Peer to Peer Taxonomy

- Grid Computing, Architectures, Process Mediation, Objects, Media

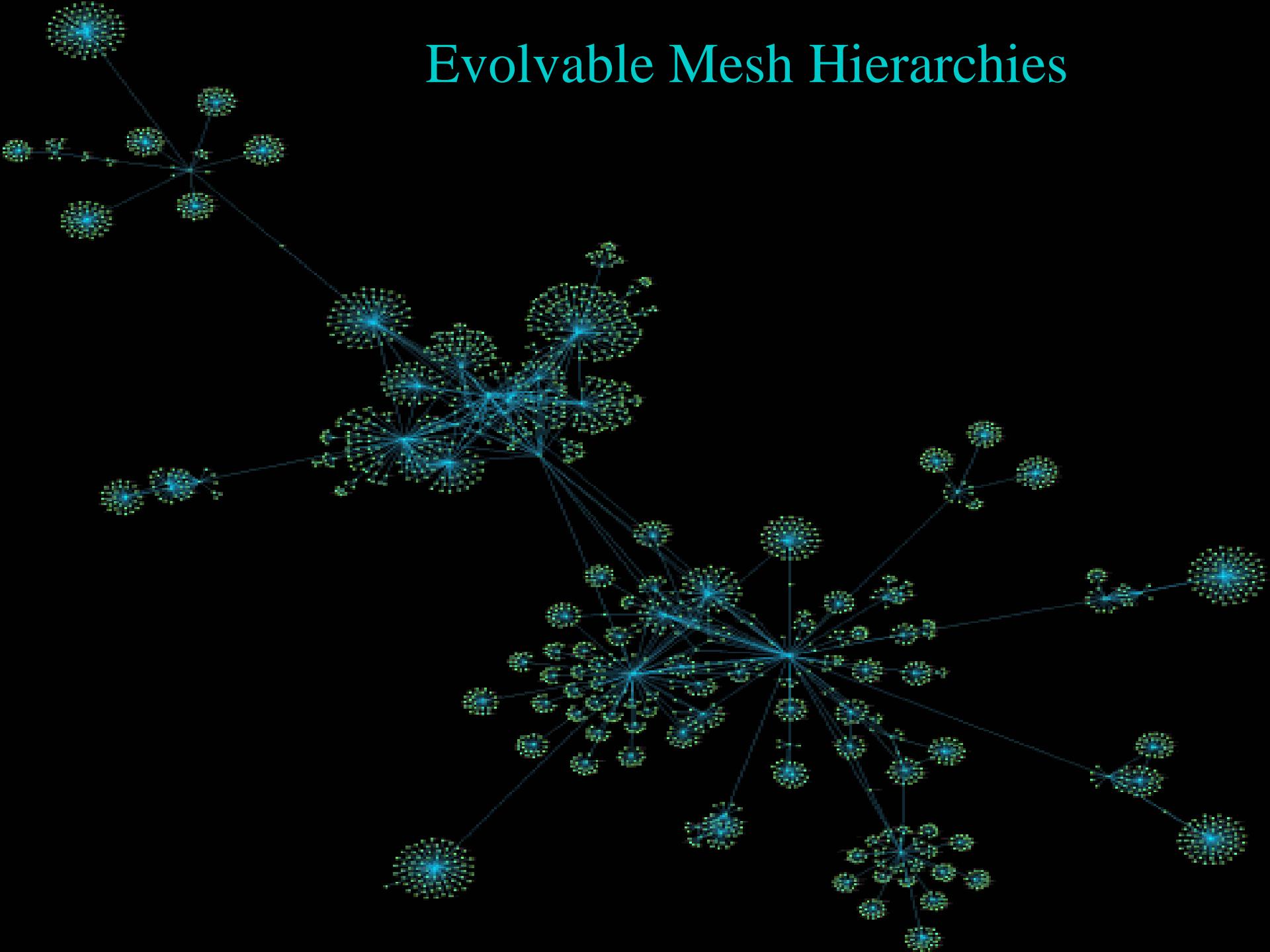


Mesh Domains

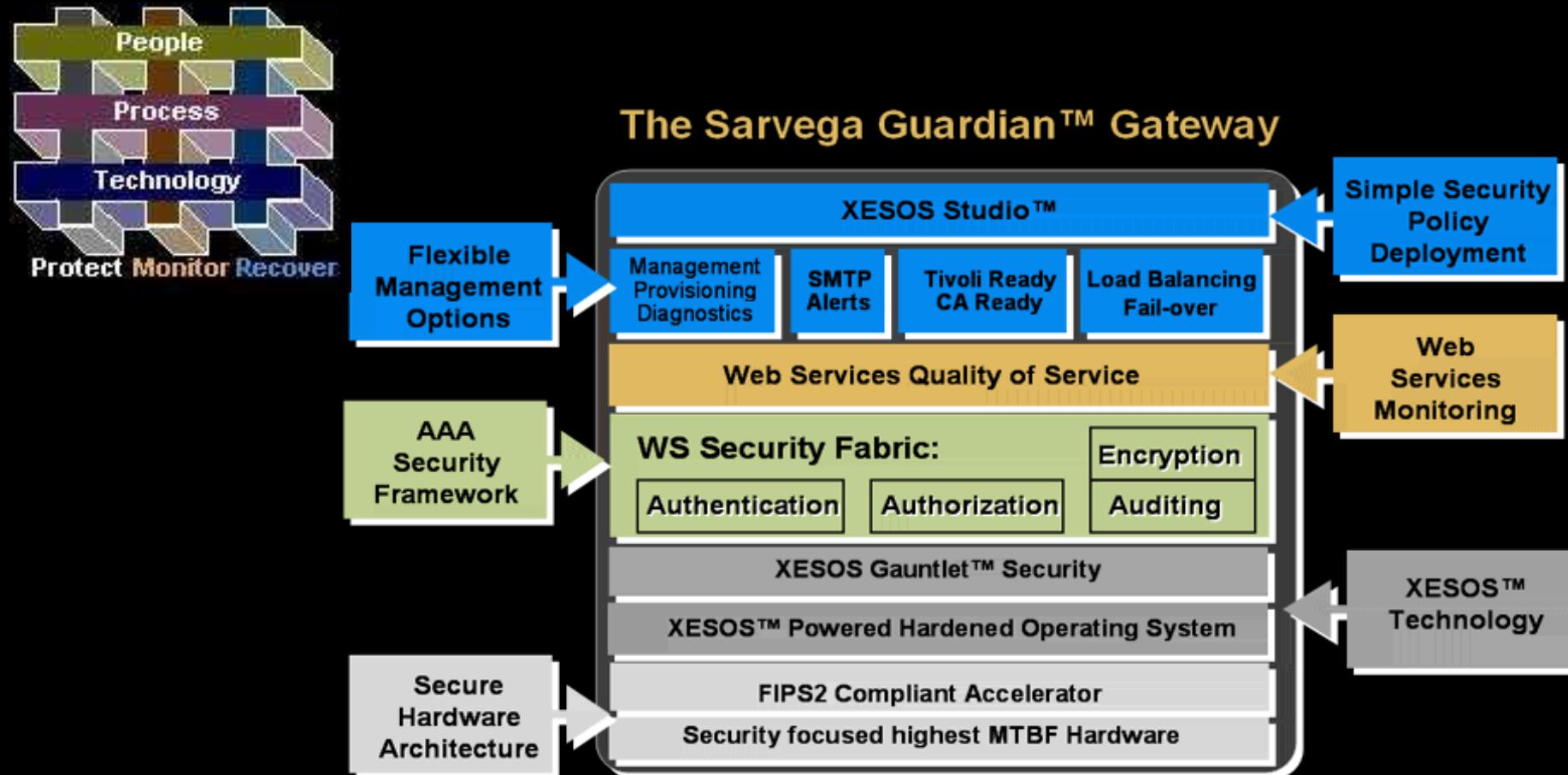


Mesh Networks

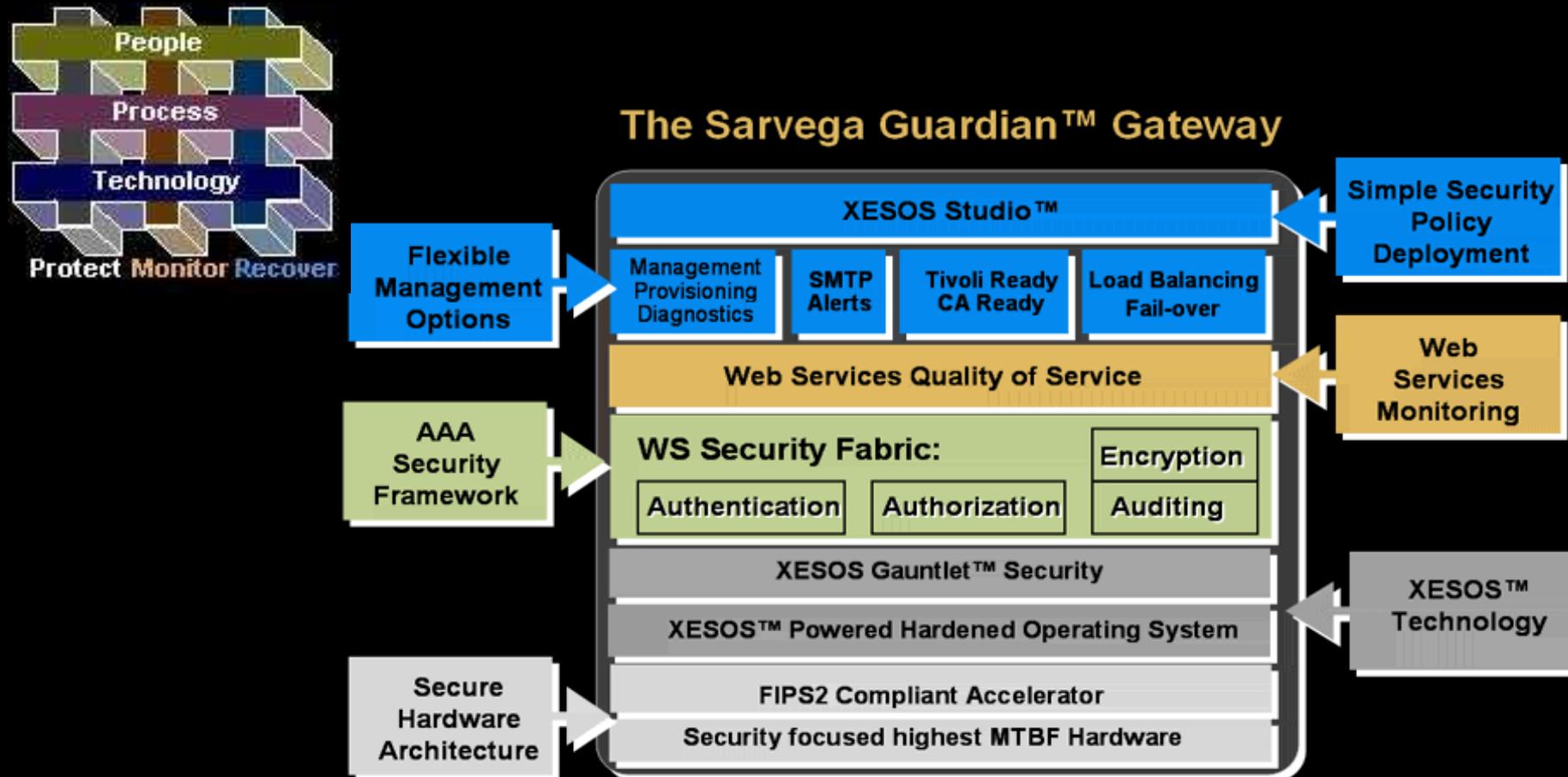
Evolvable Mesh Hierarchies



Mating the Mesh, Grid, Enterprise – The “DNA” carries the identity



Mating the Mesh, Grid, Enterprise – Does the “DNA” carry the protection?



The evolution of “hardened” mesh, grid, enterprise architectures

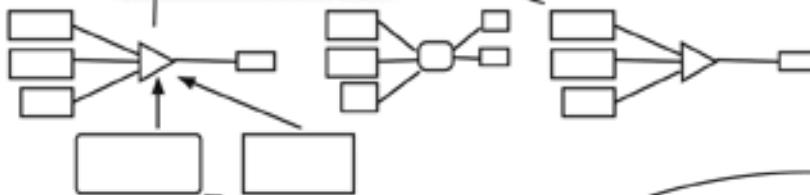
Deployment Models (e.g., USS Stennis battle group)



Organization Models (e.g., USS Lake Champlain)



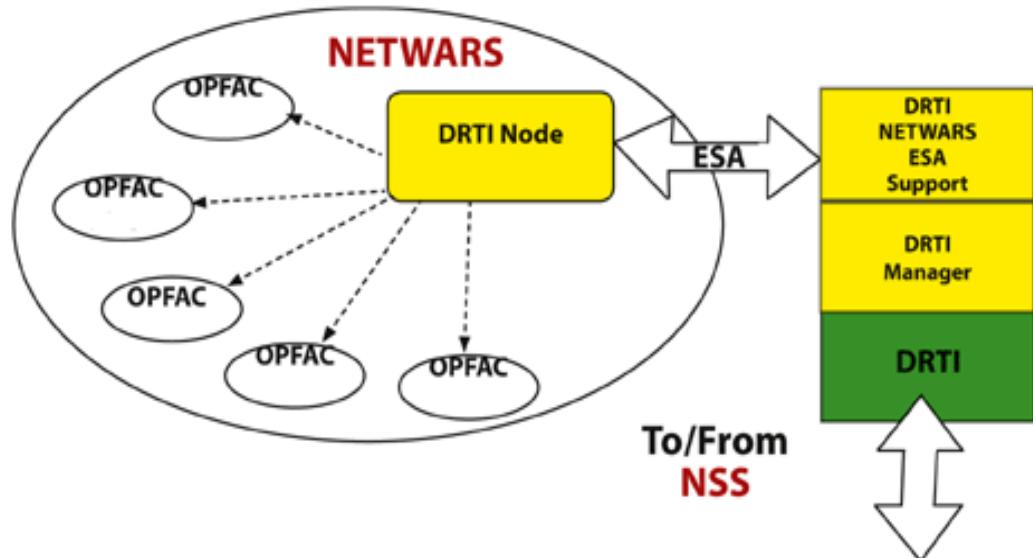
OPFAC Models (e.g., ISNS)



Device Models (e.g., Cisco 7500 router)

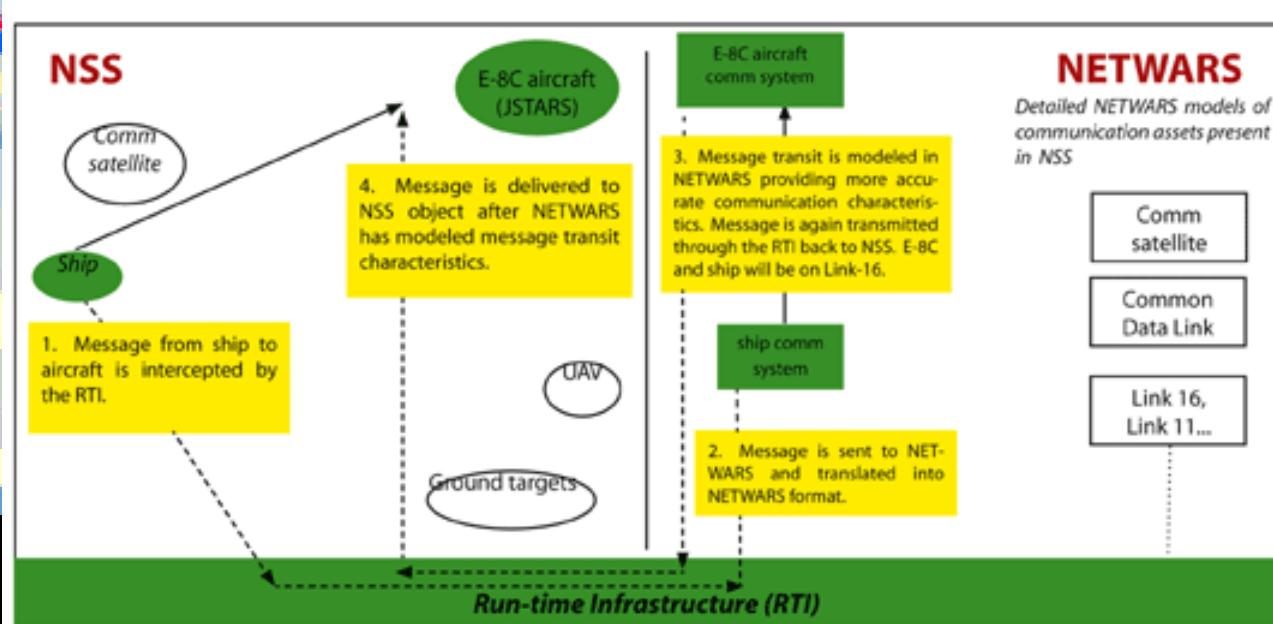
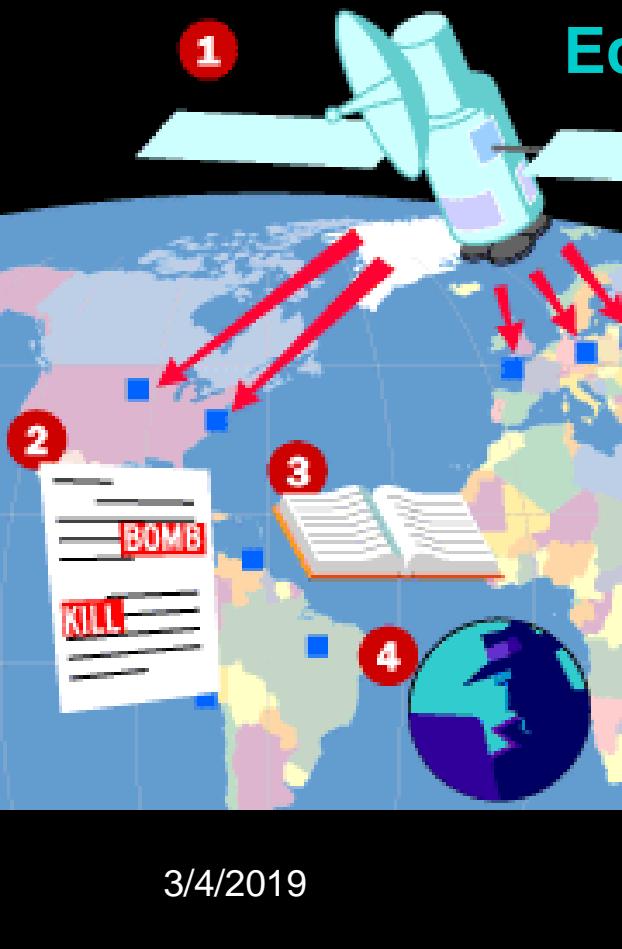


Function and process models
(e.g., Ethernet)



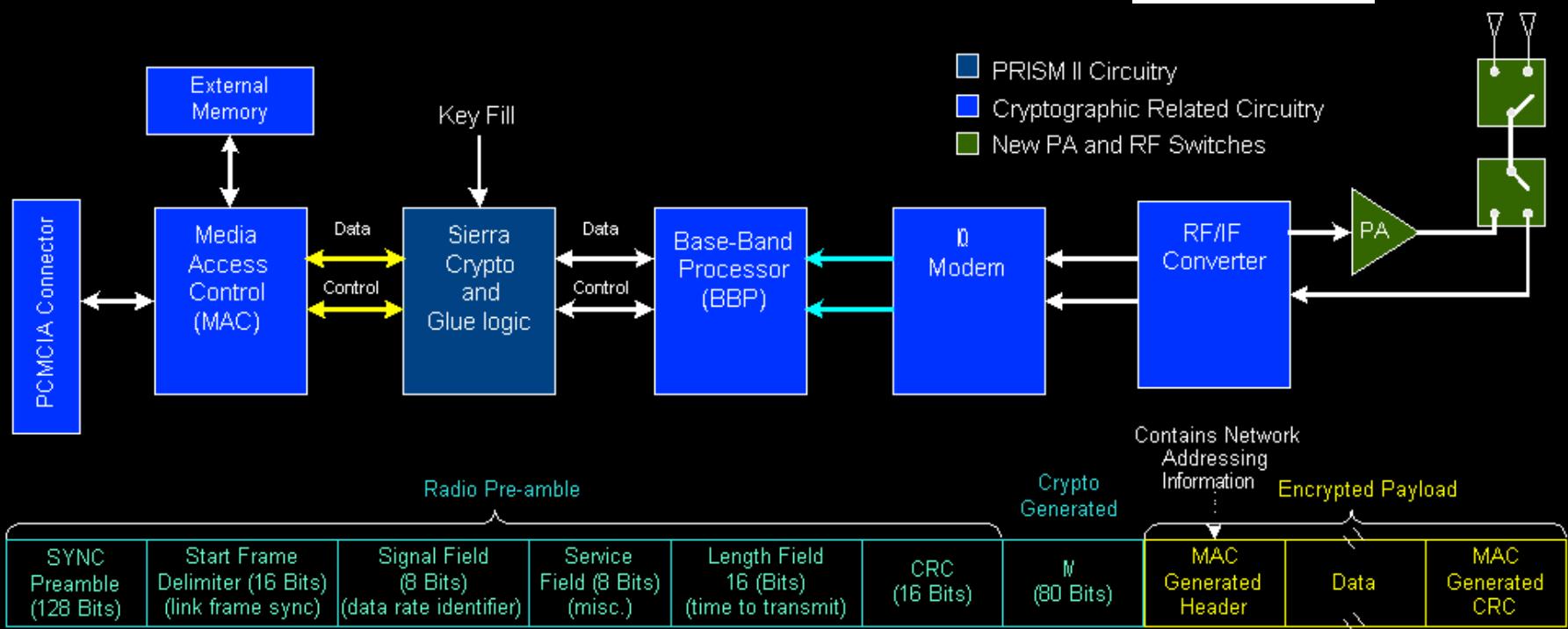
Assume as Truth . . . *Everything* is Public

- All transmissions are vulnerable

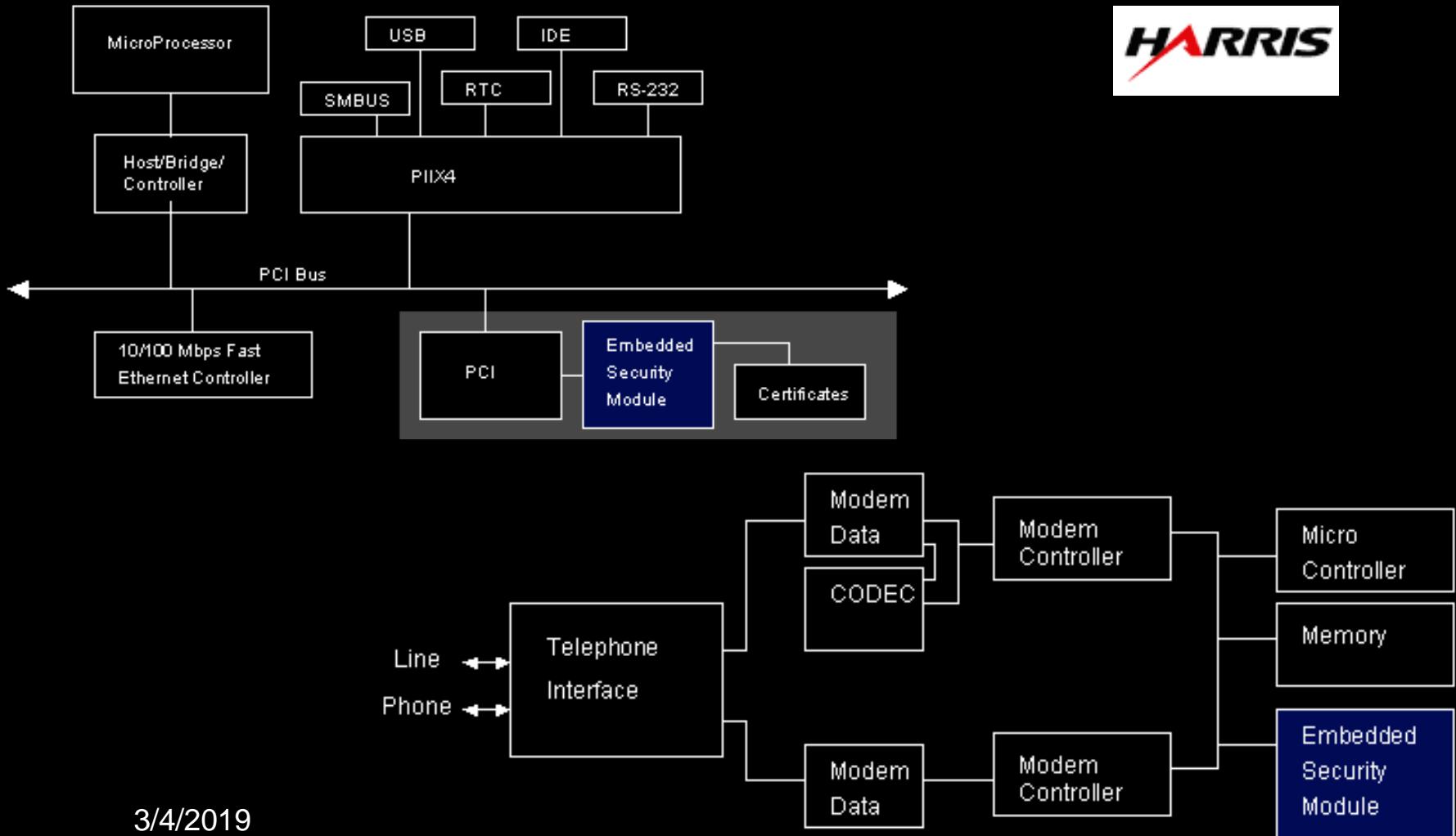


Embedded crypto in all nodes, portals, devices

- All transmissions are vulnerable



Embedded crypto in all nodes, portals, devices



Quantum crypto – the next increment of secure system evolution

- All networks are vulnerable



Alice's Key



Bob's Key



Original: (a)



Encrypted: (b)

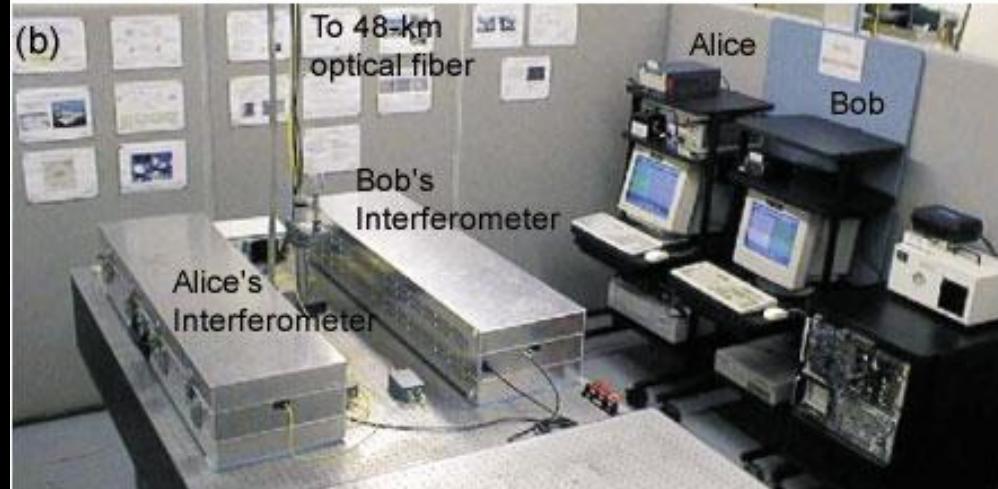
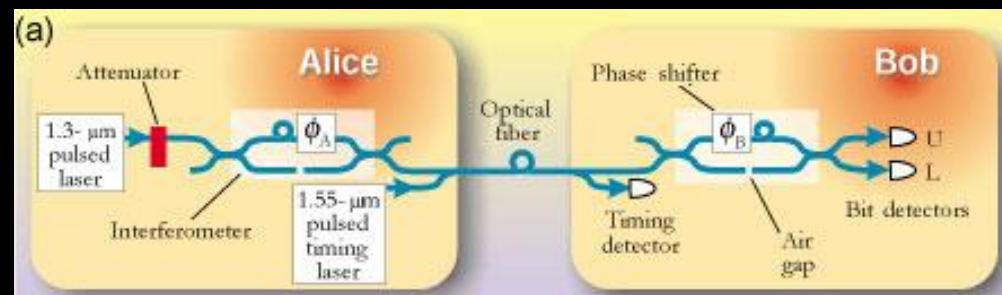


Decrypted: (c)



Bitwise
XOR

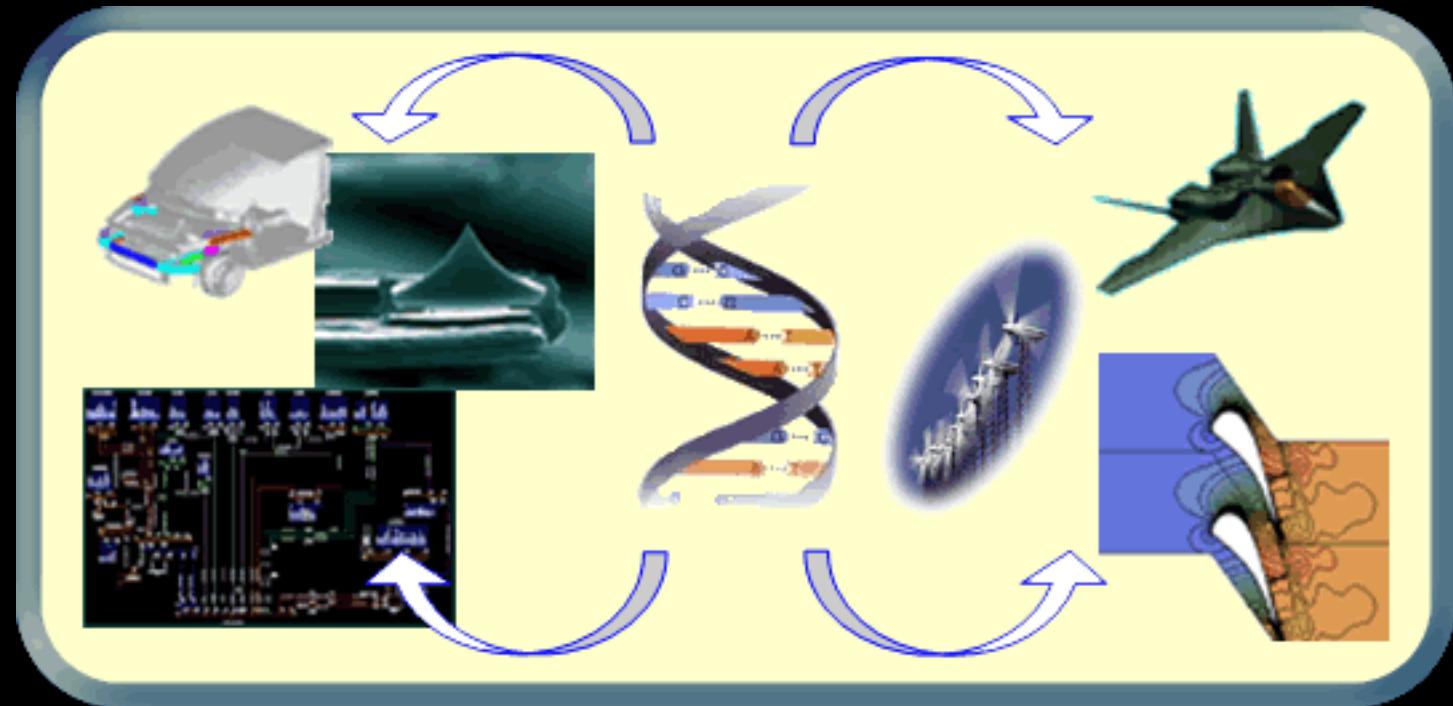
Bitwise
XOR



Evolutionary Computation –

Evolved Strategies Mapping Solutions into Domains of Extreme Complexity

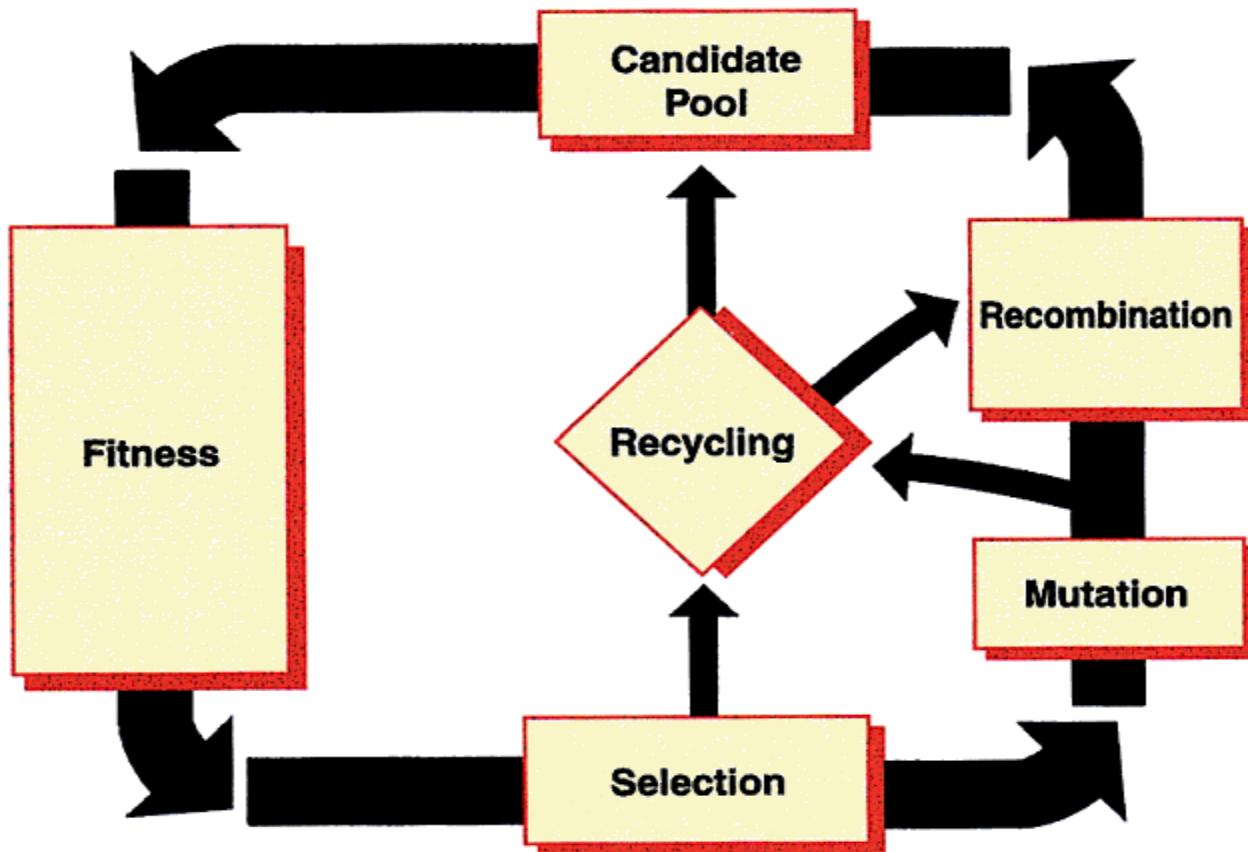
- Hardware
- Software
- “Gelware”
- Networks
- Crypto



Evolutionary Computation –

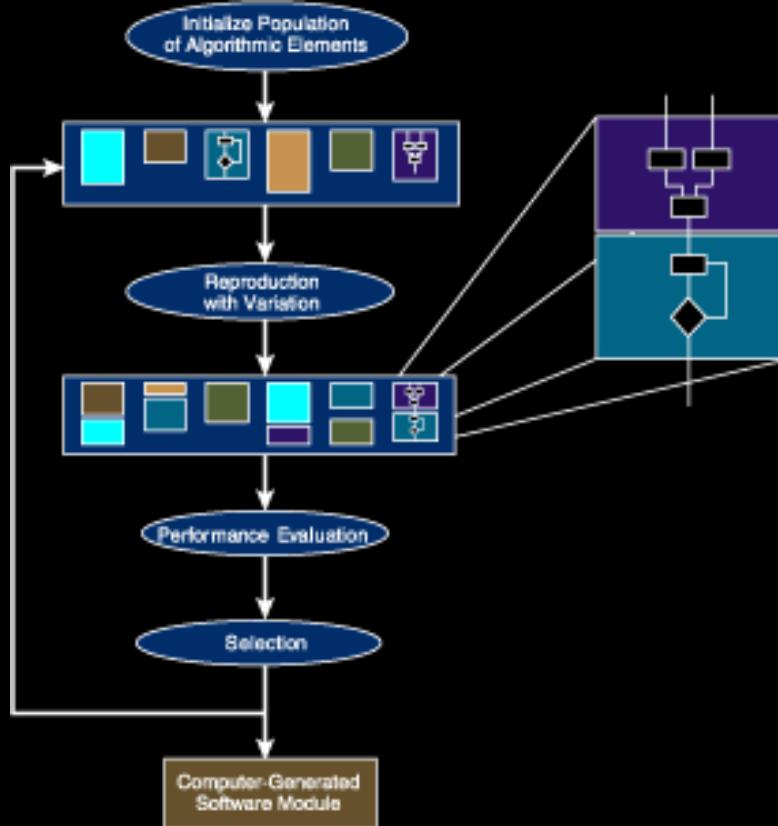
Evolved Strategies Mapping Solutions into Domains of Extreme Complexity

Evolutionary Computing Scheme



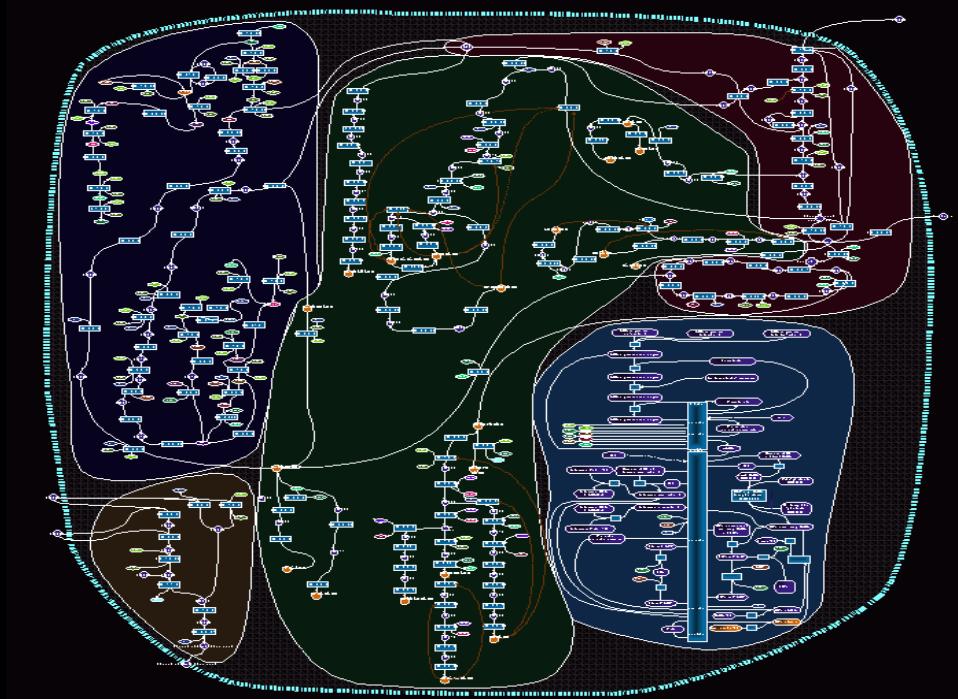
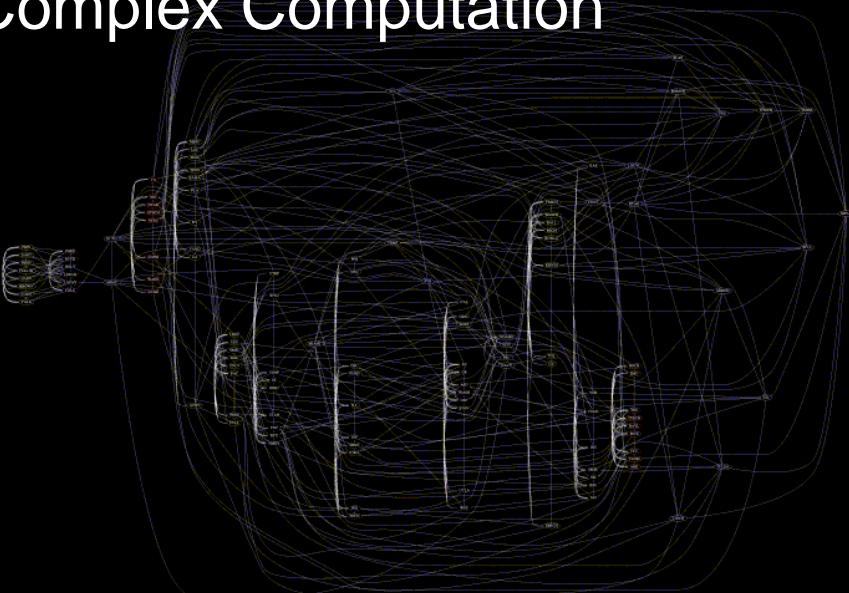
Source: J. Chen, PNAS 97: 1328-1330, Feb 2000.

Evolutionary Computation – Evolved Strategies Mapping Solutions into Domains of Extreme Complexity



Evolutionary Computation – Evolved Strategies Mapping Solutions into Domains of Extreme Complexity

Evolutionary Computing –
Biology as a Metaphor for
Complex Computation

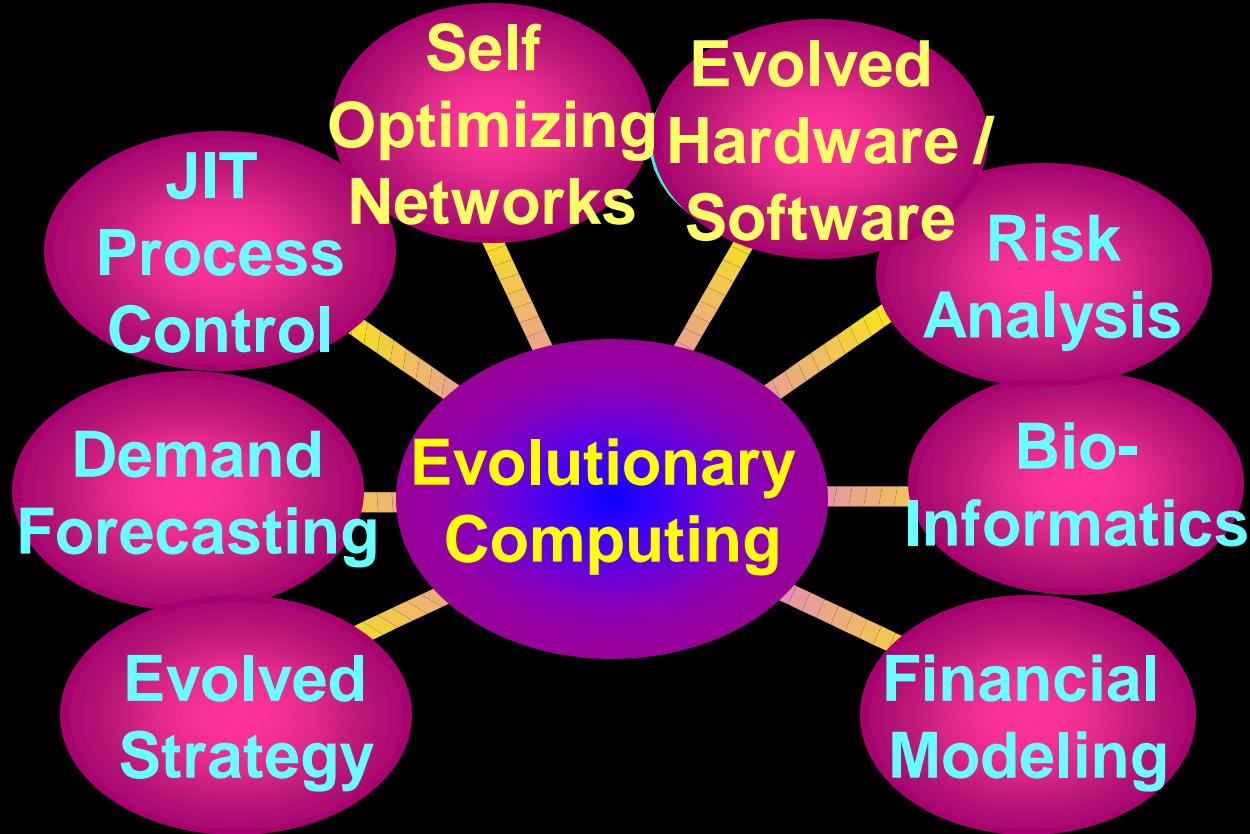


In Silico Biology – Computers
Modeling Complex Biological
Systems



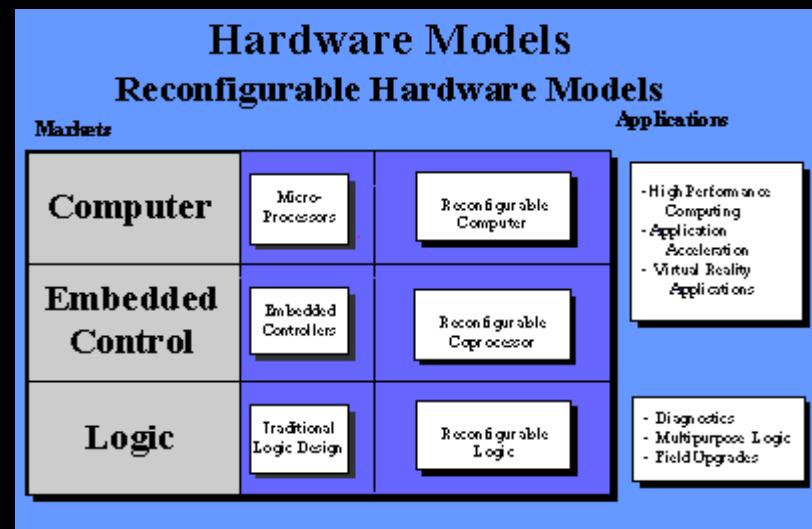
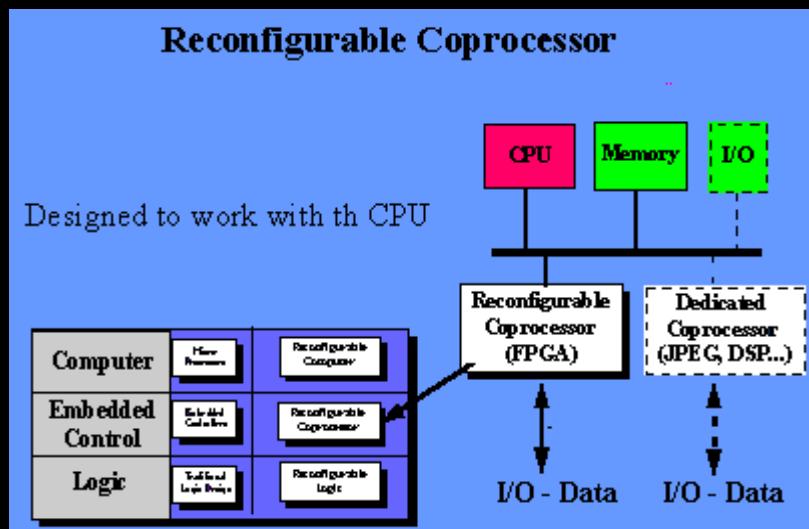
Biological Metaphors in Computing - Evolutionary Computing, Networks, Intelligence

- Genetic Algorithms
- Self Evolving Systems
- Autonomous Functionalities



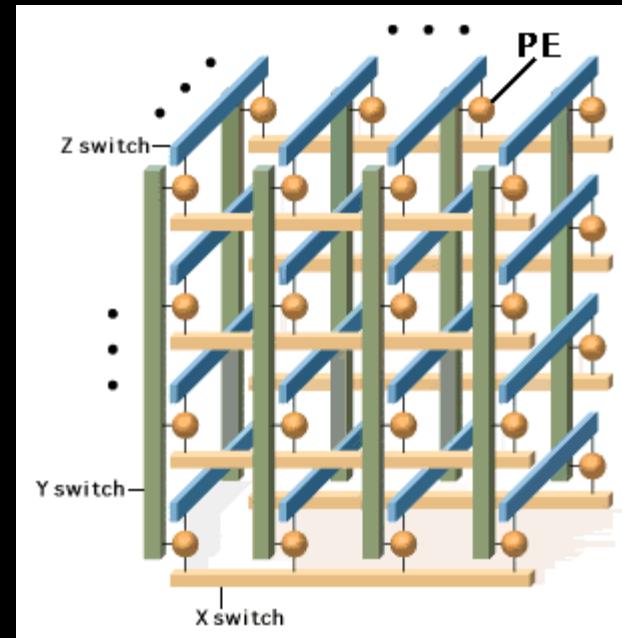
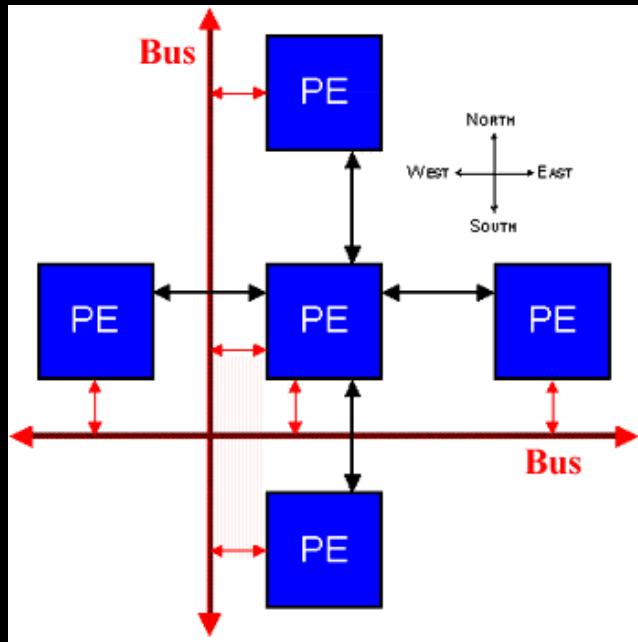
Reconfigurable Computing

- “Soft” Hardware > Gelware
- Process Brokeraged Value Chain
- Contiguously Adaptable System Architecture



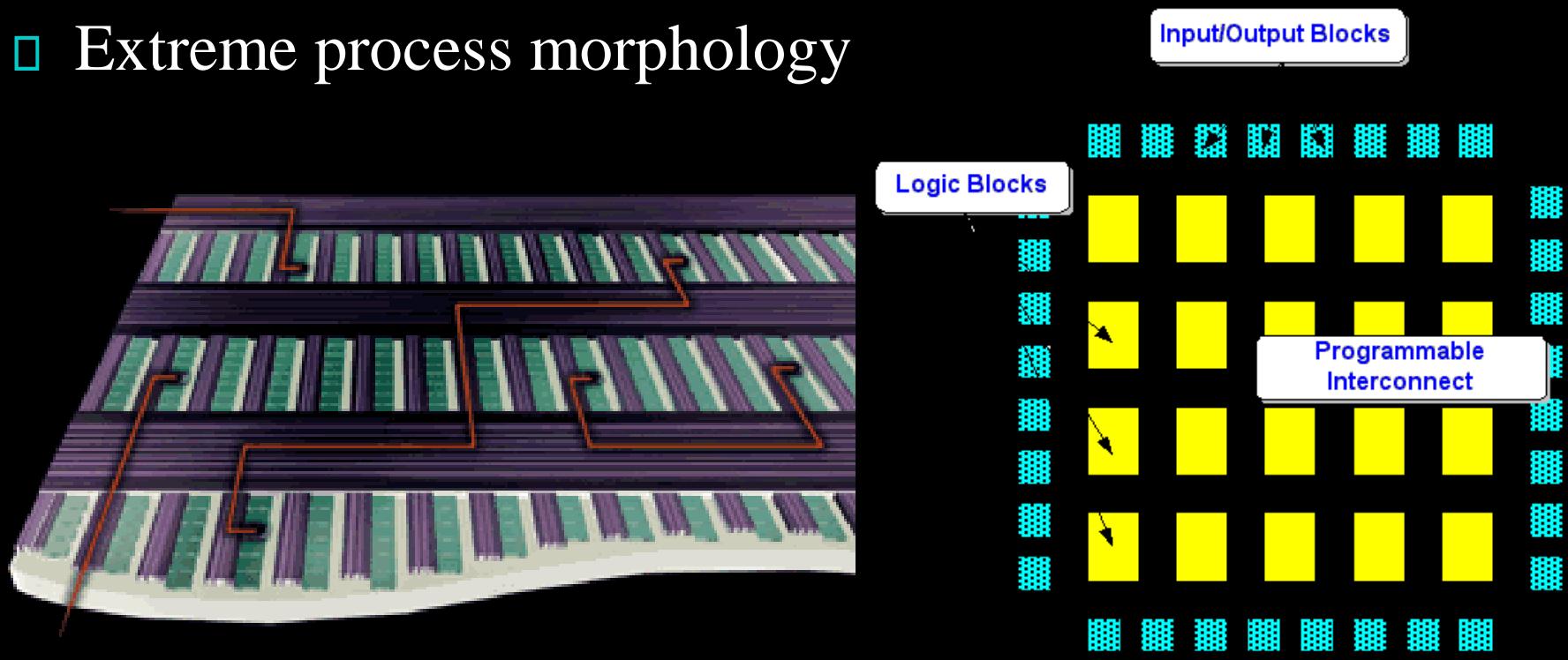
Scalable Reconfigurable Computing Fabrics

- N-Dimensional Processing Element Networks
- Contiguously Adaptable Architectures



Reconfigurable Computing Architectures – Gateway to Unique Computational Resources

- Extreme Parallelism – speed not the real issue
- Enables evolutionary and biological metaphors in computing
- Extreme process morphology



Hyper Algorithmic Logic

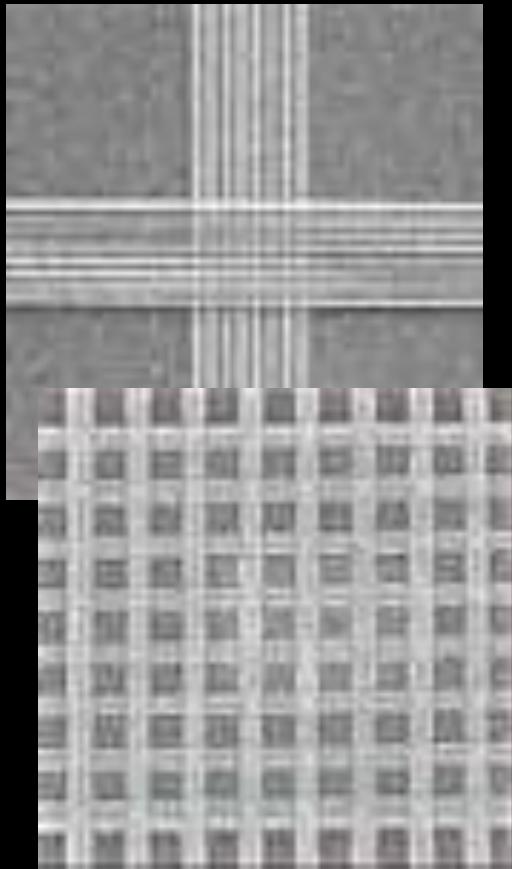
HAL hypercomputer - FPGAs



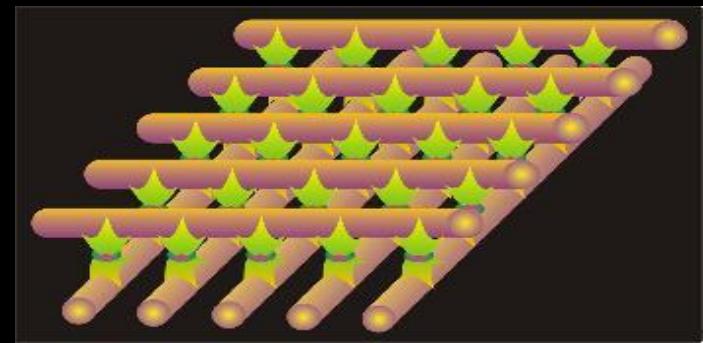
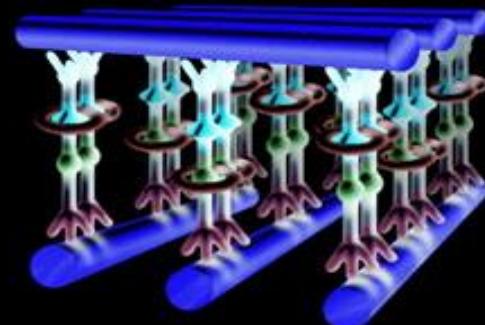
- Field Programmable Gate Array chips
- HAL – 10 FPGAs per hypercomputer
- Pieces of silicon with millions of gates
- Able to be reprogrammed based on the task on hand-creates “specialized CPU”
- Able to be reprogrammed 1000 times per second
- Unused FPGAs may work on other tasks
- Takes full advantage of an algorithms inherent parallel nature

Nanoelectronics / Molelectronics - Reconfigurable logic arrays, memory fabrics

FPGA + Biological / Evolutionary Computation = Self Healing Autonomous System Architecture

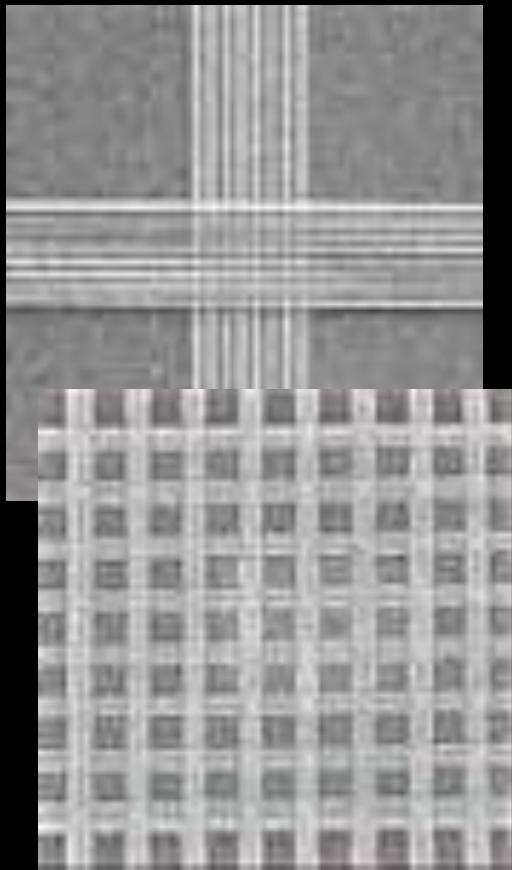


- FPGA Architecture is asynchronous (not confined by Finn's Law)
- Extremely fault tolerant
- Functional identity is in the software, not the hardware
- Well suited for contiguous fabrication processes

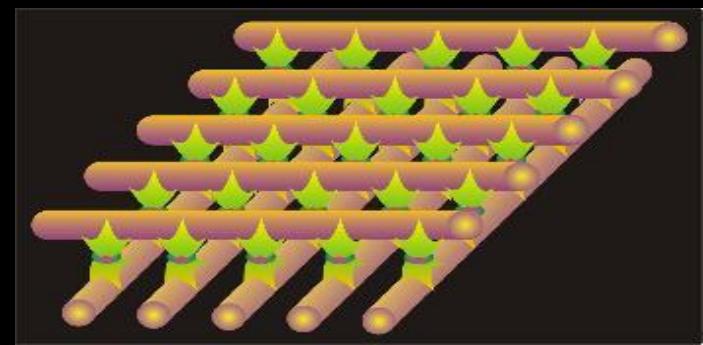
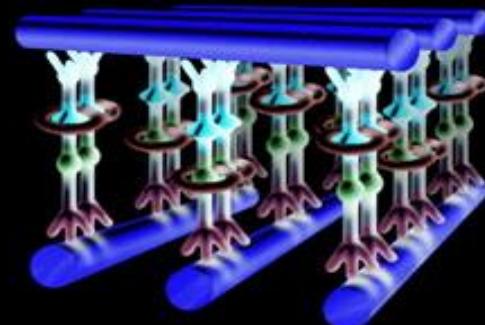


Nanoelectronics / Molelectronics - Reconfigurable logic arrays, memory fabrics

FPGA + Biological / Evolutionary Computation = Self Healing Autonomous System Architecture



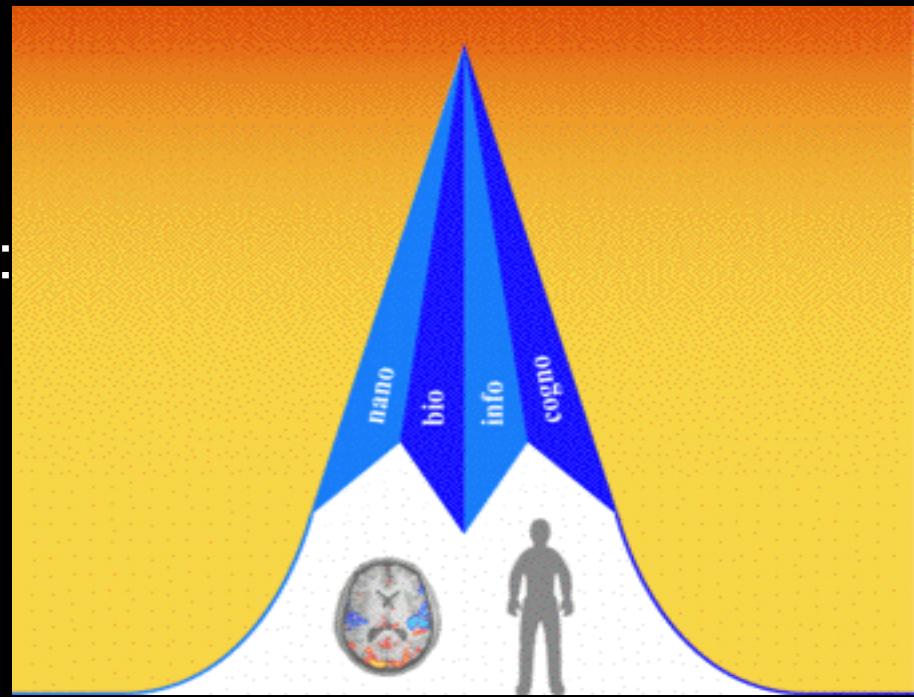
- FPGA Architecture is asynchronous - not confined by Finn's Law
- Extremely fault tolerant
- Functional identity is in the software, not the hardware
- Well suited for contiguous fabrication processes



The Emergent Nanotech / Biotech / Infotech / Cognotech Operational Ecology

NBIC Conference
Converging Technologies
for Improving Human Performance:
Nanotechnology, Biotechnology,
Information Technology and
Cognitive Science

NSF/DOC-sponsored report
<http://www.wtec.org/ConvergingTechnologies>

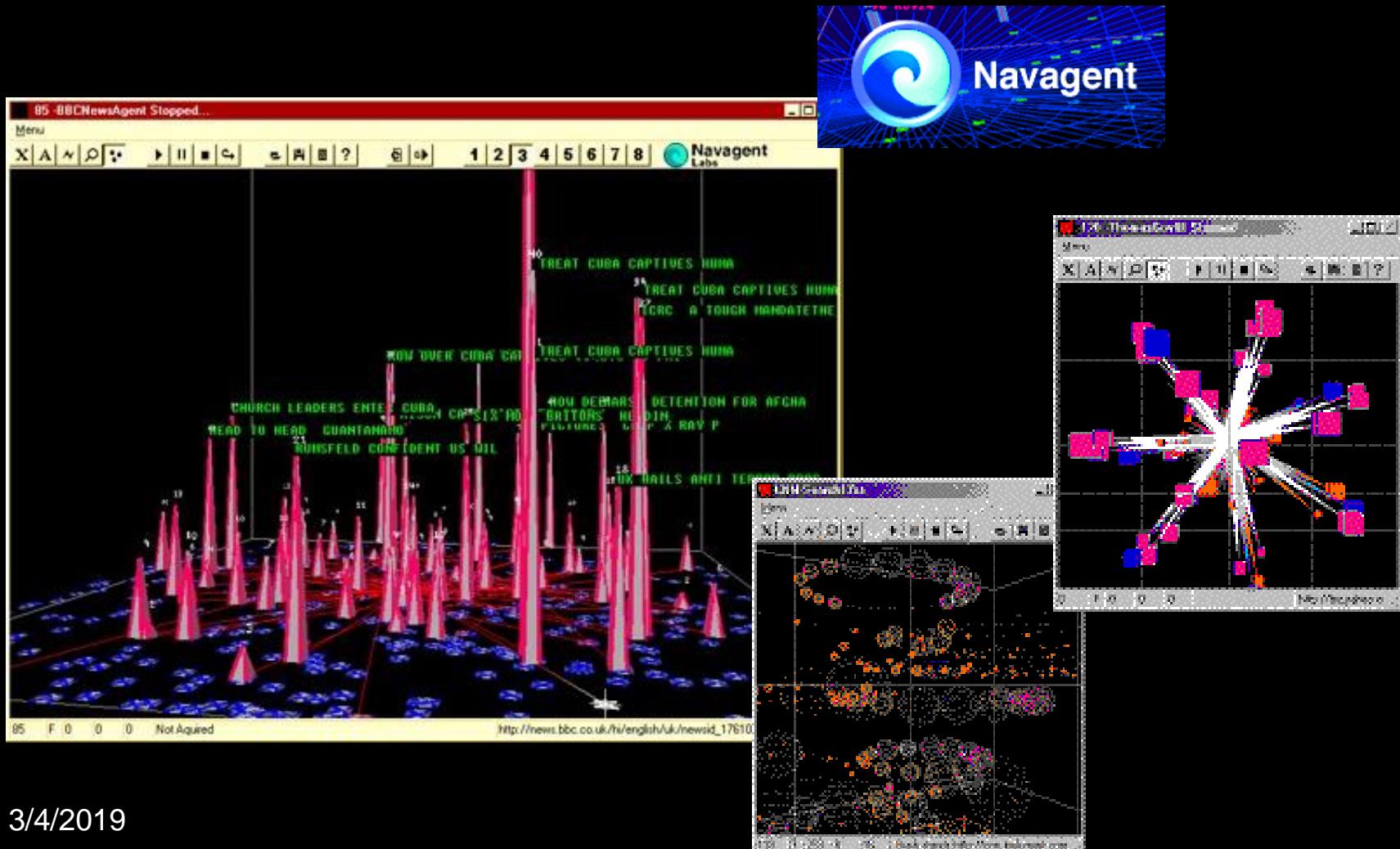


Contextual Cognition in the Emergent Ecology >

Hyperdimensional Existence Navigation

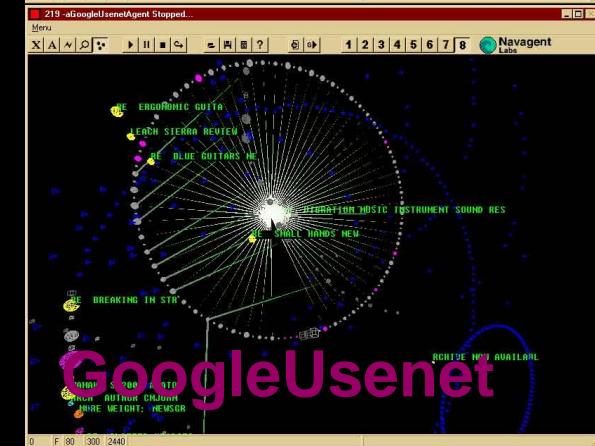
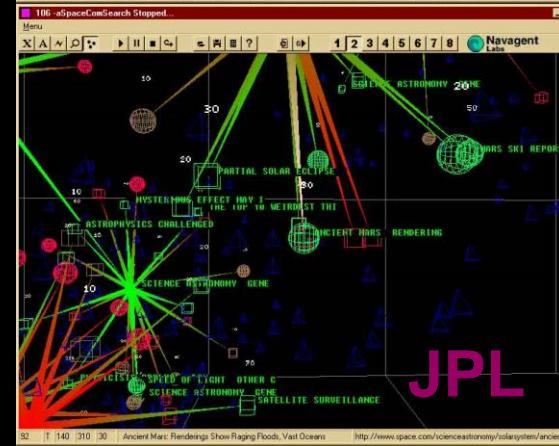
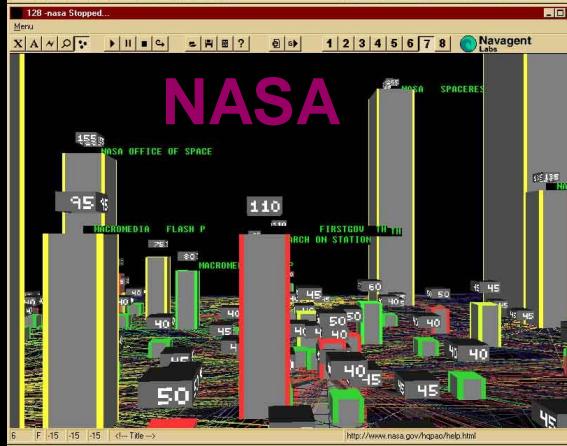
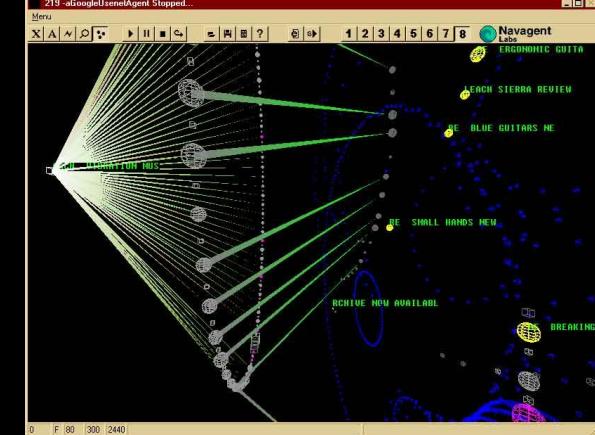
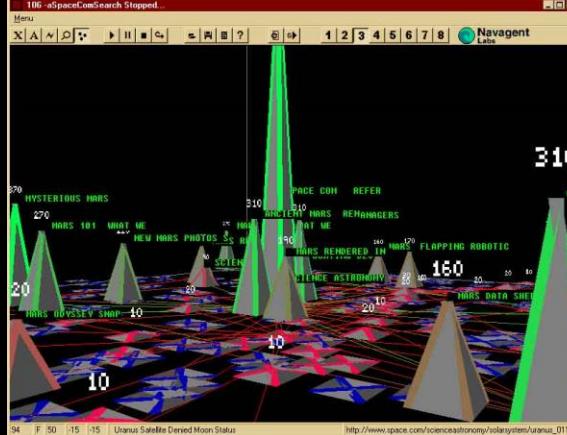
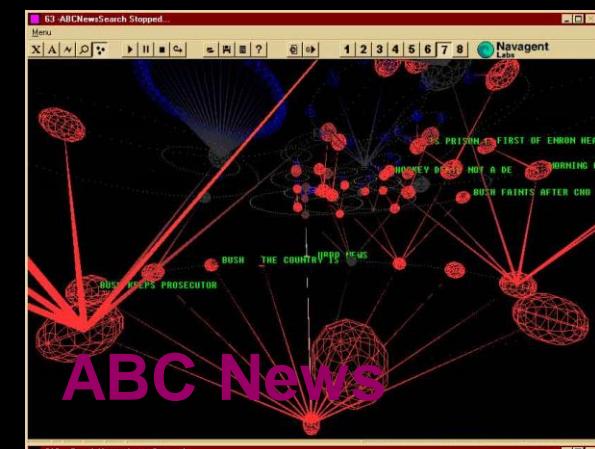
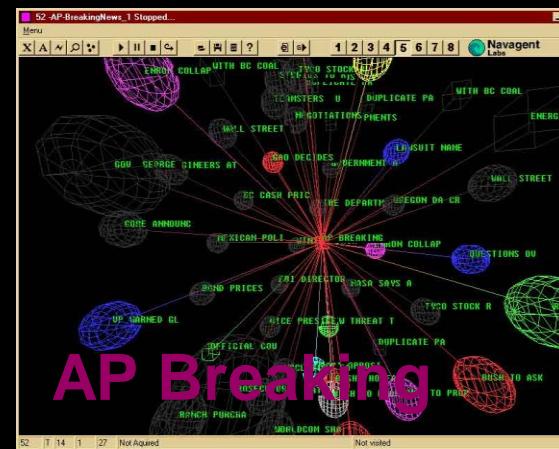


Contextual Cognition of Emergent Trends and Event Clustering in Complex n-Dimensional Knowledge Domains

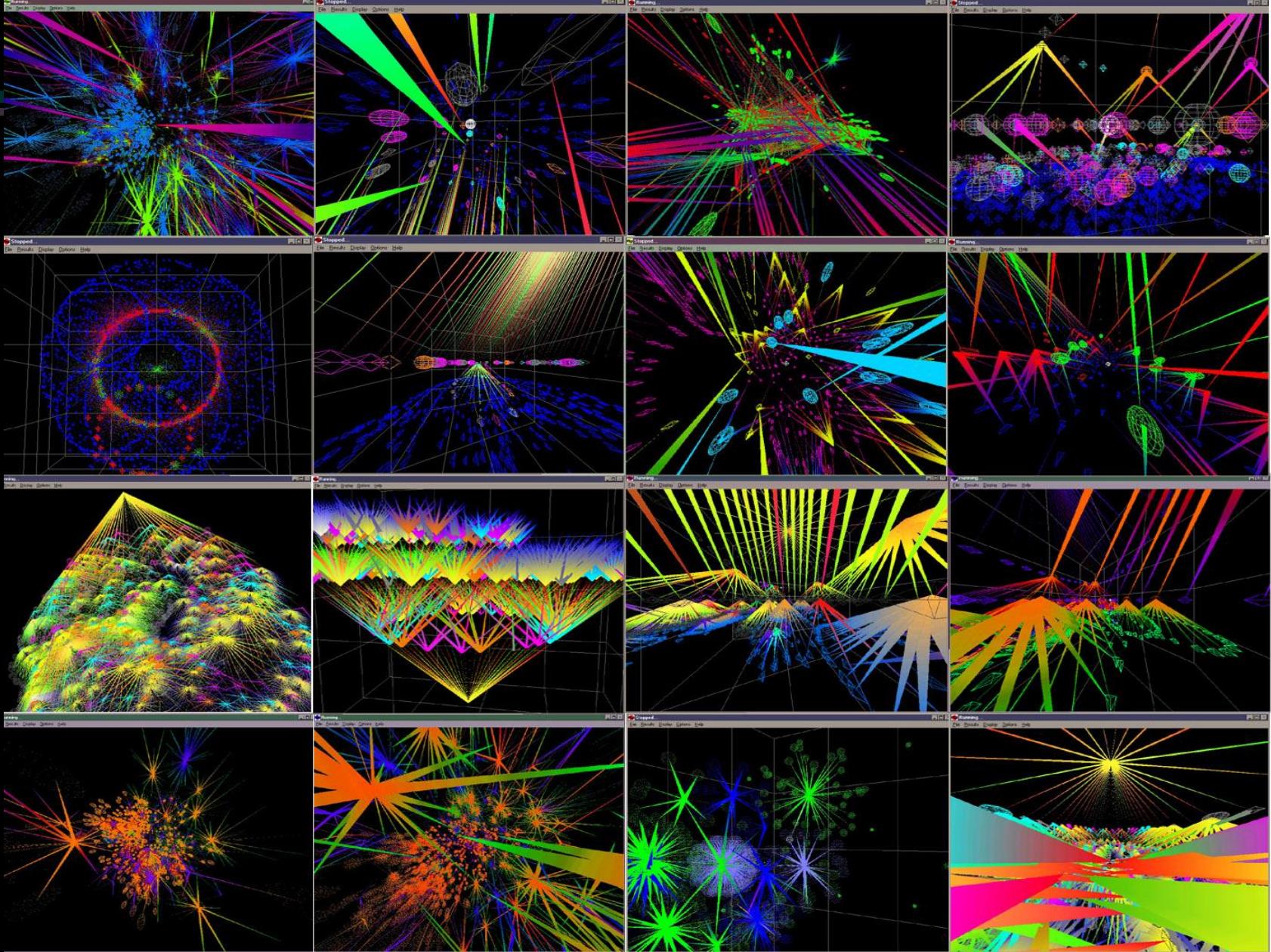




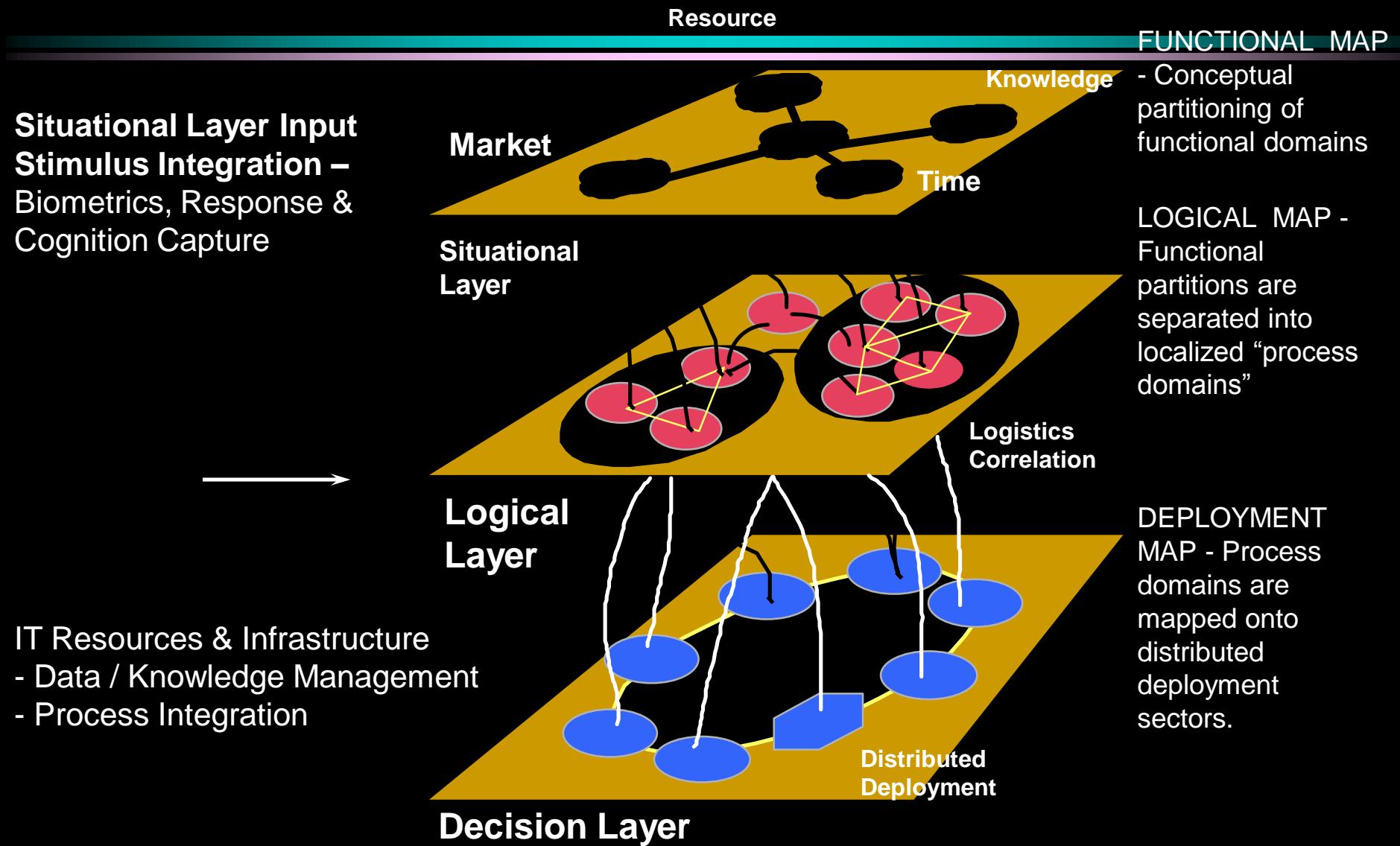
NAVAGENT



Contextual Cognition of Emergent Trends and Event Clustering in Complex n-Dimensional Knowledge Domains



Decision Rendering Process Map



Biological System Substrate Process Modalities - Evolution of the Human / Internet Symbiosis

Ubiquitous
Biometric Interface

Self Evolving
Knowledge Domains

Behavioral
Template Mapping

Content Definable
Functionality Mapping

Self Organizing
Networks

Content Addressable
Information Mapping

Process Elements of the Emergent Human / Internet Symbiosis

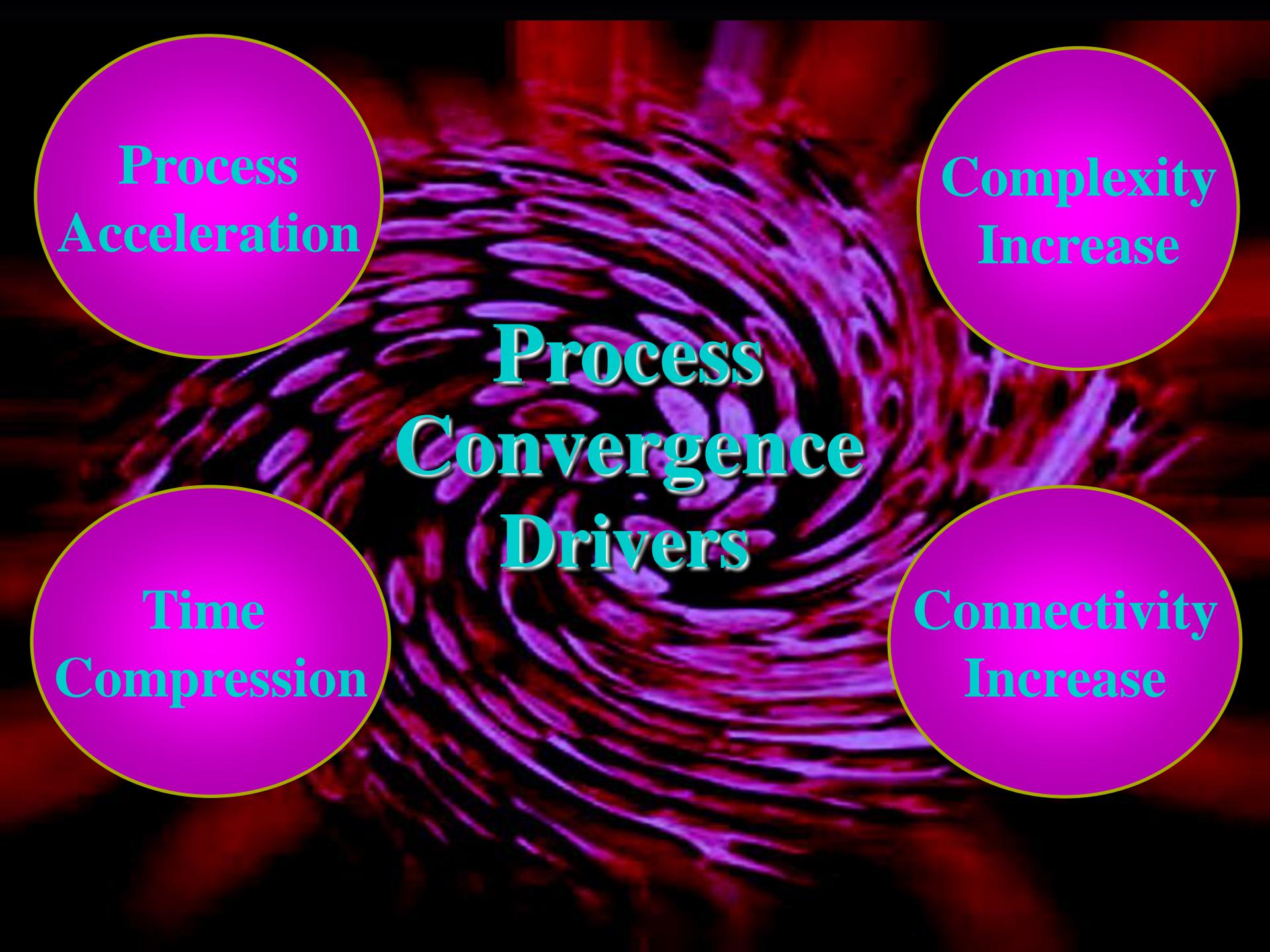
Internet as an Organism Threshold

Intelligent Agent Entities
Multi-Agent Colonies / Hierarchies
Self Organizing Knowledge Ontologies

Biological Metaphors in Computing
Self Organizing Routing Structures
Defensive Networks
Synthetic Sentience

Distributed Artificial Lifeforms
Collective Symbiotic Intelligence
Evolutionary / Genetic Computation

Realtime Tele-Existence Streaming
Psycho-ergonomic Interface
Biometric Transparency

The background of the slide features a dynamic, abstract pattern of red and purple lines that swirl and converge, creating a sense of motion and complexity.

Process
Acceleration

Complexity
Increase

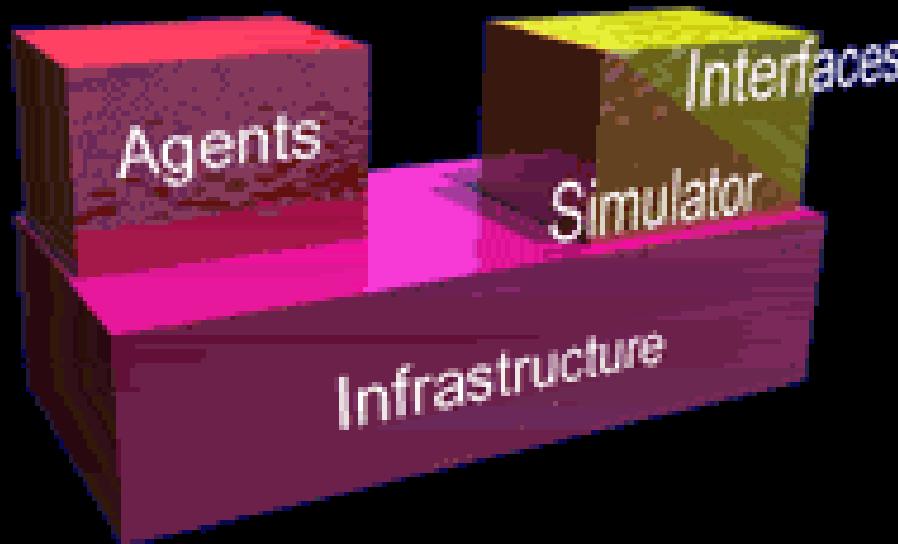
Time
Compression

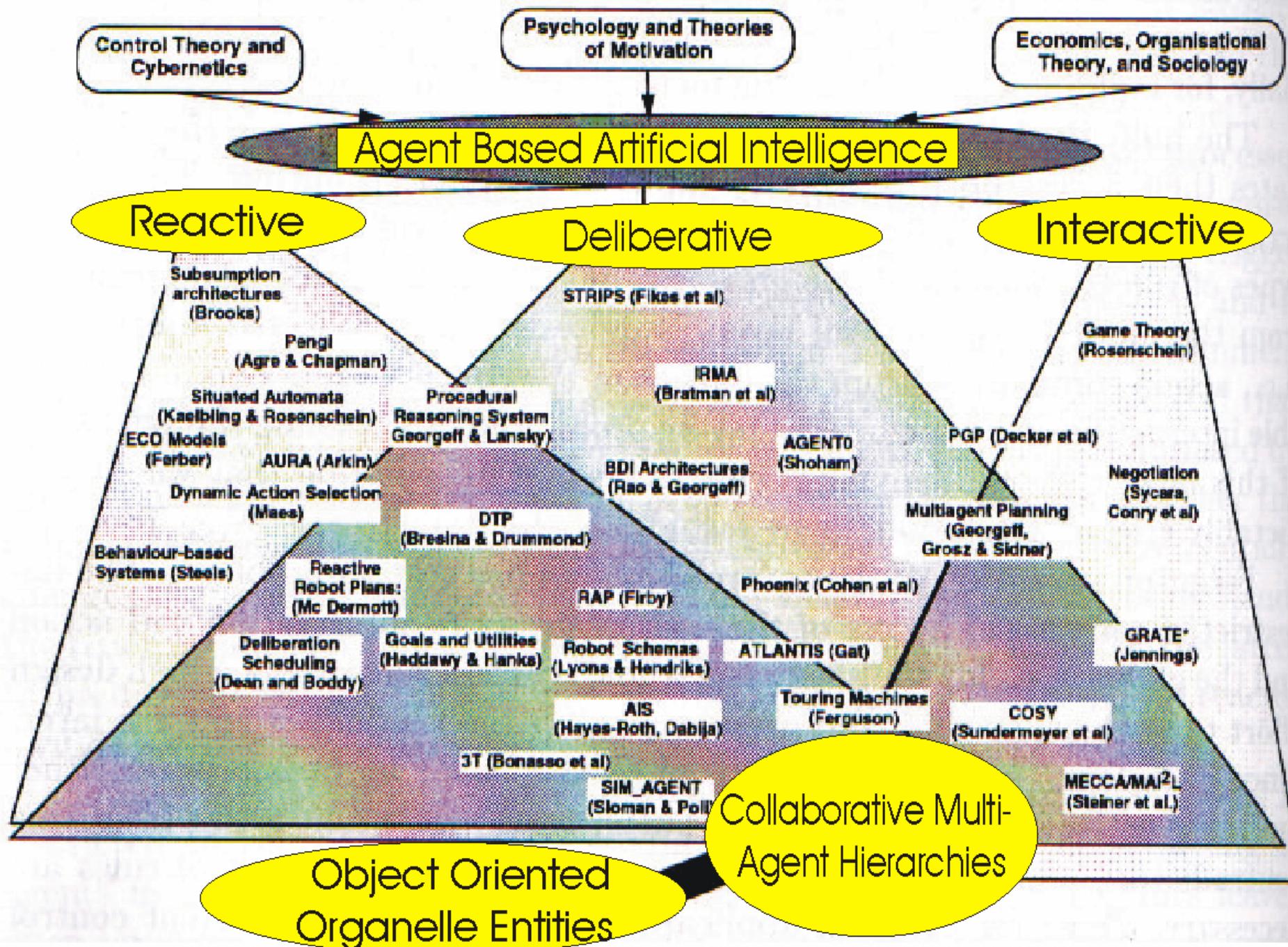
Process Convergence Drivers

Connectivity
Increase

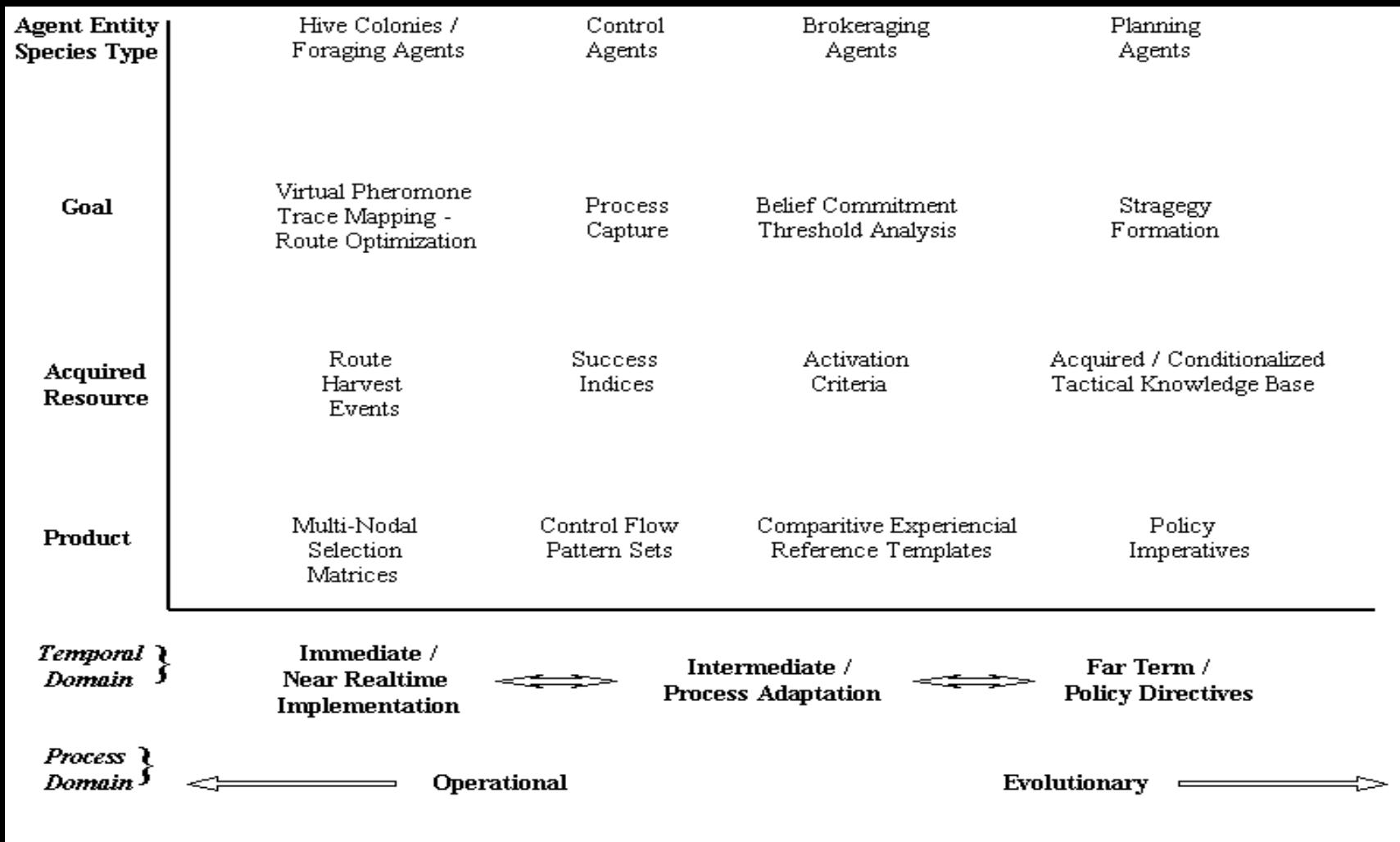
Agents and Agent Ecologies

- Information / Knowledge Processing Agents
- Negotiation / Brokeraging Agents
- Decision Rendering Agent Systems





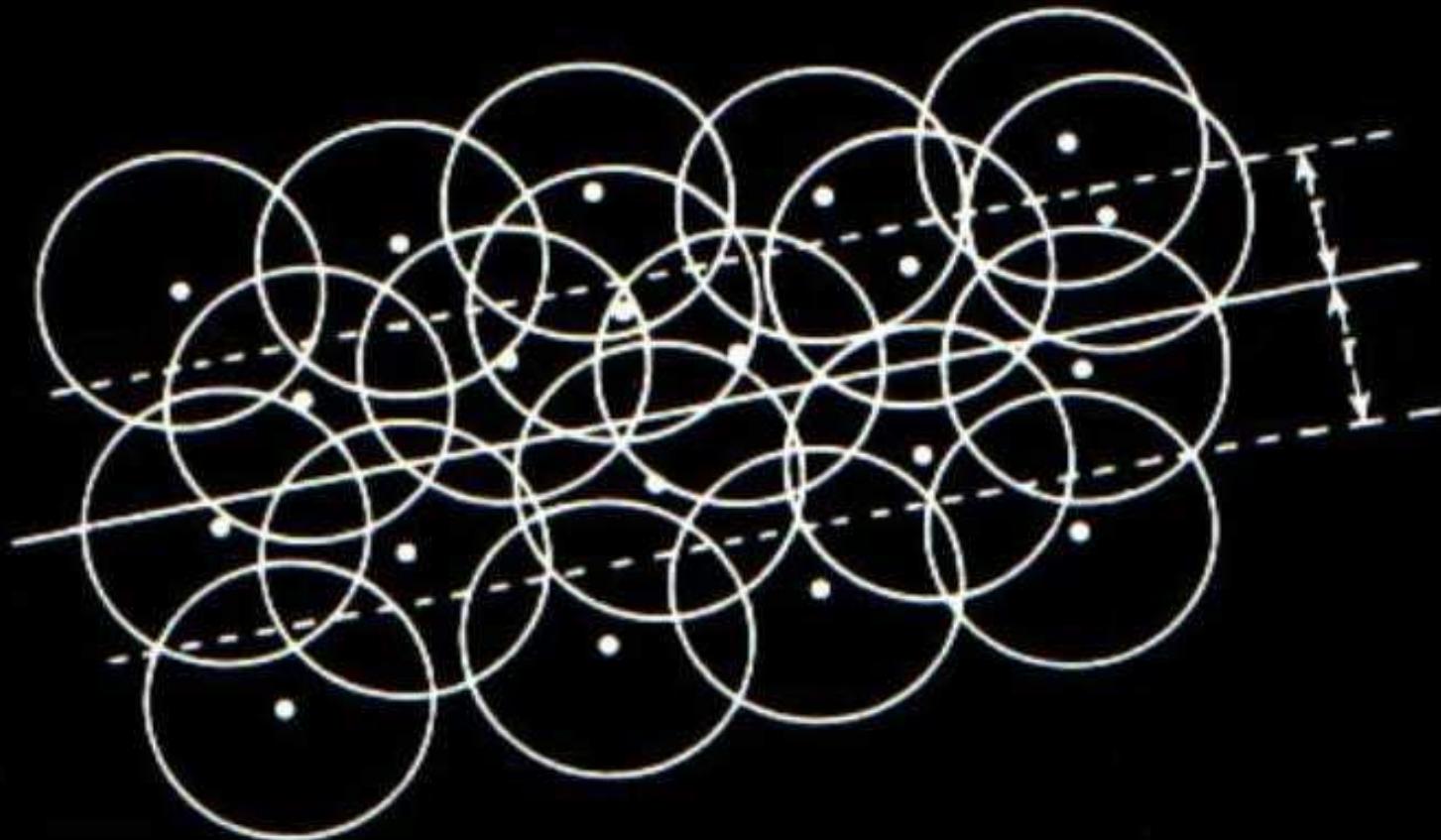
Autonomous Agent Hierarchy - Collective Organism Entity



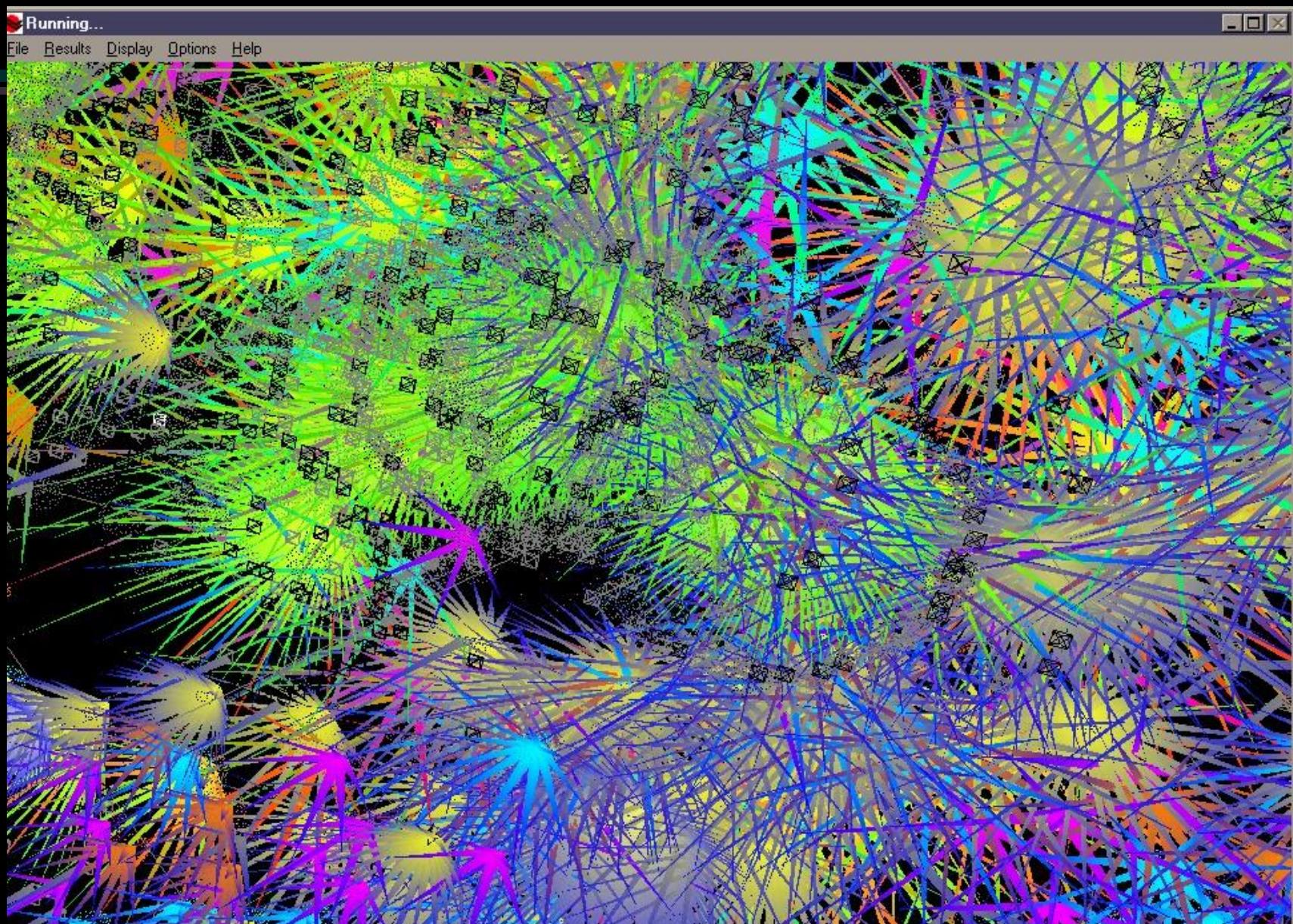
Evolutionary Belief Drivers – Trauma Constraints vs. Reward Catalysts



Content Dependant Process Routing – Knowledge Domain Proximity Epicenters



Contextual Cognition of Emergent Trends and Event Clustering in Complex n-Dimensional Knowledge Domains

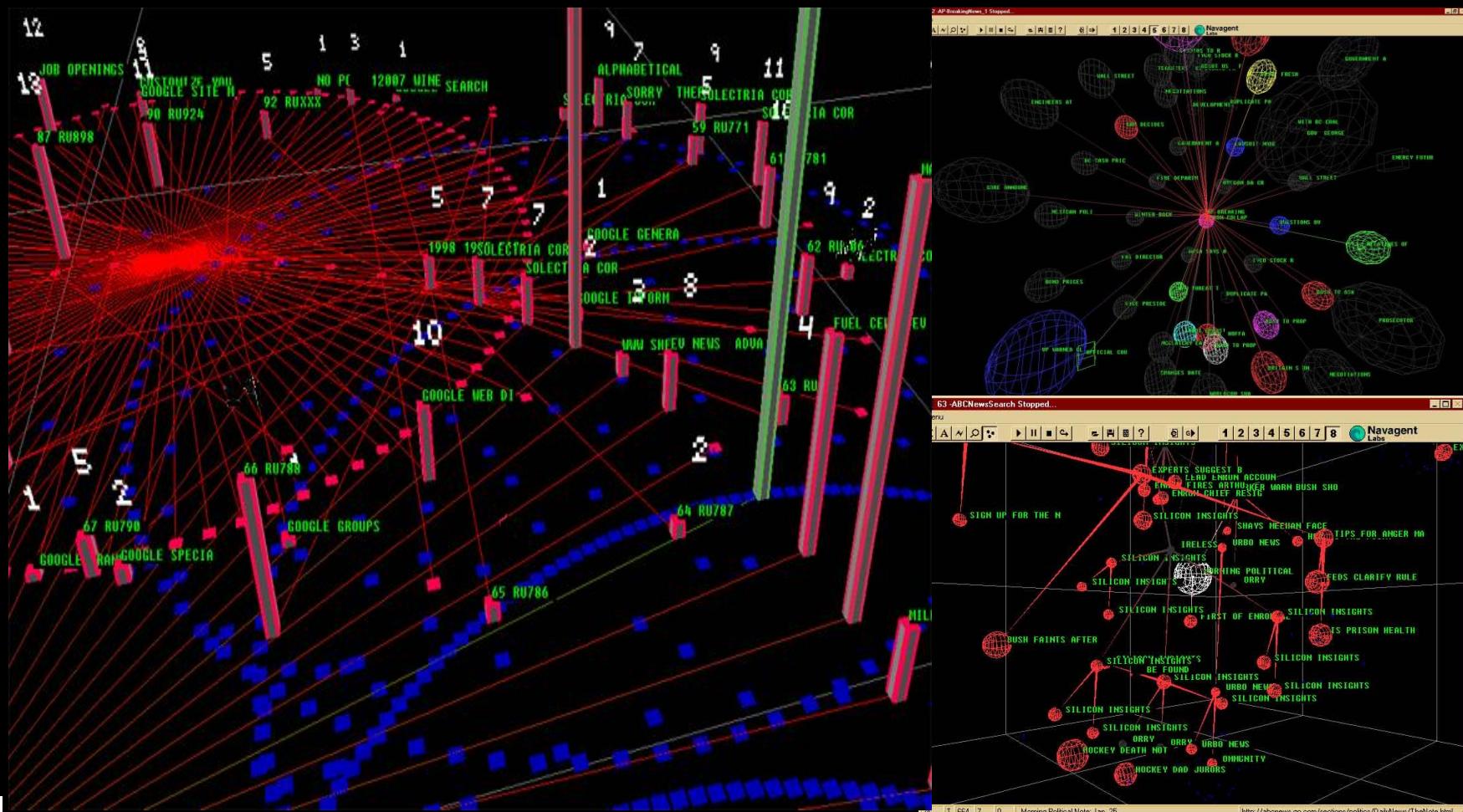


SearchOPS N-Viz Display Analysis Suite

Intuitive spatial networks

Qualitative spatial browsing

Quantitative spatial information



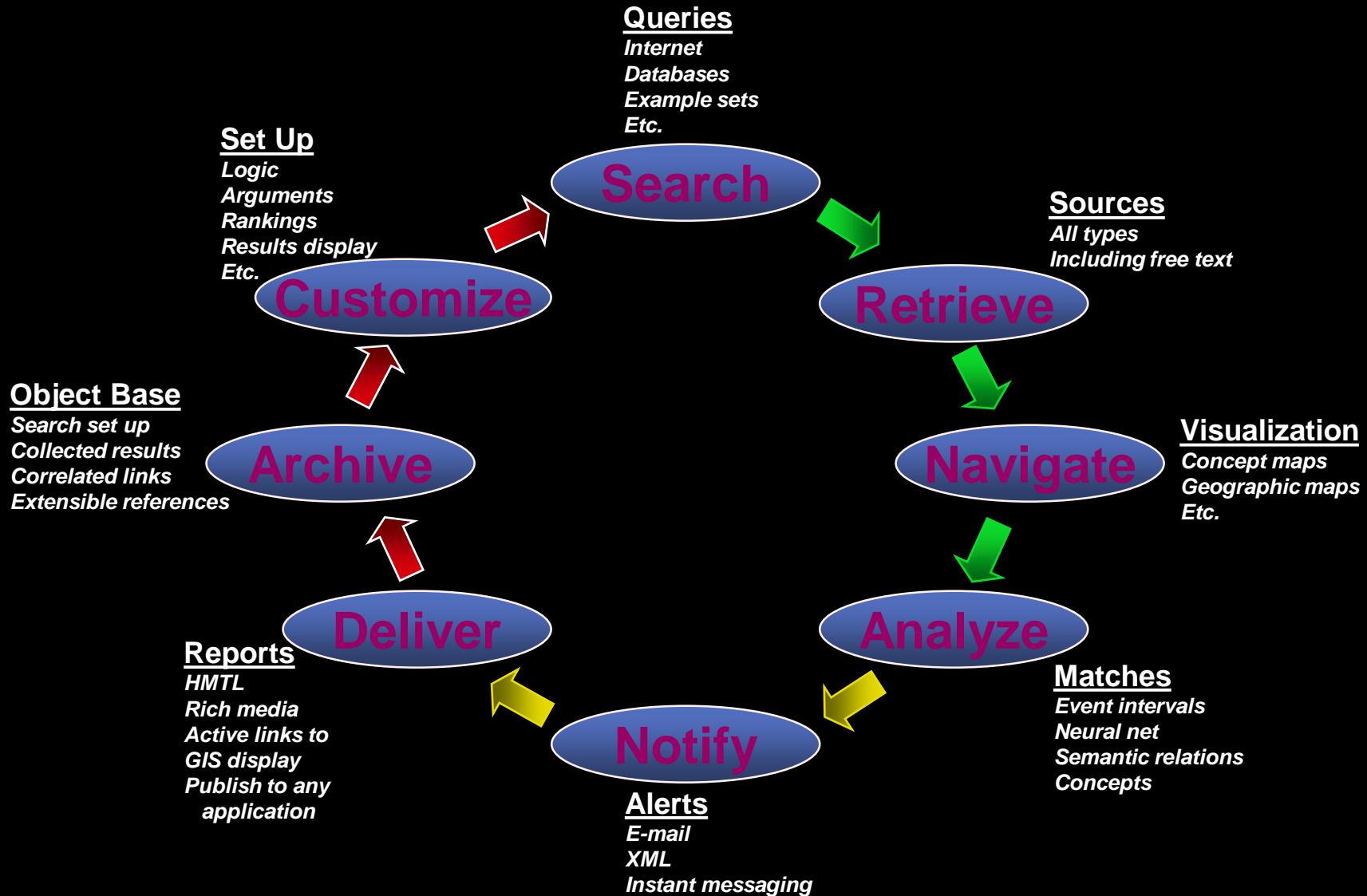


The Real Time Mission Critical Visual Data Mining Loop

- Current Open-source Information Gathering:
 - Very time intensive
 - Steep learning curve with certain tools
 - Cannot use classified system
- Current system difficulties:
 - Correlating classified and open-source data
 - Using incompatible databases from various agencies
 - Handling disparate data types
 - Databasing free text information
 - Quickly producing new, ad hoc queries
 - Forwarding research to deployed forces
 - Generating queries from the field



SearchOps Process





SearchOPS OSINT OODA Mining

OBSERVE

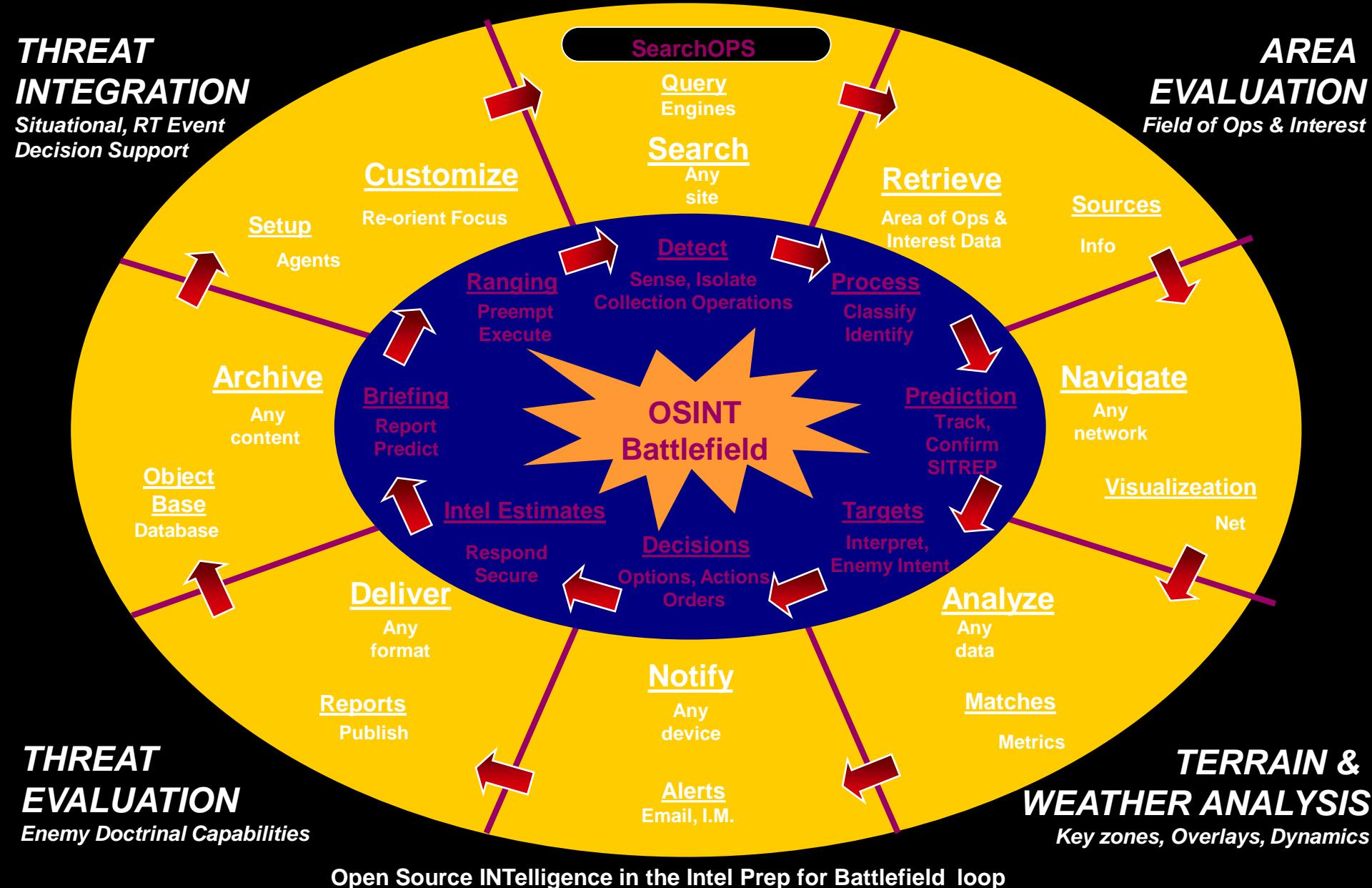
ORIENT



Open Source Intelligence in the Observe > Orient > Decide > Act loop



SearchOPS OSINT IPB Mining





SearchOPS OSINT Terror Cell CAPP Mining

PROFILE

Terrorist Affiliation
Datasets

COLLECT

Terrorist Activity
Datasets

SearchOPS

Query
Engines

Search

Any site

Retrieve

Any
Data pattern type

Sources

Info

Customize

Any
focus

Setup

Agents

Archive

Any
content

Object Base

Database

Profile

T Affiliates

Interrogation

T Players



Confirm

T Capabilities

Trace

T Networks

Navigate

Any
network

Visualization

Net

Penetrate

T Engagements

Modus Op

T Strategies

Analyze

Any
data

Matches

Metrics

Deliver

Any
format

Notify

Notify

Any
device

Alerts

Email, I.M.

PENETRATE

Terrorist Resources
Datasets

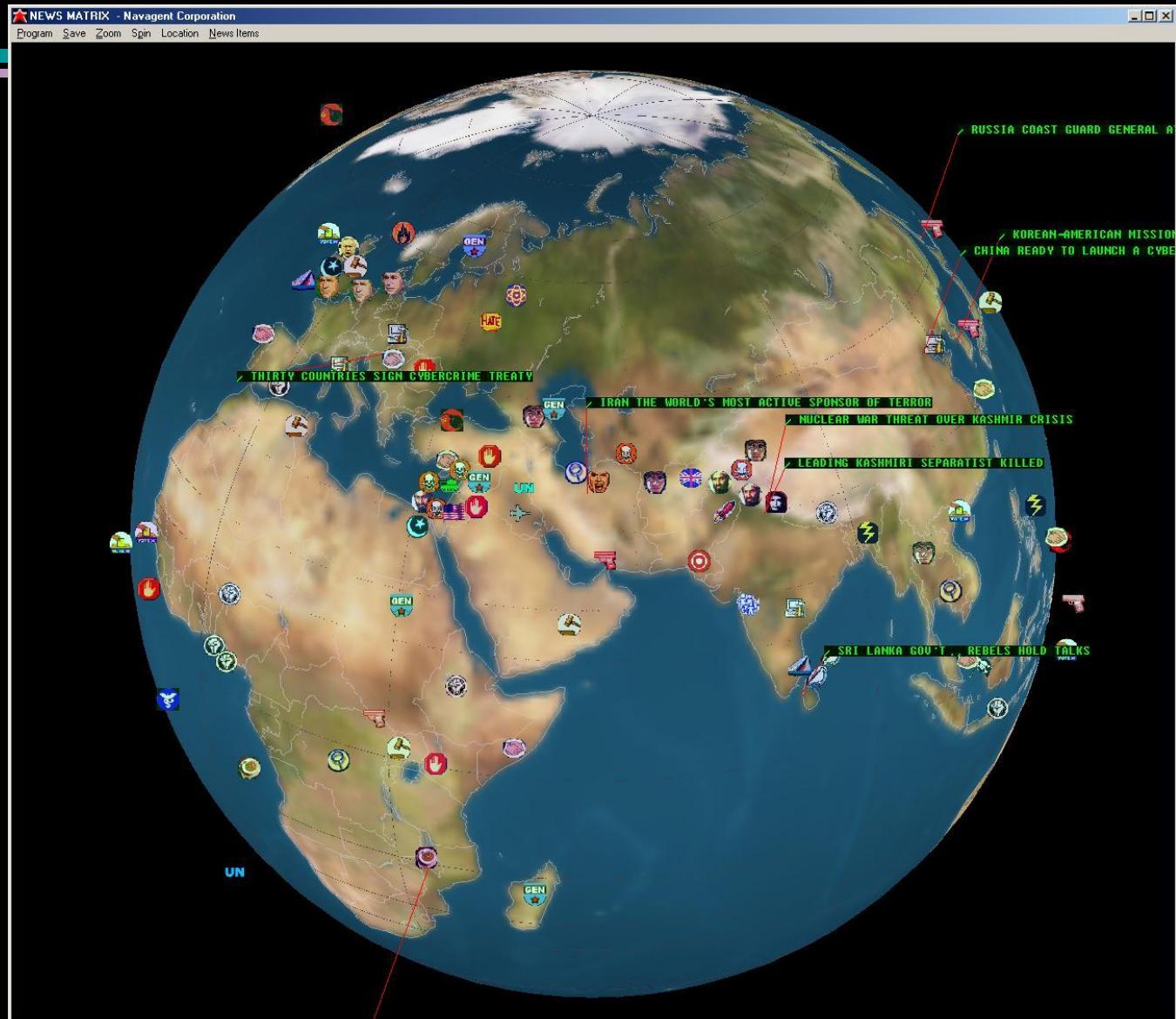
ANALYZE

Terrorist Intention
Datasets

Open Source INTelligence in the CAPP loop

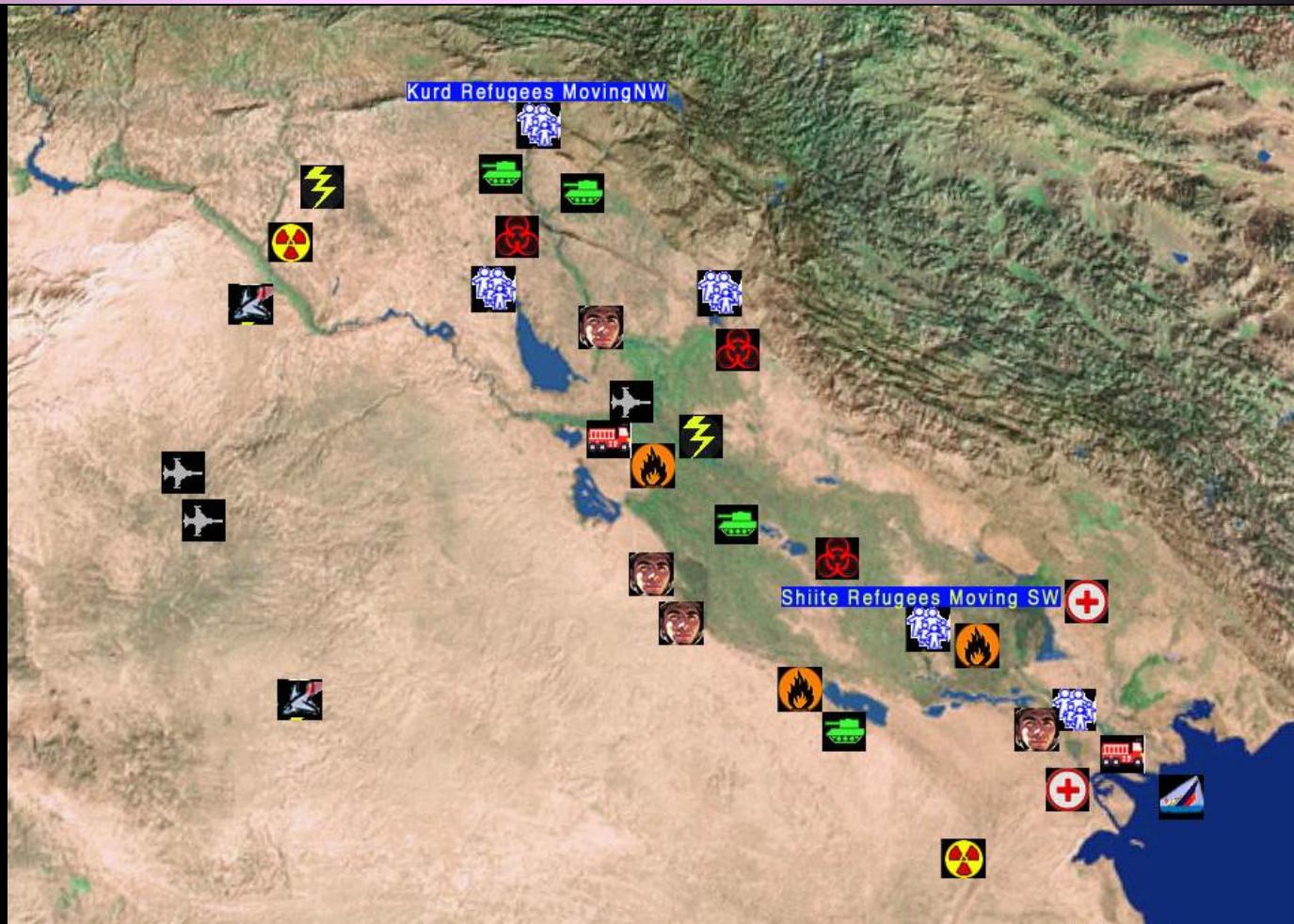
SearchOPS GeoBrowser

- Commander's page
 - Displayed in the GeoBrowser



SearchOPS GeoBrowser (2)

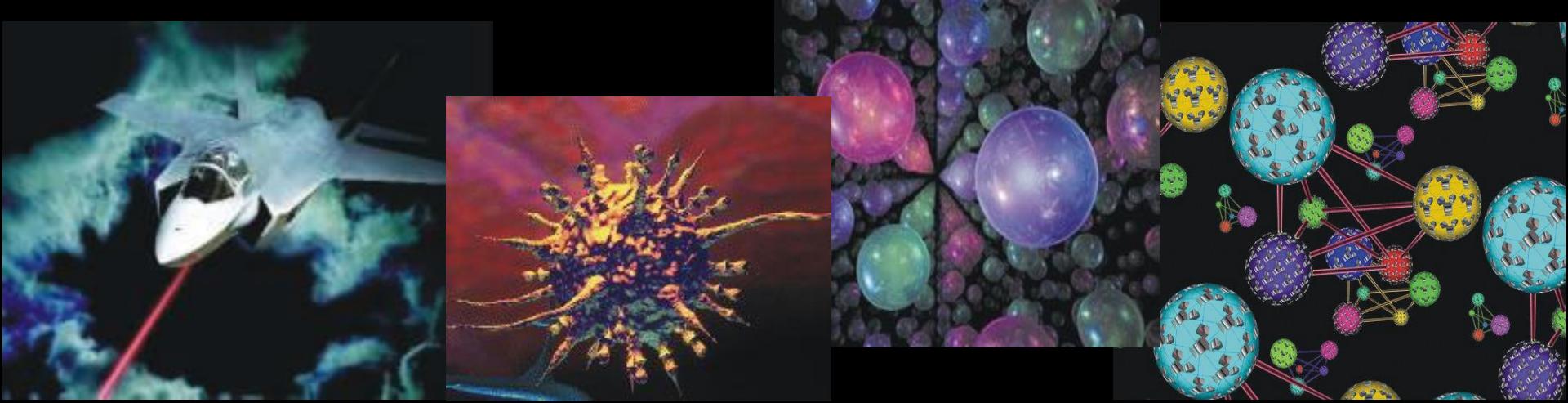
- Commander's page
- Closer view displayed
- Real-time zoom, pan, rotate, jump to ..



Nanotechnology in Defense

Future arenas of Advanced Materials, Integrated Systems, Adaptive Process Morphology

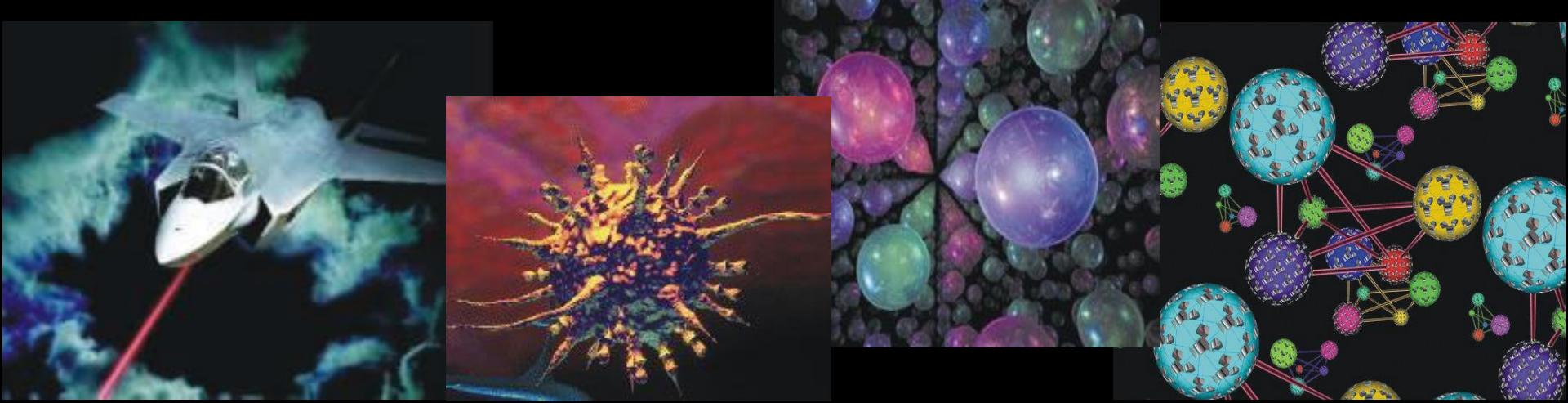
- Zero “time of flight” weaponry / laser, particle beam
- Alternative propulsion systems, microcavitation
- Micro-nano satellite “colonies”, autonomous vehicles, intelligent swarms
- “Smart” environments, distributed sensors, intelligences, artificial entities
- Integration of humans, autonomous intelligences, complex knowledge ontologies
- Self healing / self organizing adaptive systems, networks
- Anticipatory response to hyper-virulent, xenomorphic nano-organisms



Nanotechnology in Defense

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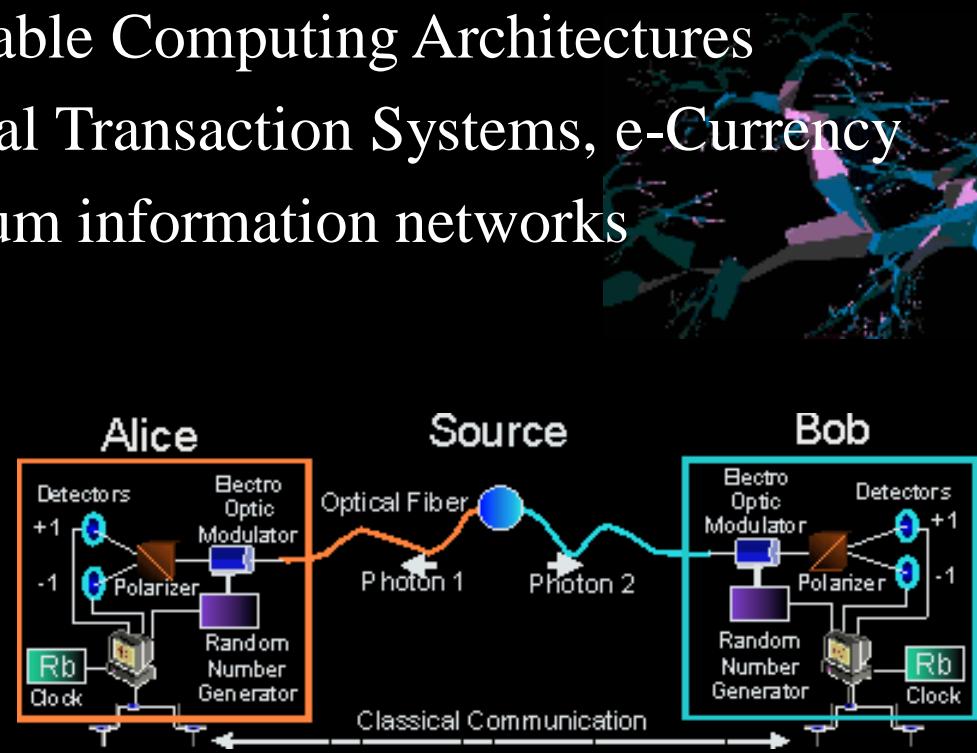
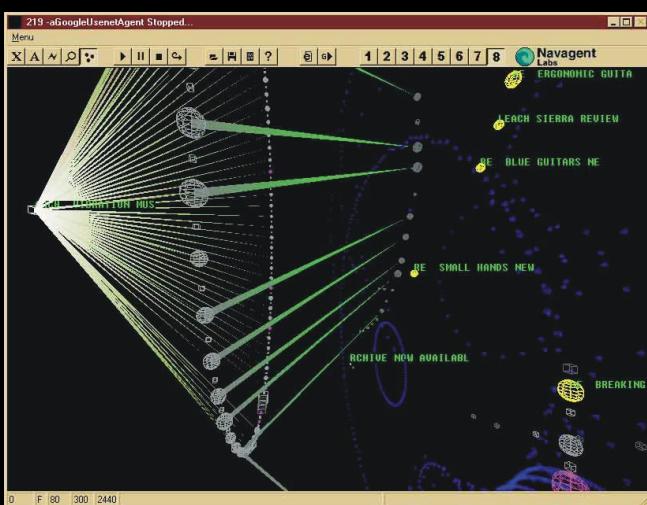
- Zero “time of flight” weaponry / laser, particle beam
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- “Smart” environments, distributed sensors, intelligences, artificial entities
- Integration of humans, autonomous intelligences, complex knowledge ontologies
- Self healing / self organizing adaptive systems, networks
- Anticipatory response to hyper-virulent, xenomorphic nano-organisms



Nanotechnology in Defense

Strategic Imperatives in the “Virtual” Battlefield

- Self healing network ecologies – Biological Metaphors in Computing
- Recon bots, defense bots, anticipatory autonomous “hunter/killer” bots
- Artificial life / immune systems / intelligences
- Next Generation Reconfigurable Computing Architectures
- Defensive Banking / Financial Transaction Systems, e-Currency
- Quantum encryption / quantum information networks





Grand Challenge



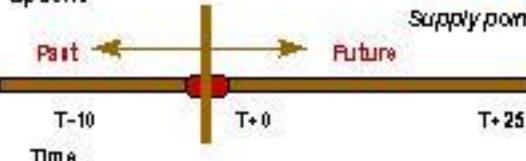
Automated Logistics Plan Creation



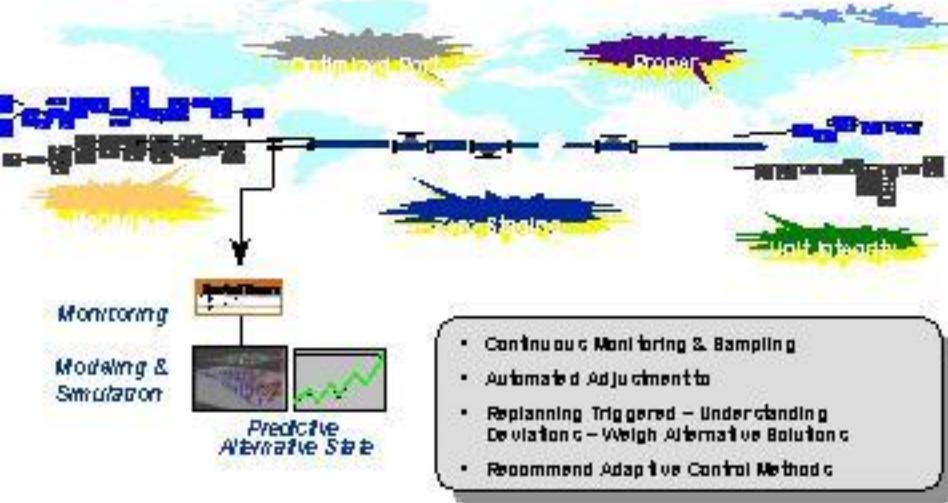
Real-time Logistics Situation Assessment

Advanced Situation Assessment

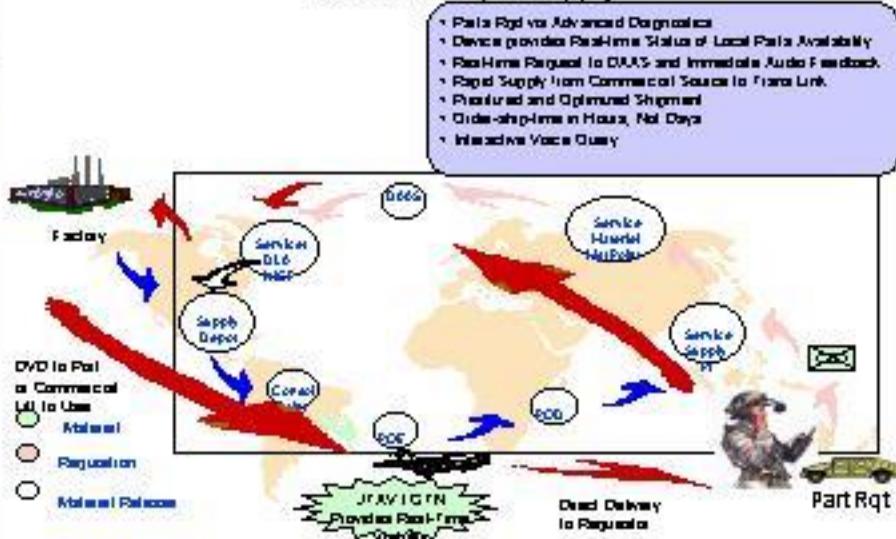
- Visualization and Data Manipulation Environments
- Automatic, Dynamic Graph Creation
- Automatic Explanations With Coordinated Text and Graphics
- Automatic Invocation of Models and Simulation
- Plan Sentinels and Automated Replan Options



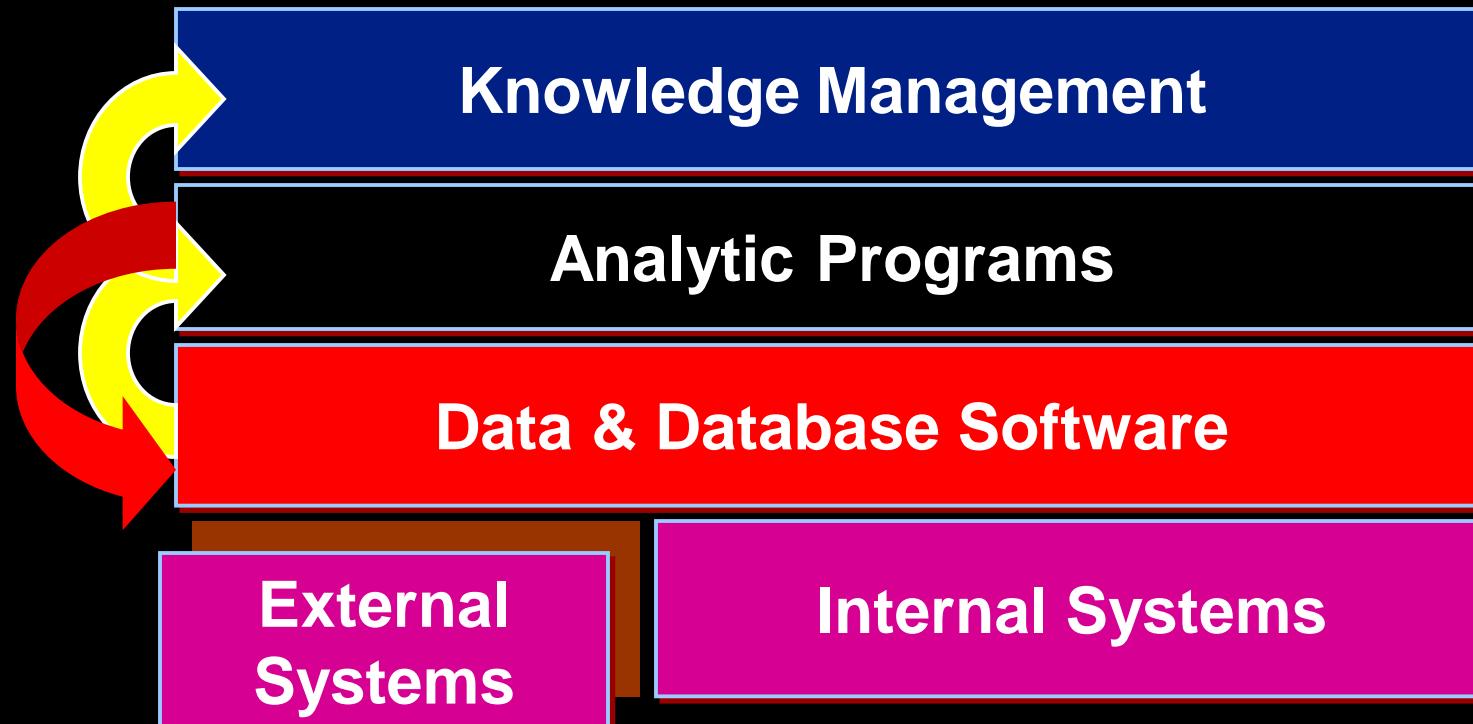
End-to-End Movement Control



End-to-End Rapid Supply



“Traditional” Corporate Data Environments



Process Convergence > Intuitive Systems

Epicenter of Intelligence – transition from Application to Content

- Traditional centralized intelligence enterprise applications –
 - > Enormous infrastructure cost and complexity
 - > Intelligence inherent in the application
 - > System integrity is highly brittle
 - > Content is dumb
- Distributed intelligence enterprise applications –
 - > Flexible, modular infrastructure elements
 - > Application is not the epicenter of intelligence
 - > System integrity is adaptive
 - > Content is intelligent

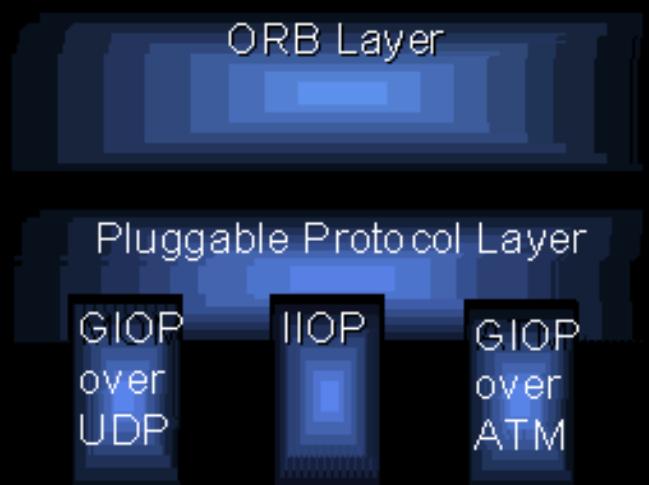
Process Convergence > Intuitive Systems

Epicenter of **Security** – transition from Application to Content

- Traditional centralized intelligence enterprise applications –
 - > Enormous infrastructure cost and complexity
 - > **Security** inherent in the application
 - > System integrity is highly brittle
 - > Content is dumb
- Distributed intelligence enterprise applications –
 - > Flexible, modular infrastructure elements
 - > Application is not the epicenter of **security**
 - > System integrity is adaptive
 - > Content is intelligent

Distributed Persistent Objects

- Process Brokerage
- Distributed Intelligence Assets
- Transactional Systems Architectures



The Evolutionary Tree for Distributed Computing

Persistent Objects < > Evolving Architectures

• • •

Object Management Group - CORBA

IOP is the remote invocation protocol for CORBA.

Pros: CORBA is very robust and stable standard and is vendor neutral

Cons: Challenging to implement and high development cost

Microsoft -DCOM begat COM+, COM+ begat the .NET FRAMEWORK

Pros: Relatively easy to learn and implement

Cons: Restricted to Microsoft's products and not easily integrated to applications built on other platforms

Sun Microsystems -EJB and RMI

Pros: RMI and EJB are open standards built around the J2EE specification

Cons: EJB, despite vendor claims, is largely untested. It is not clear if it can fulfill its promise

The three main standards for distributed computing work relatively well within their specifications but do not offer much cross-platform/vendor integration. Enterprise Application Integration (EAI) is born to enable better cross-application connectivity.

Broadly Distributed Computing falls into two categories - Microsoft and Rest of the World! RMI interoperates with CORBA relatively easily; making this standard accessible for cross-vendor implementations.

There are two main modes of EAI - Remote Procedure Call (RPC) and Messaging.

RPC's are complex to implement across multiple applications. RPC's allows remote objects to be invoked as if it was a local one.

Messaging is a more feasible method for interoperating heterogeneous applications than RPCs. Messaging passes data between applications instead of remotely calling on objects.

Simple Object Access Protocol (SOAP) is introduced by Microsoft. SOAP is one of the **major cornerstones** for Web Services. SOAP is an XML/HTTP-based protocol for accessing services, objects and servers in a platform-independent manner.

SOAP is simply a communication protocol that COM(.NET) or CORBA objects can use to communicate. It can be said to replace DCOM and IIOP. It **DOES NOT** replace CORBA or .NET - this may change in the future. I will post an article on this in the near future - otherwise please see my seminar series on "The Future of Distributed Computing".

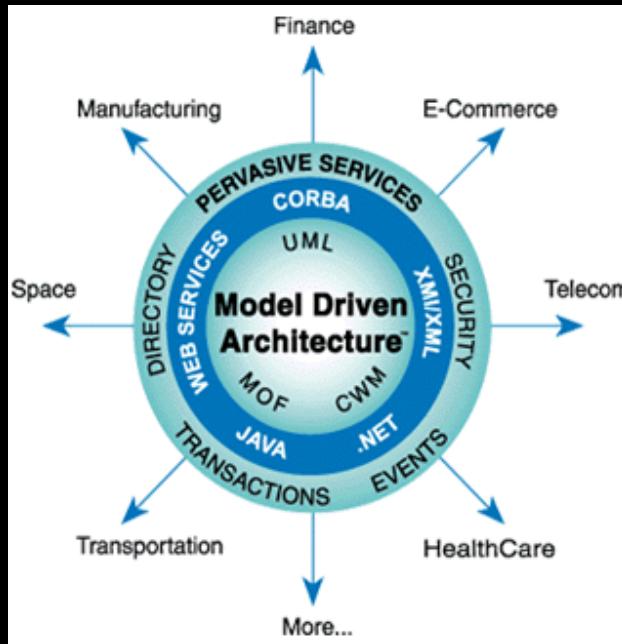
Side note: Many of you will have no doubt heard of XML-RPC. I term "XML-RPC to be a subset of SOAP".

Model Driven Architecture - MDA Background and History

MDA - Model Driven Architecture - supports the principled design, development, testing, provisioning, sustainment, evolution and lifecycle management of systems through a separation of concerns, including architecture from platform.

Standards developed, adopted and maintained by members of the Object Management Group (OMG) form the foundation of MDA.

The OMG is an open forum for revising, enhancing & extending MDA.



Fundamentally, MDA consists of specifications in the form of models.

Tooling developed by industry, government & academia embody MDA standards.

Methodologies and best practices prescribe how to use MDA.

The MDA Machine

A machine for the authoring, transformation and management of specifications.

Specifications may take the form of:

Models

Data

Code

Artifacts

Rose
UML

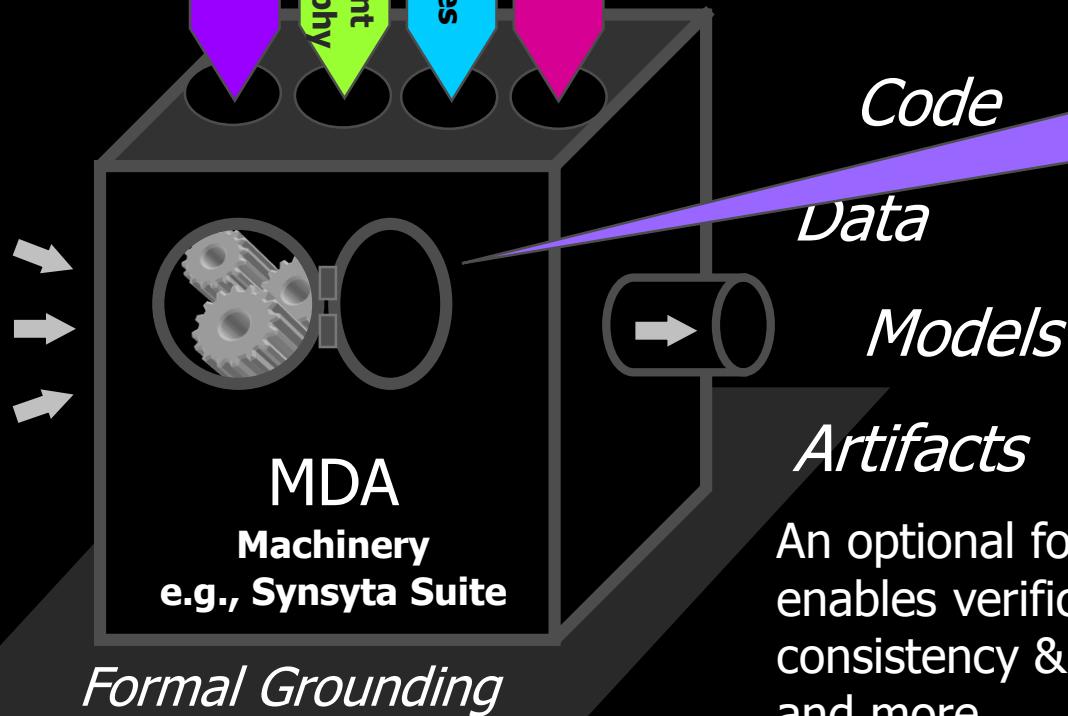
C-X
Component
Choreography

VOM
Ontologies

...

The machinery is neutral but polymorphic, configurable for numerous and diverse uses.

Let's take a look inside.



An optional formal grounding enables verification of consistency & correctness, and more.

Inside the Machine

Unified Modeling Language

MDA specifications are expressed in a language, e.g., UML.

Each language is specified by a metamodel, e.g., the UML metamodel, and supported by tooling that embodies the metamodel, e.g., a UML modeling environment.

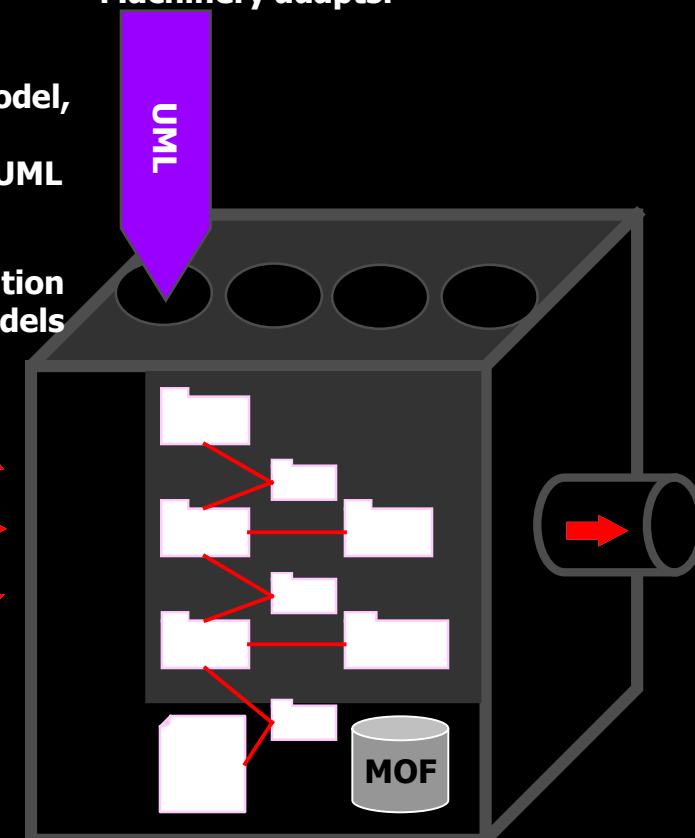
MDA machinery supports the creation and management of new metamodels in the same fashion it does models.

Specifications enter and exit MDA machinery via standardized mappings.
There are programmatic APIs, e.g., JMI - Java Metadata Interface, and also document-centric forms, e.g., XMI - XML Metadata Interchange.

Supporting a limitless array of languages is another way MDA Machinery adapts.

By treating computing, including software and hardware, as a system of interrelated specifications, MDA adapts to a wide spectrum of applications and architectural approaches with its principled machinery for authoring, transformation and management.

An MDA Pattern is the primary way of adapting MDA Machinery to a task.



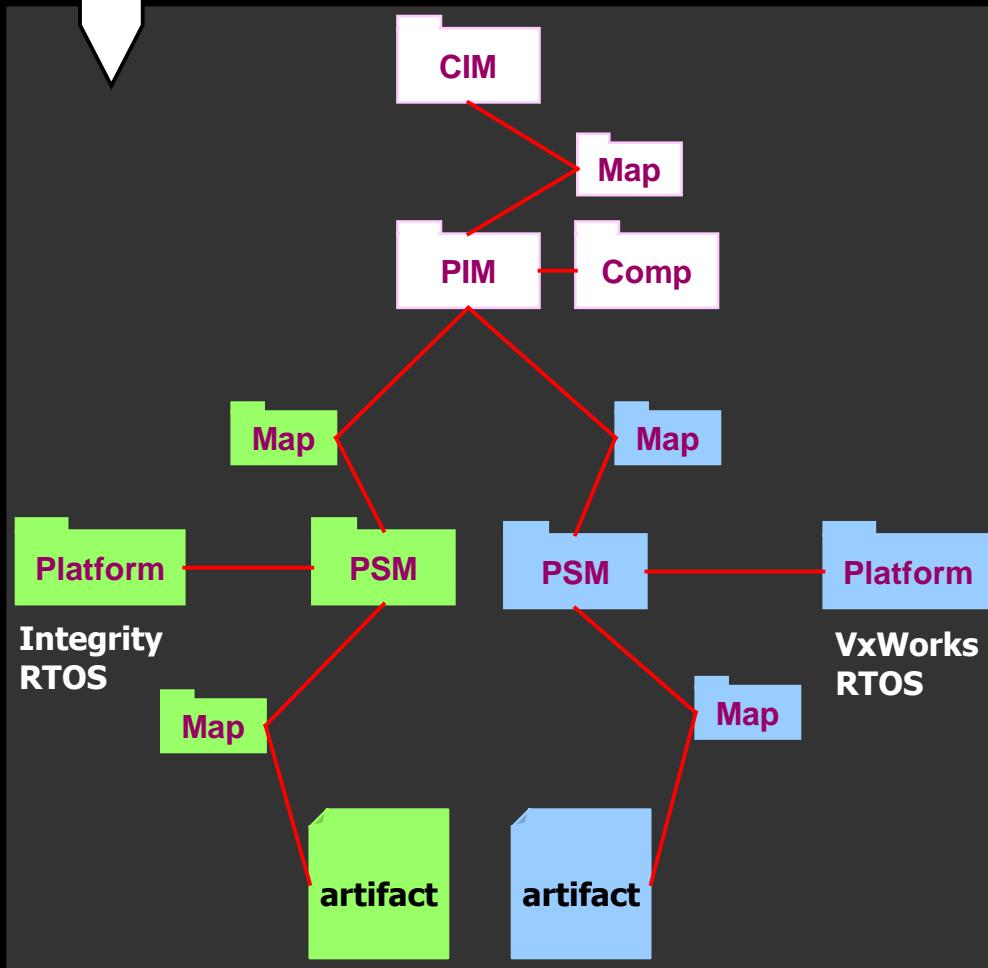
Each application and architectural approach may utilize one or more MDA patterns while an MDA pattern itself may reference or incorporate one or more other MDA patterns.

The MOF - Meta Object Facility - provides a principled means of defining metamodels and is the basis for model and metamodel repositories, i.e., how specifications are managed.

MDA Patterns

Portability

UML



A PIM may be mapped to multiple PSMs in order to target numerous platform targets or to port a system design from one platform to another.

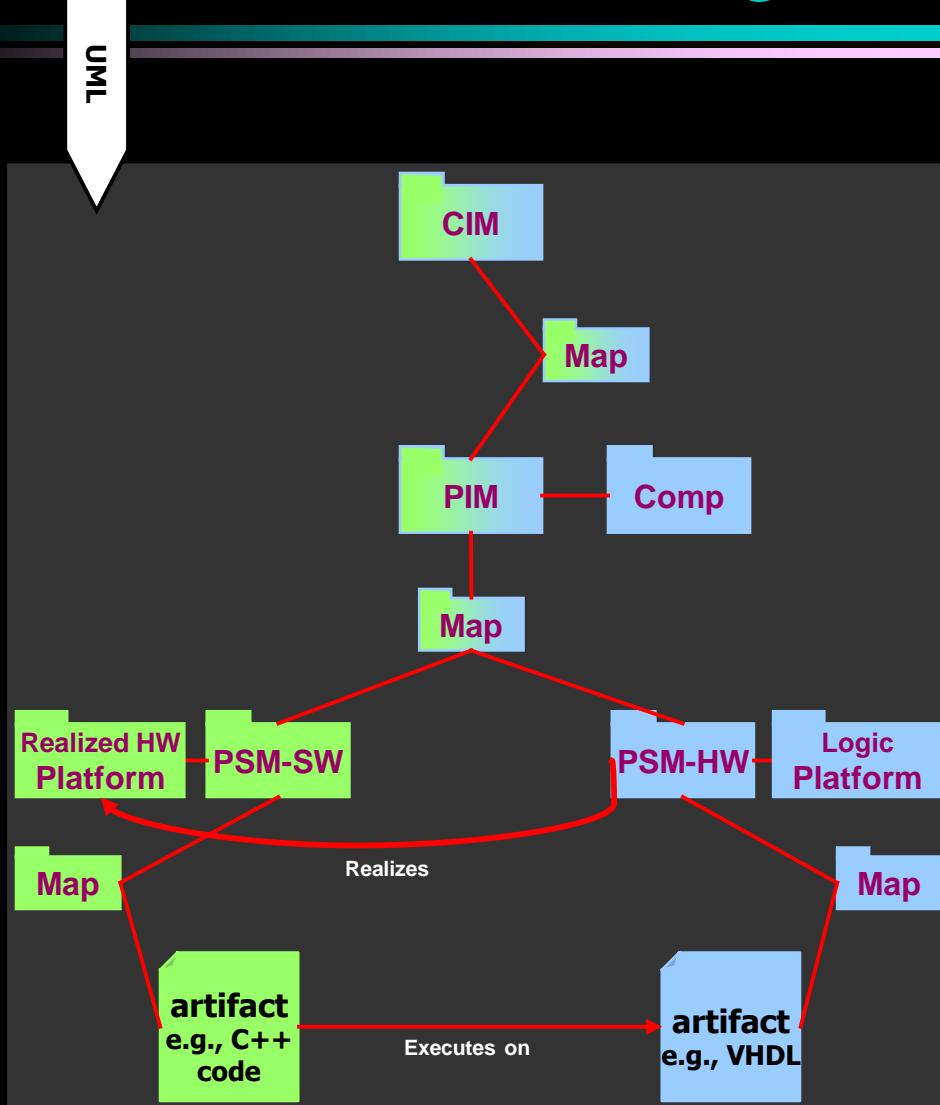
In the illustration we see that the Platform Independent Model of structure, function and behavior is mapped to two RTOS platforms, Integrity and VxWorks. This preserves the investment in system design, obviating the need to "start from scratch" or to extract requirements from a developed system in order to migrate to a new platform or support additional platforms.

This pattern is particularly valuable when a supported platform is versioned to a new release, an expected and repeating event, typically more frequent than wholesale platform swap-out.

A variant of the Portability pattern maps a CIM to multiple PIMs, enabling high-level requirements, objectives and constraints to be specified in terms of various computational models.

MDA Patterns

Codesign - Deferred SW/HW Split



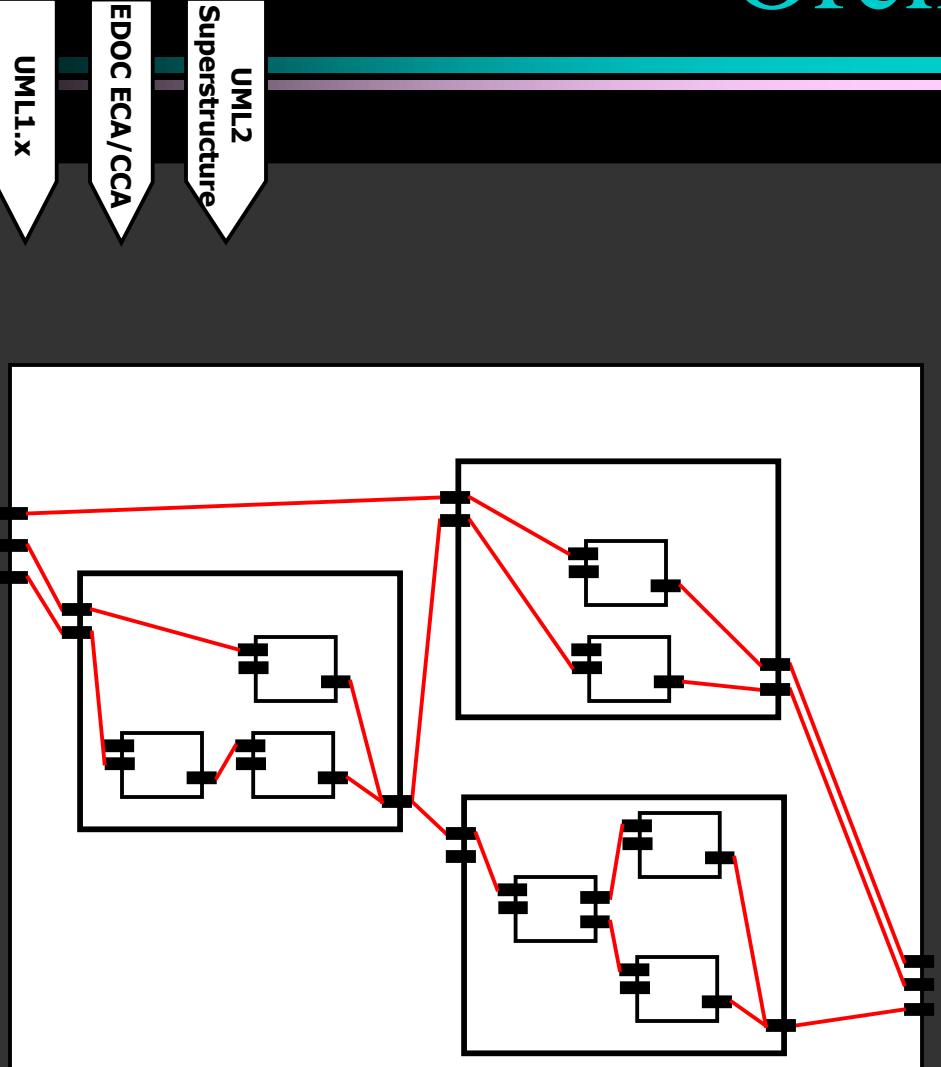
Codesign is a systems approach to the coordination of software with hardware. It supports two approaches to this end:

- The partitioning of functionality between software and hardware is deferred to an arbitrary point in the design process
- Software and hardware design are enabled to shape one another over the course of design

To the left we see an MDA pattern to support the former approach. Functionality for the system as a whole, software+hardware, is specified via a CIM and PIM. Codesign then extends the development via refinement pattern: the PIM to PSM mapping partitions functionality between two platforms:

- Functionality to be realized by, for example, a reconfigurable platform such as an FPGA, or specified via logic layout such as with VHDL. This PSM specifies how the gate logic platform is configured to realize a processor architecture.
- Functionality to be realized in software. This PSM specifies how software will realize an application when executed on the realized processor.

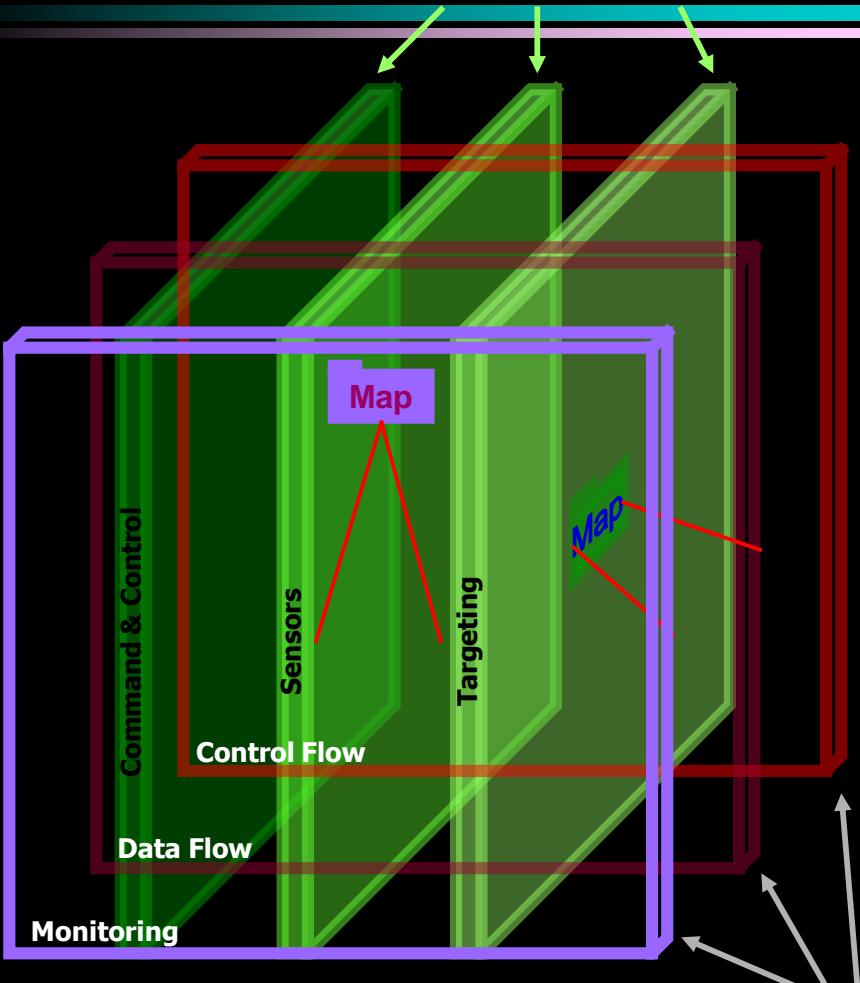
MDA Patterns Orchestration



MDA provides several approaches to orchestration; we examine the most powerful, called Enterprise Distributed Object Computing (EDOC). A language extension to UML 1.x and now incorporated in the UML2 Superstructure, EDOC provides the means to model platform independent components, where a component may represent a data element, an actual component, an operation, a process, ..., even an entire organization. One may also choreograph components with EDOC, treat a choreography as a component, and nest these to an arbitrary depth.

EDOC components and choreographies may be used at the PIM, PSM and potentially even the CIM level and applied together with collaboration/interaction and platform hierarchies patterns. Indeed, Orchestration may be employed to represent the structure of platform hierarchies and the interaction within and between their layers.

Patterns for Platform Hierarchies



MDA Patterns System of Systems

A System of Systems (SoS) involves both hierarchy, as with platform hierarchies and codesign, as well as collaborative/integrated relationships of peer, master, slave, intermediary, etc., as with distributed systems and applications. SoS is a product of multiple, interwoven MDA patterns.

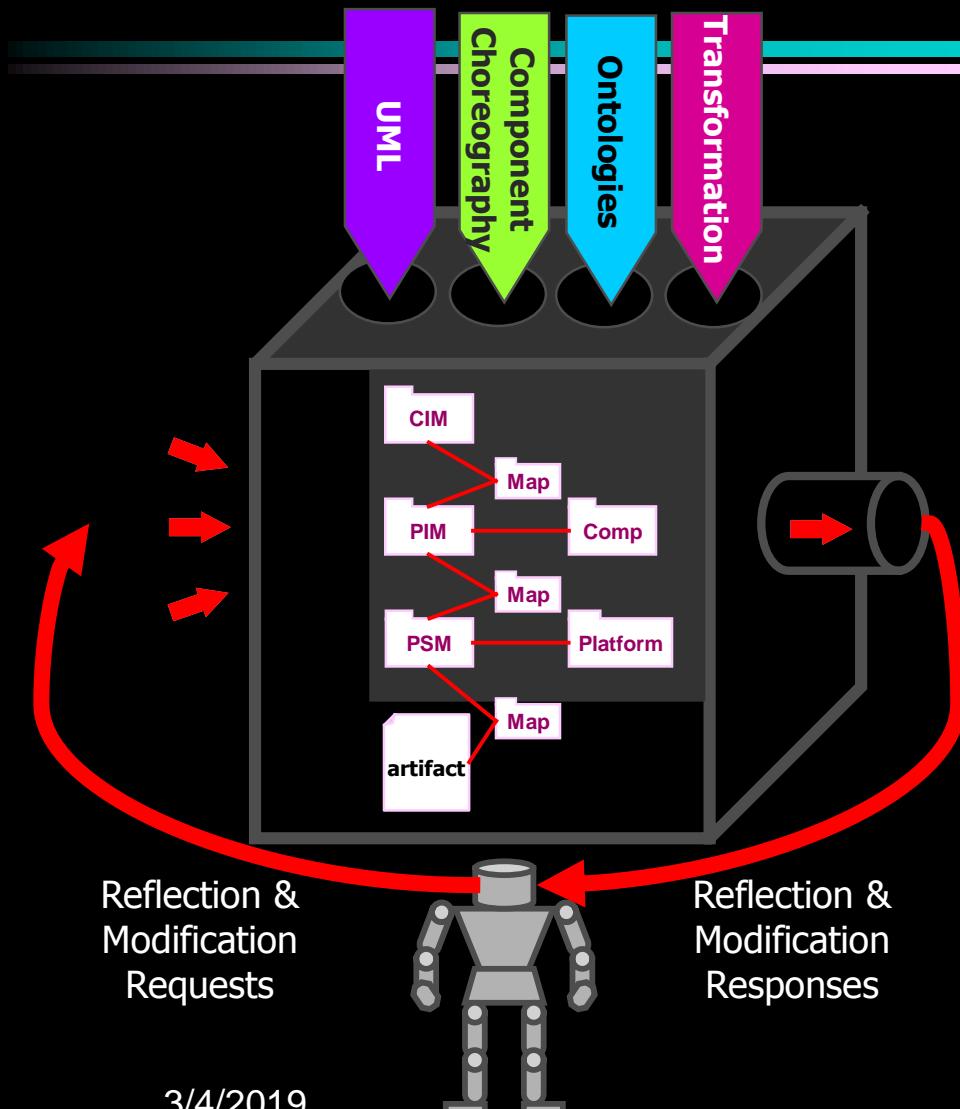
In the SoS pattern each hierarchy of systems is organized by a pattern discussed previously, such as platform hierarchy. These hierarchies, and the systems within, collaborate and integrate according to other patterns such as collaboration/integration, orchestration and transformation.

For example, the multiple hierarchies supporting command & control, sensors and targeting may be represented by the patterns laid out left to right while control flow, data flow and monitoring across these hierarchies may be represented by the patterns arranged front to back.

Mapping models present within patterns of collaborating systems interrelate the multiple hierarchies, establishing networks; maps present within patterns of hierarchies of systems interrelate multiple networks, across function and levels of organization.

MDA Patterns

Reflection & Metalevel Programming



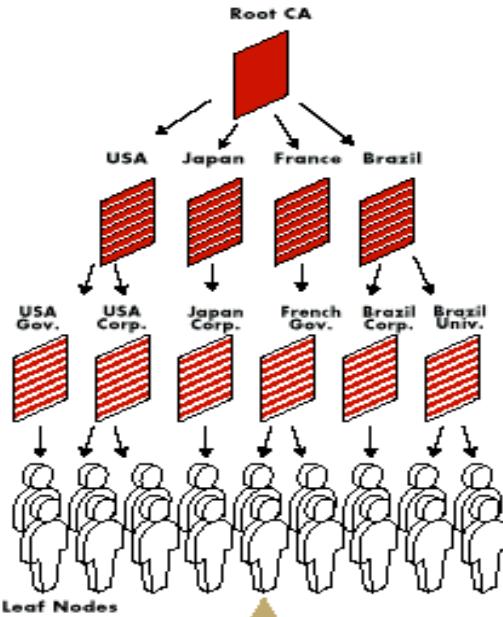
Artifacts produced by MDA machinery, e.g., generated code, can be enabled to access the MDA machinery at runtime by utilizing programmatic APIs, like JMI, CORBA and web services interfaces, and also via XMI document exchange.

This means that generated code may introspect and reflect on its own models and mappings, from platform specific to platform independent - where algorithms are represented, to computation independent where goals, requirements, policies, and constraints are declared. The code may even navigate metalevels so as to reflect upon the metamodels and meta metamodels on which it is founded.

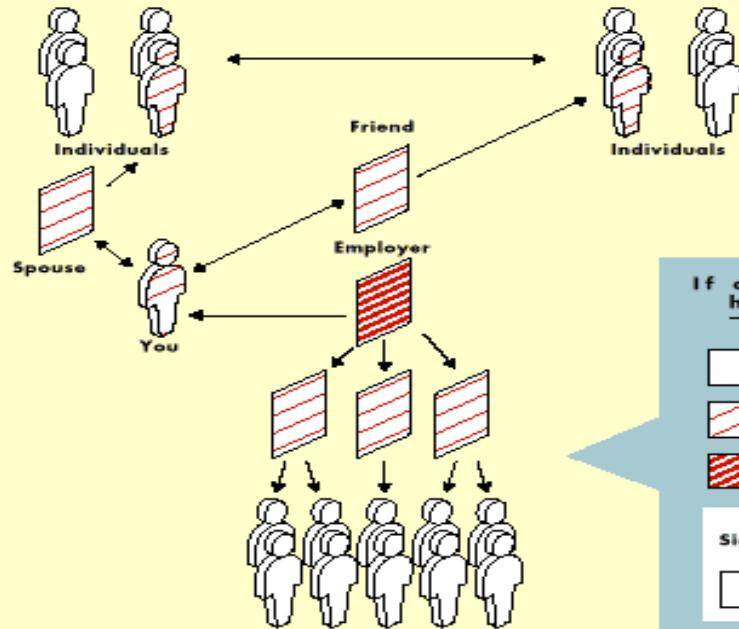
Passive introspection and reflection are just the beginning, however. The code may also modify any of the elements it reflects on, revise and extend these, and regenerate and reprovision its own code base, even at runtime via an online upgrade. This becomes the basis for systems that adapt and learn.

“Web of Trust” Modalities

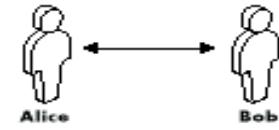
HIERARCHIAL



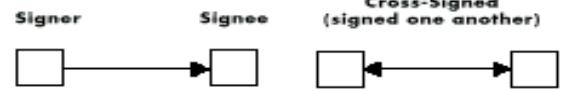
DISTRIBUTED
(Web of Trust)



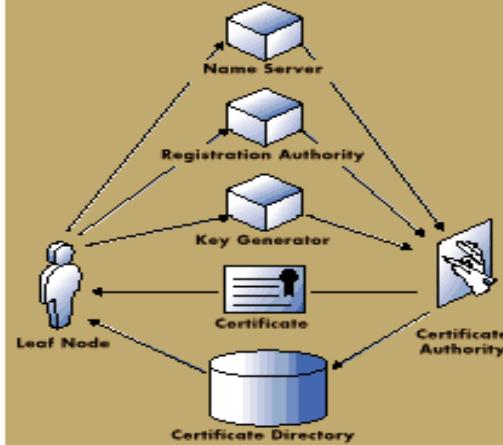
DIRECT
(Peer to peer)



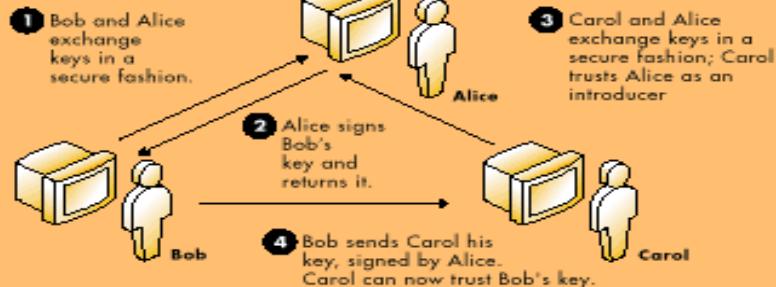
If certificate's key is compromised,
how many others does it affect



Third Party Services



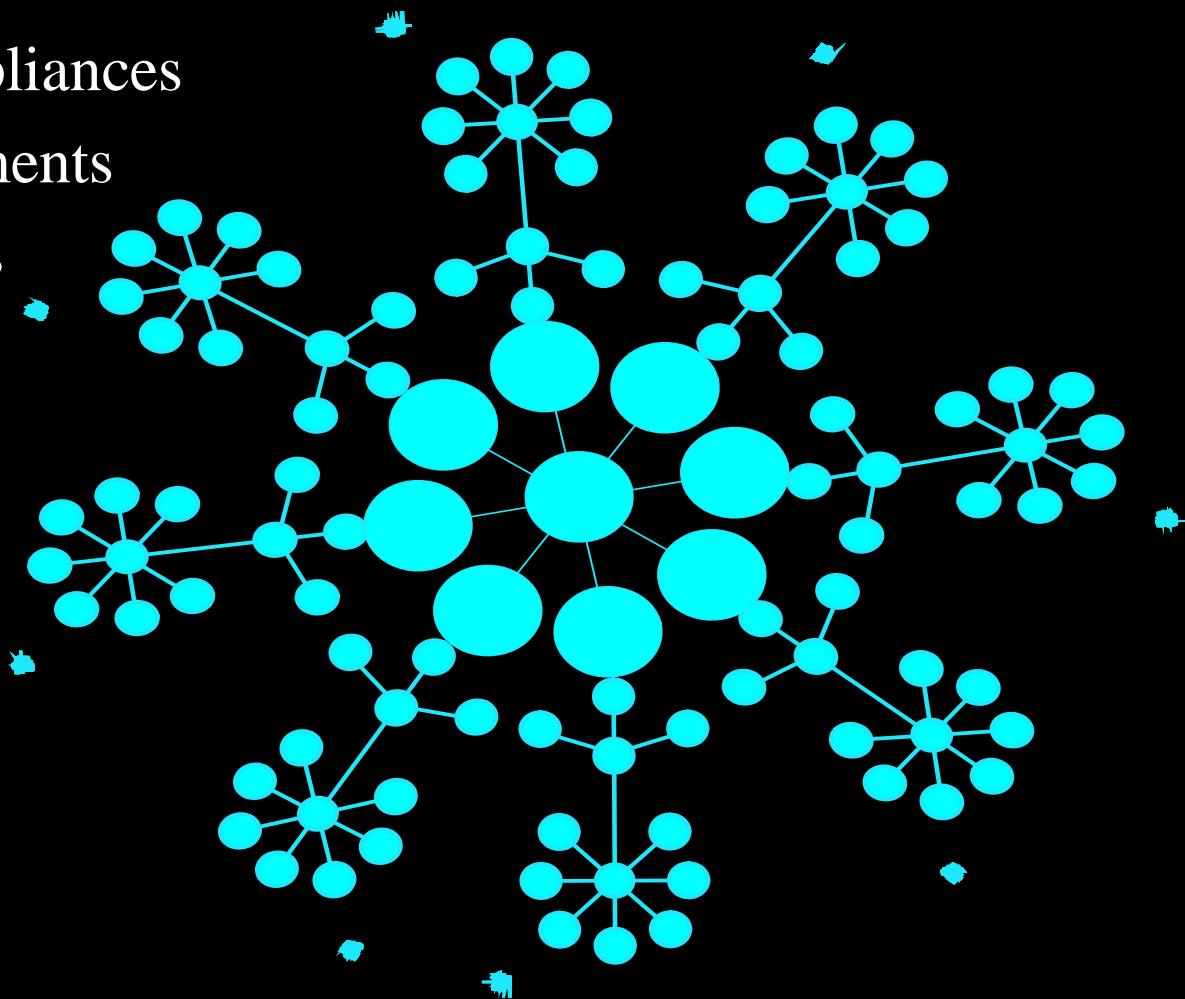
Basic Web of Trust (primitive)



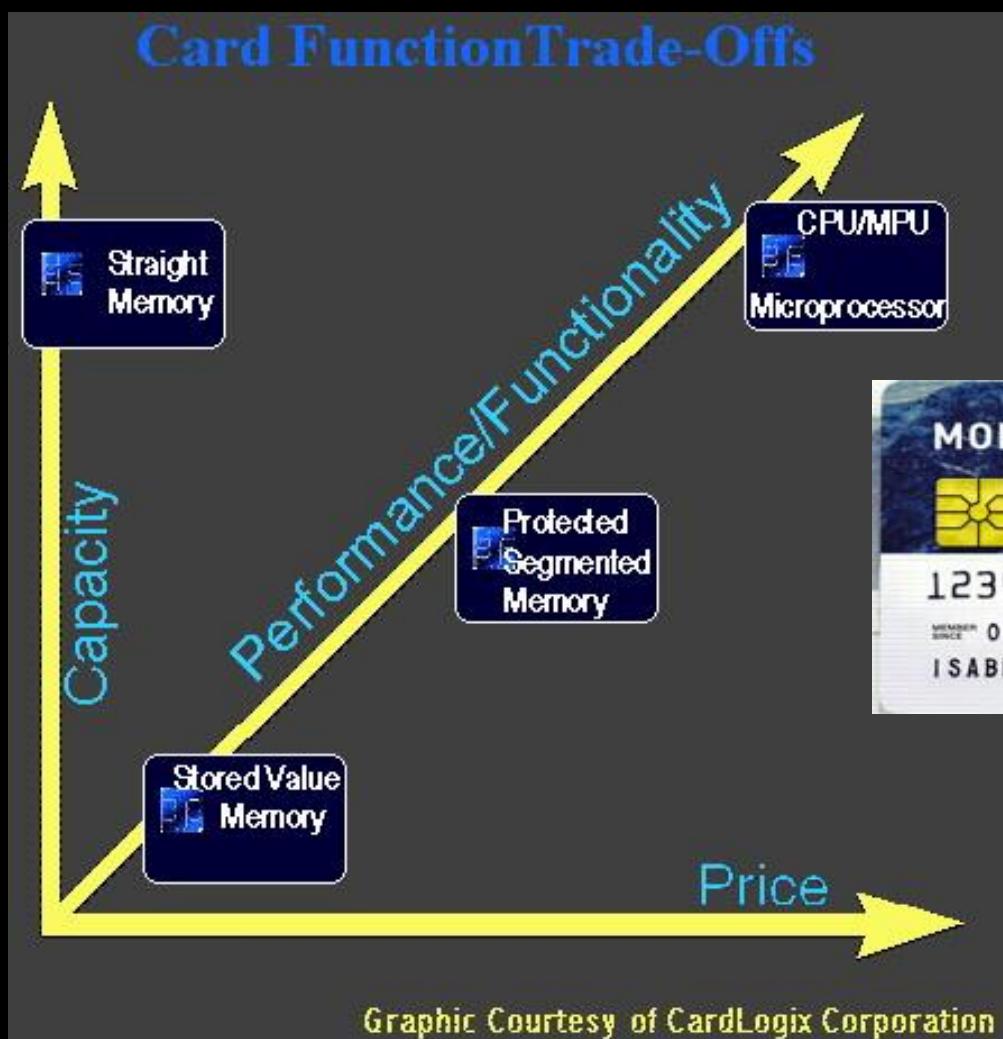
Conditionalized
Existence
Acceptance

The E-Commerce Operational Ecology

- Scalable Computing Fabrics and Networks
- Transactional Media Appliances
- Virtual Fiduciary Instruments
- Ubiquitous Portal Access



Embedded Intelligence – Protected Process Transaction Portals



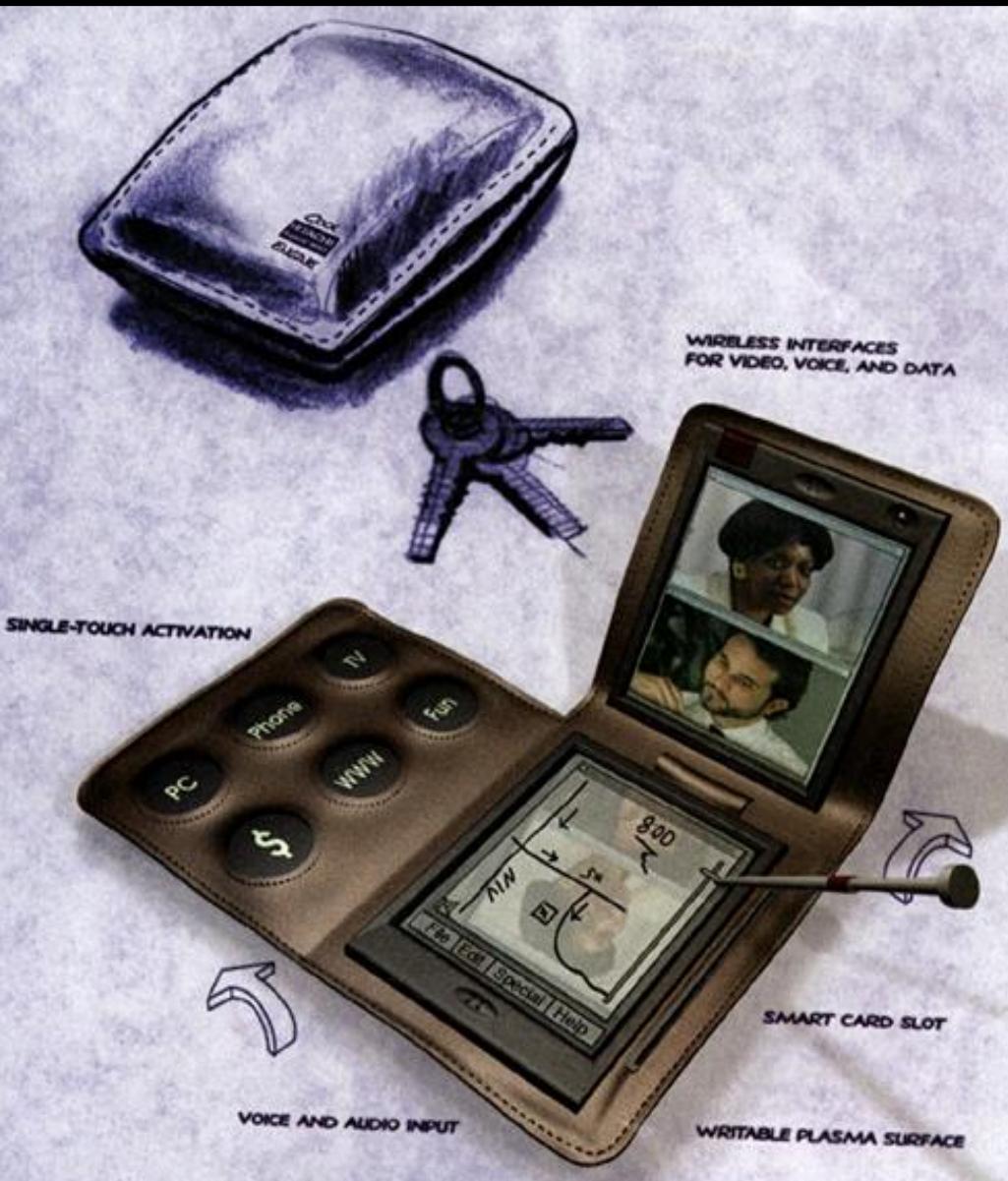
Embedded Intelligence – Protected Process Transaction Portals

DNA | SECURITY SOLUTIONS



VCA - Virtual Commodity Assets

Smart Cards > Digital “Wallet”



Presence Acknowledgement >

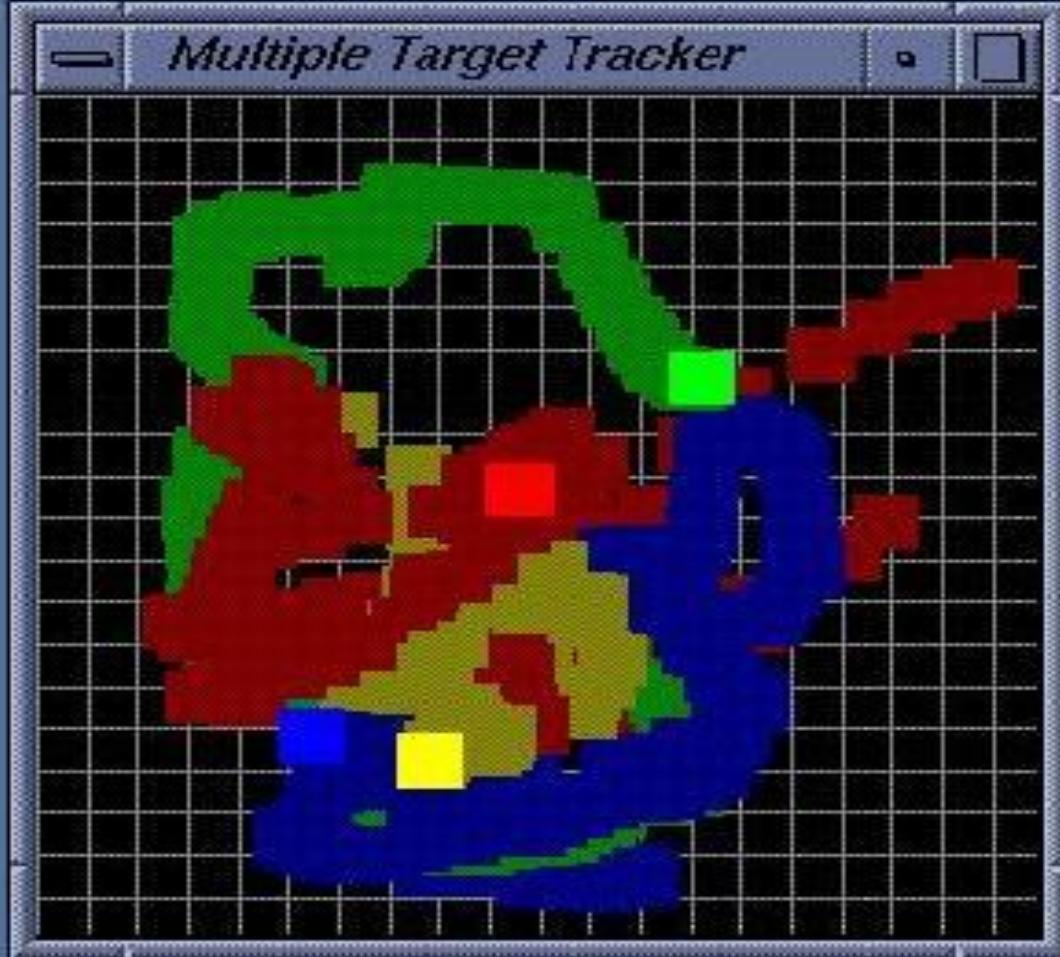
Existence Transaction

Ubiquitous Virtual Currency

Grid Access > Ubiquitous

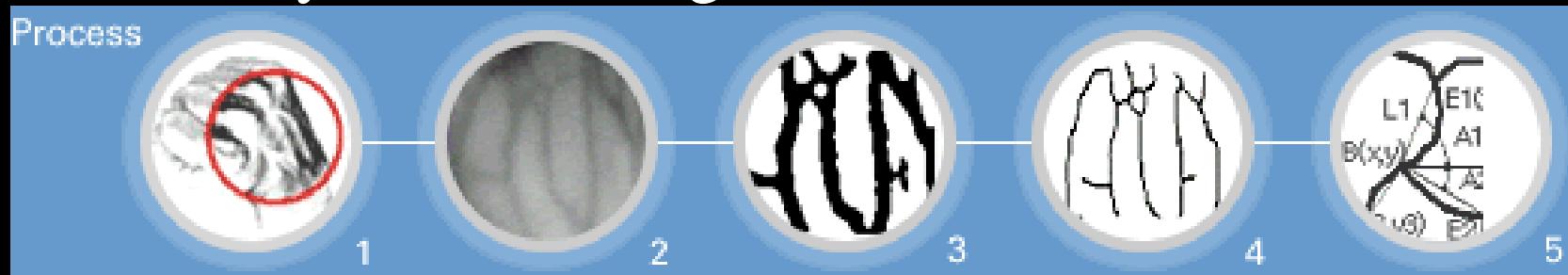
Process Grid Immersion

Integrated Smart Environments – Existence Transaction



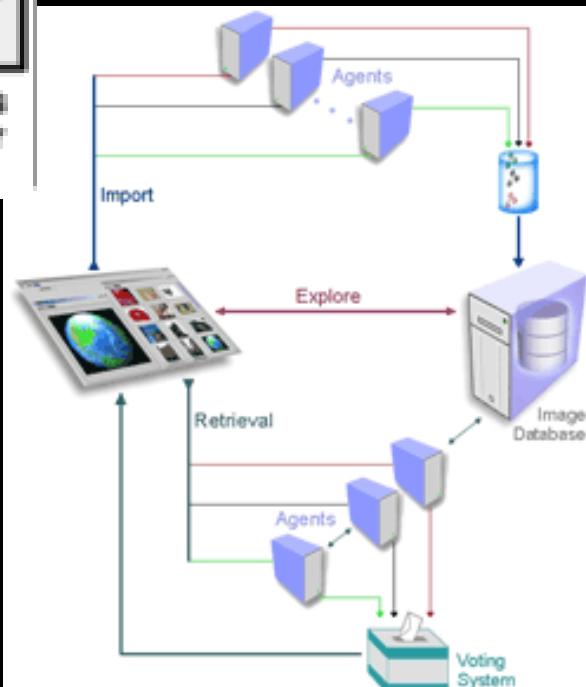
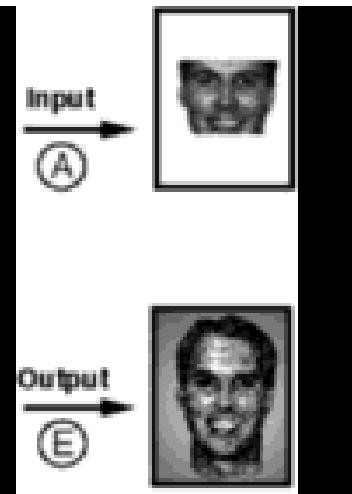
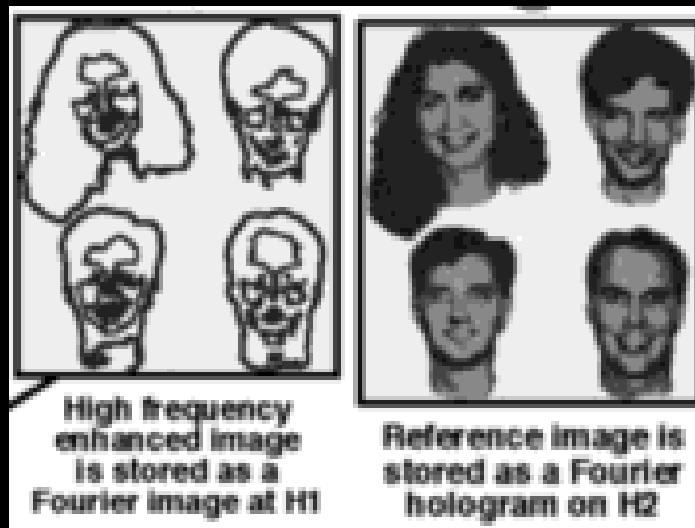
Presence Acquisition, Acknowledgement, Verification

- Transition from exobiometrics
- Mandatory Process Integration

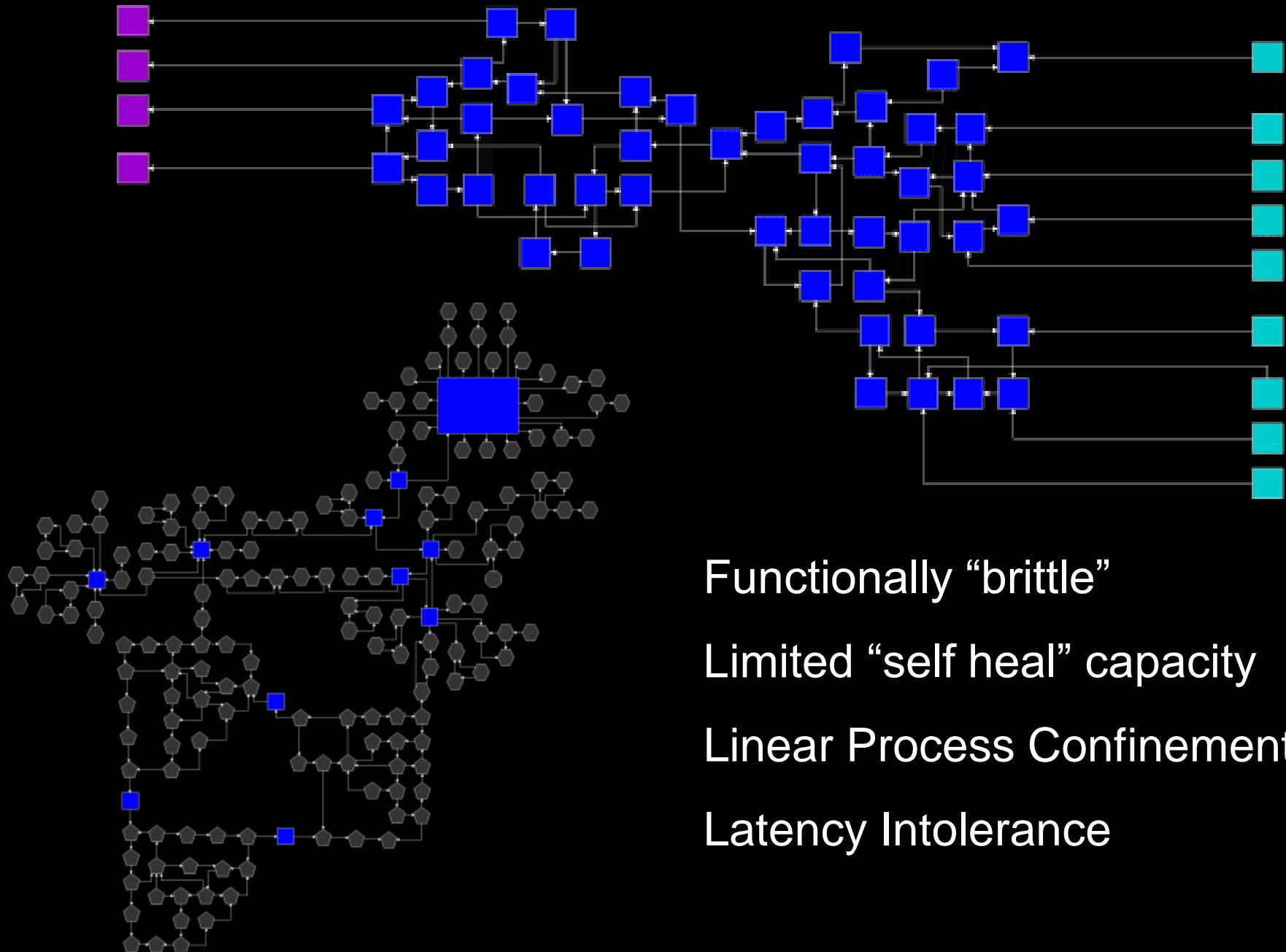


Content Addressable Feature Recognition

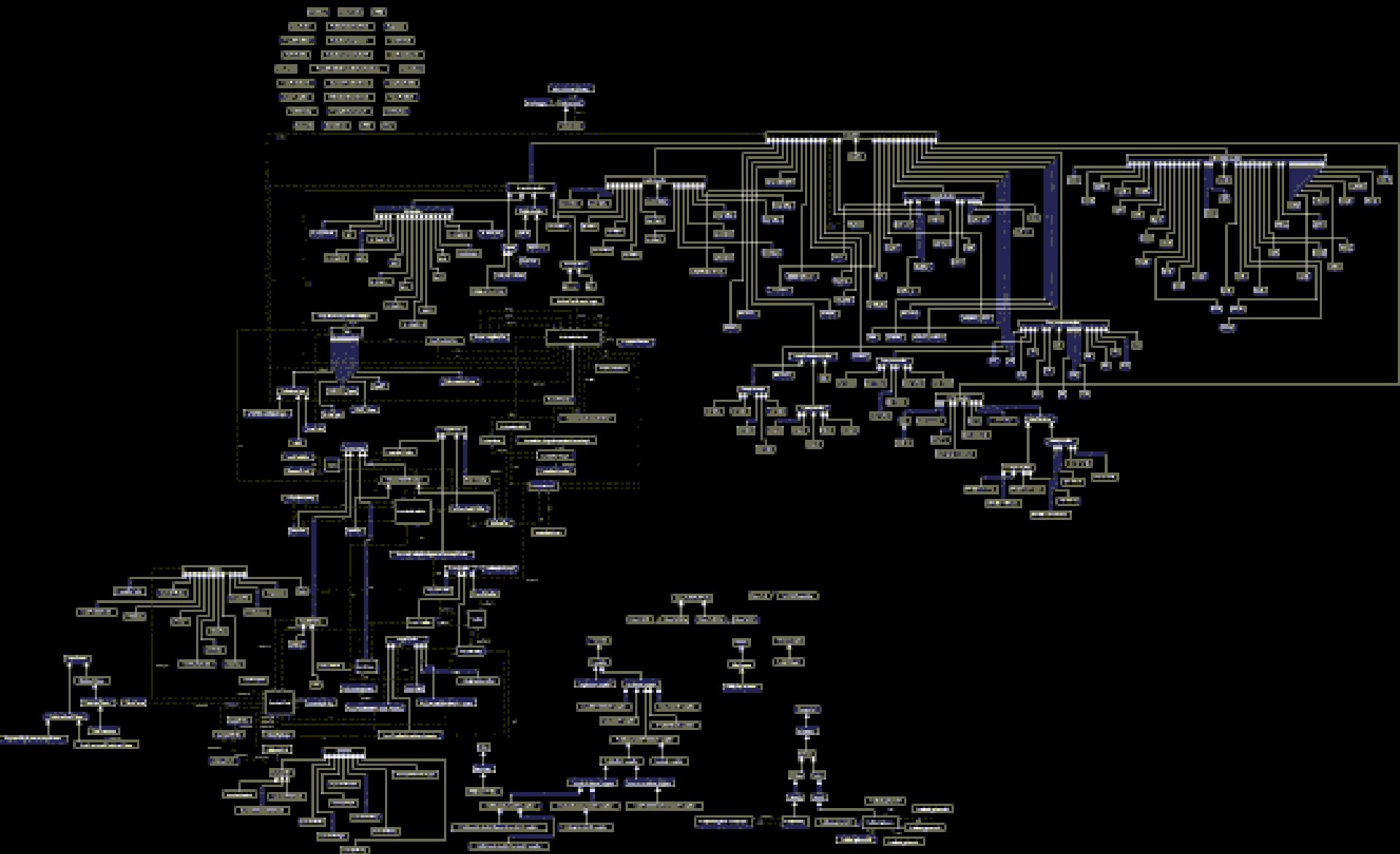
- Fourier / Holographic
- Wavelette
- Fractal



Orthagonal Process Domains

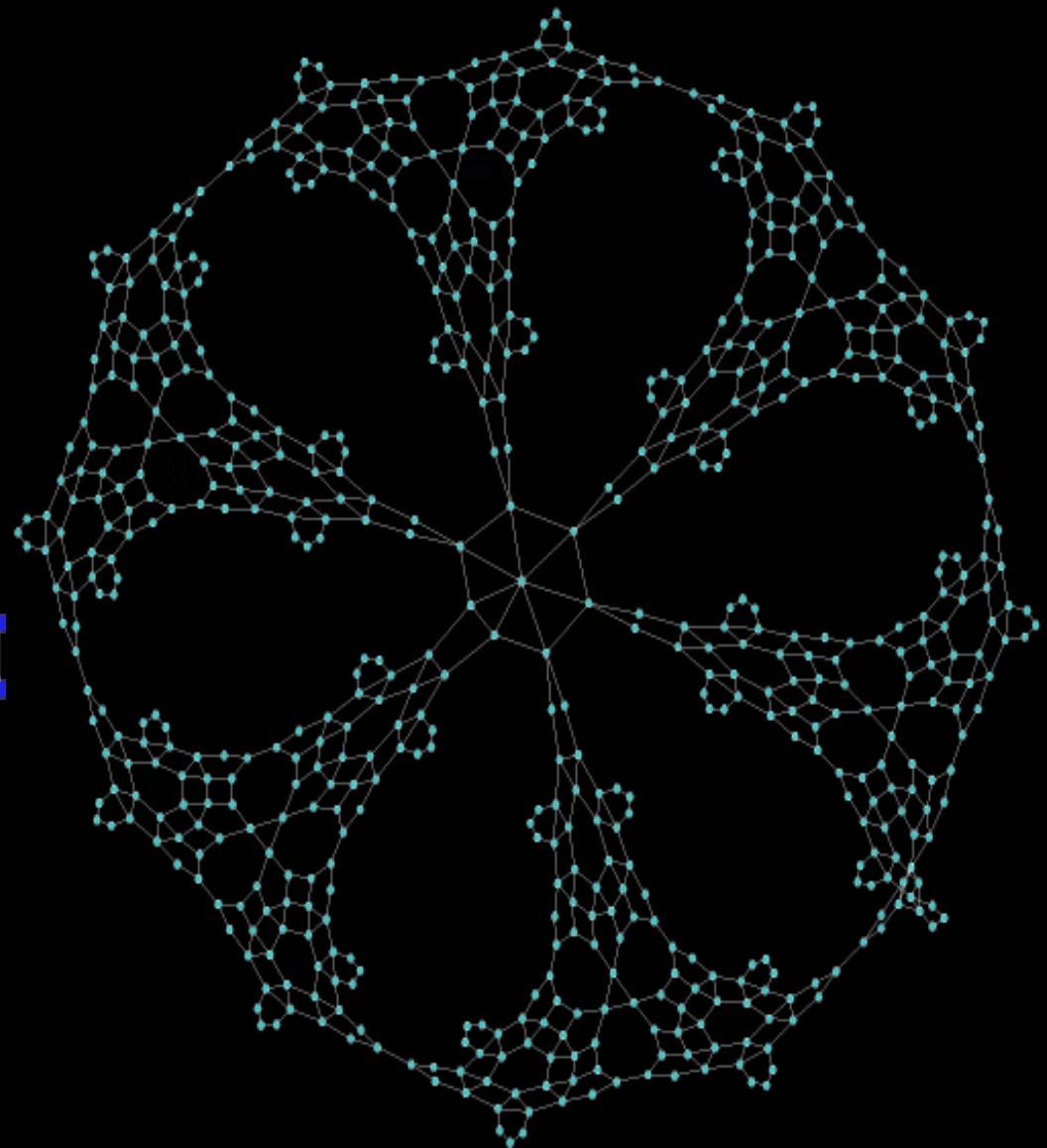
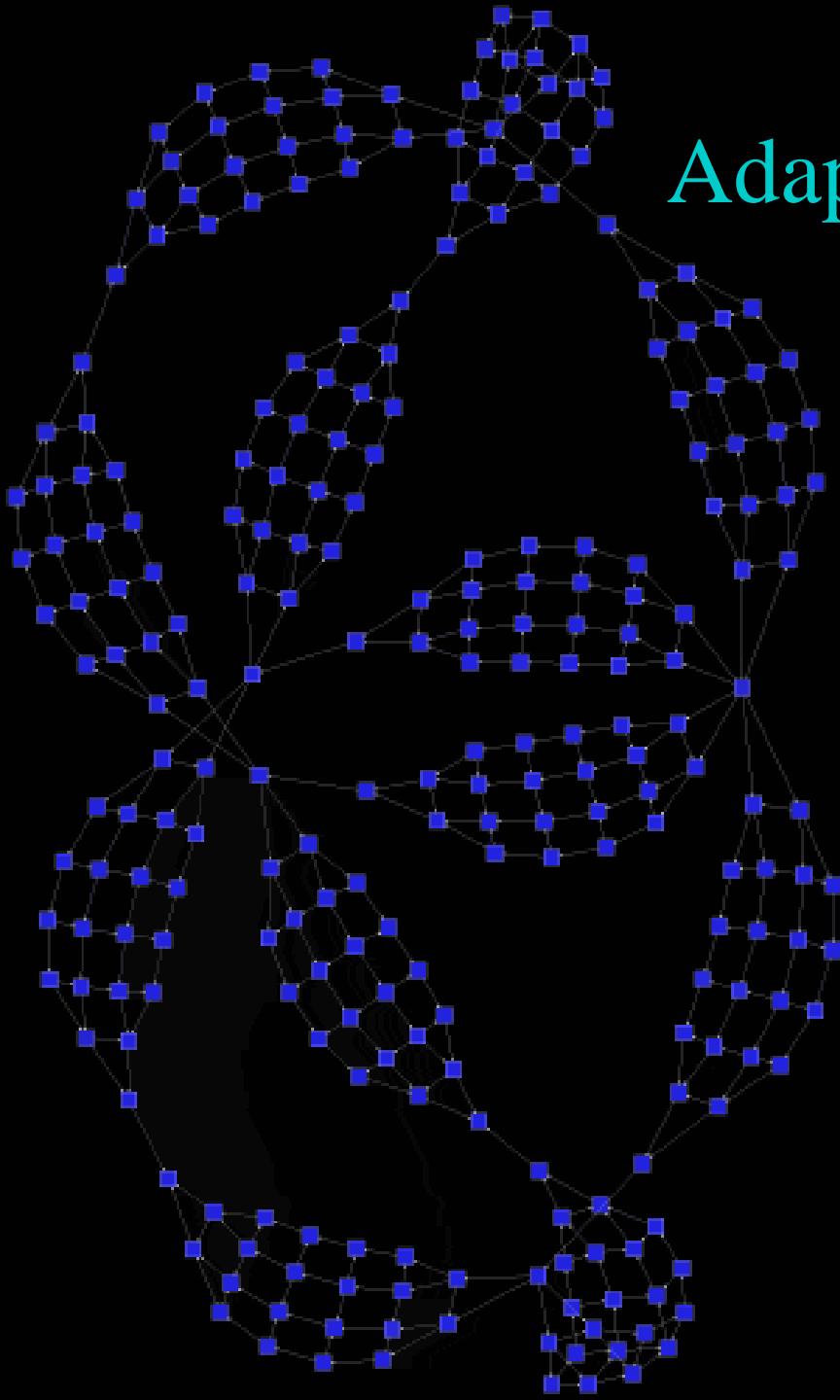


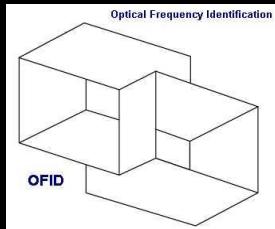
Functionally “brittle”
Limited “self heal” capacity
Linear Process Confinement
Latency Intolerance



3/4/2019

Adaptive Mesh Morphology

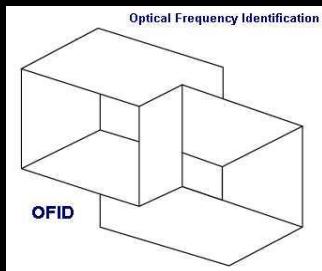




Nanomesh Networks

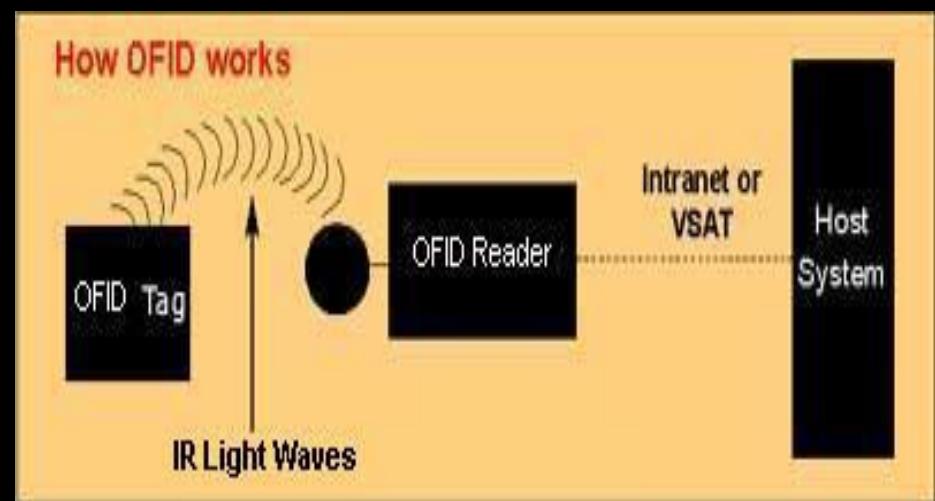
A nanomesh network could be created with an array of active optical frequency identification micro-devices that are built around a single circuit secure memory architecture.

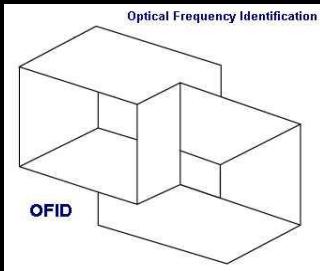
- uses very low power *infrared* emitters and detectors instead of antennae,
- requires far less processing power than active RF devices because the operating system serves only one memory space that is non-erasable and does not burden the CPU to confirm a transaction.
- requires fewer components than active RF devices
- point to point transmission from 3 inches in continuous mode, up to about 18 feet in burst mode.
- infrared transmission can penetrate translucent materials.
- cost continuously and dramatically goes down as the device shrinks in size
- entire ~~device~~ is scalable down to “smart dust”



Active OFIDs vs. Active RFIDs

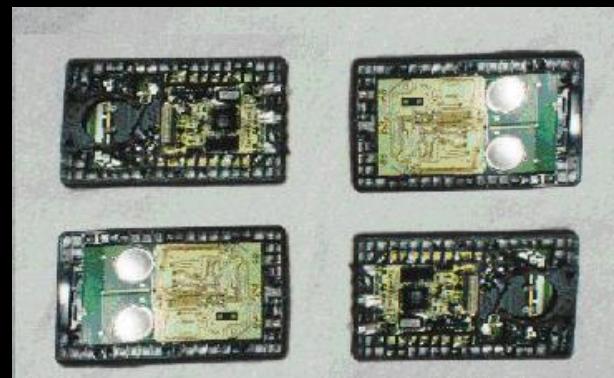
- Active OFIDs with single circuit secure memories have a number of distinct advantages over comparable active RF devices (RFIDs) with two circuit read-write memory architectures:

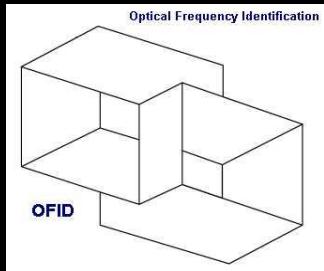




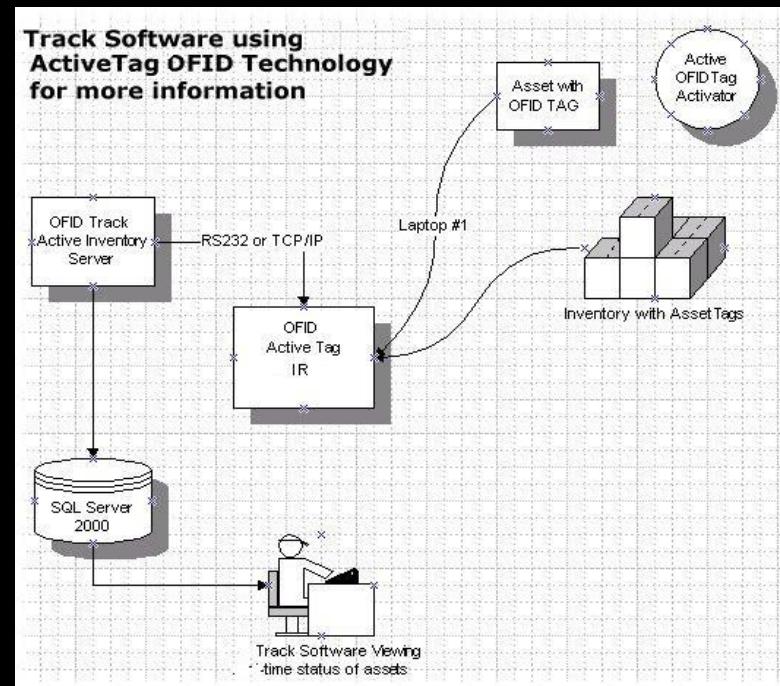
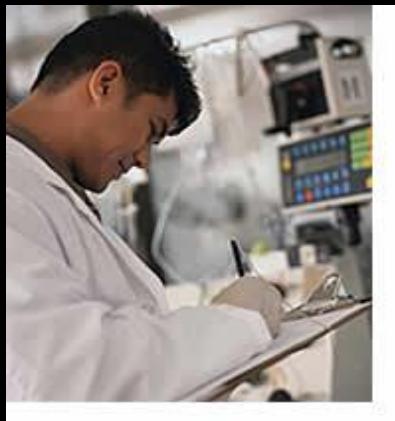
Security Enhancement

- Existing devices with two circuit read-write memory architectures are inherently more vulnerable to compromise. In an existing type of device, data is written from volatile memory into read-write memory under the supervision of a control program that is not located in the read-write memory.
- This opens up at least three means for tampering with the data: after data is written, it may be completely erased without trace; forged data may be rewritten in place of correct data, and the control program itself may be altered.



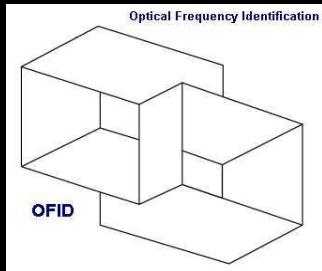


Active Medical Card

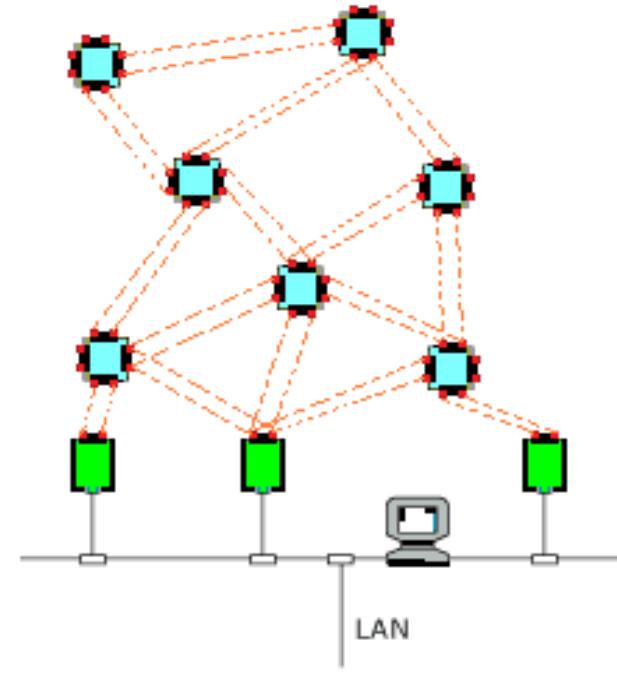


Wireless Internet Link "My NodePage" www.OFIDDevices.com

www.OFIDDevices.com



Active Micro-Mesh Network – “Spray-on Wireless Network”

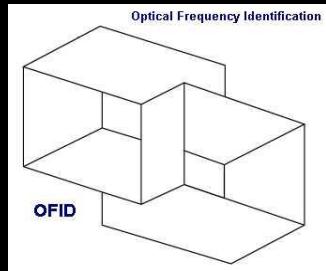


OFID

Docking Station

Computer





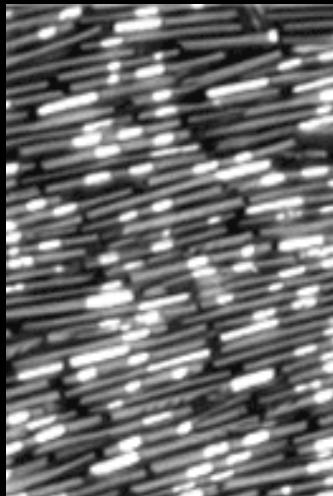
Military Applications



Ubiquitous Object Interface

- Nano Bar Codes
- Micro / Nano RFID – OFID devices
- Printable Nano-circuitry

Smart Objects, Dynamic Documents, Aware Environments

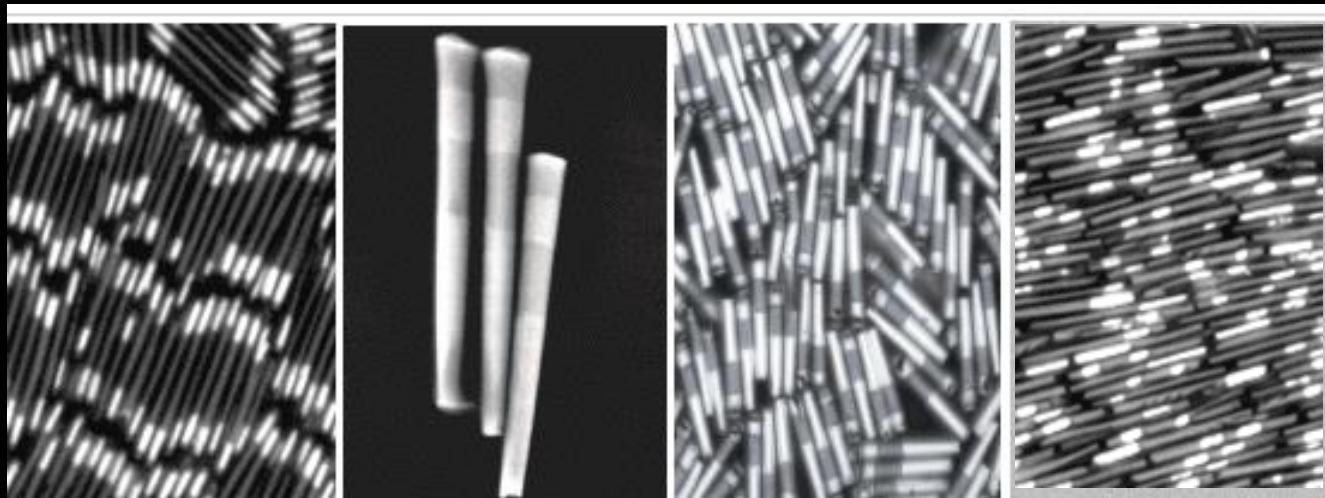


SEM Photograph of
185 Micron NanoBlocks

Ubiquitous Object Interface

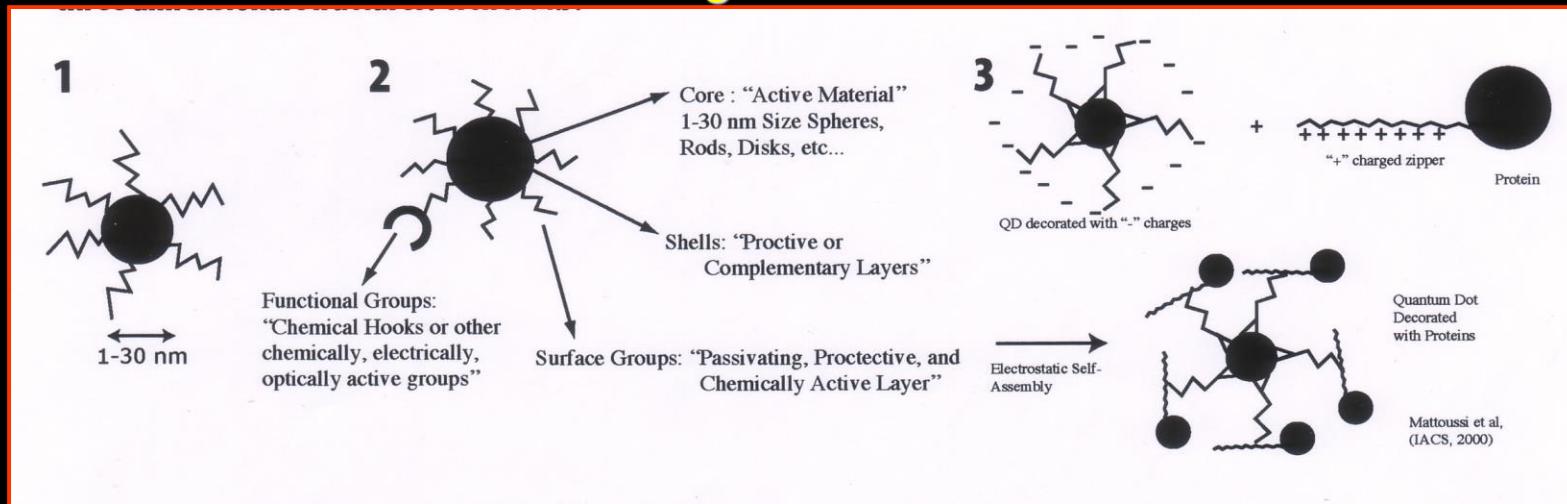
- Embedded ID, functionality
- Track, Trace, Acknowledge

Nanoplex Technologies Inc.

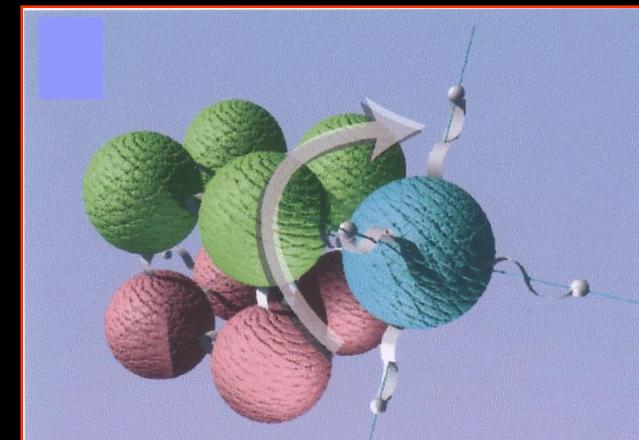
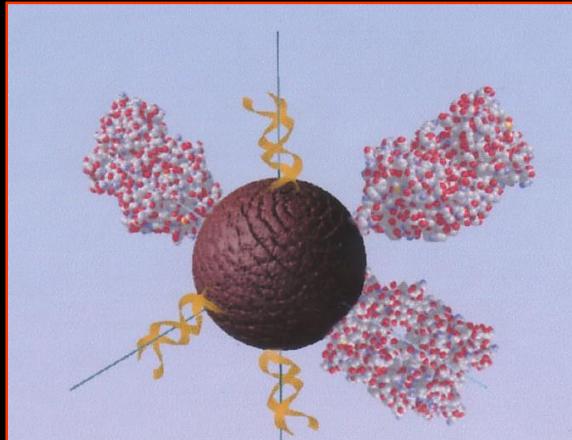
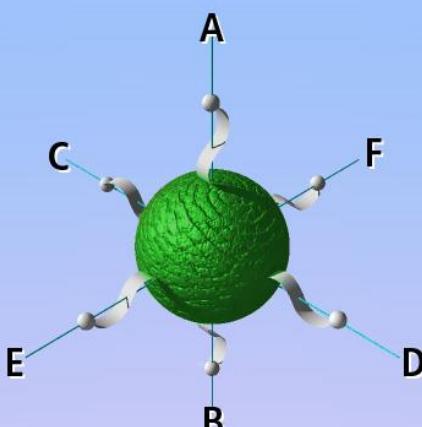


Objective: Improved Processes for Manufacturing High Precision Functionalized Nanostructures

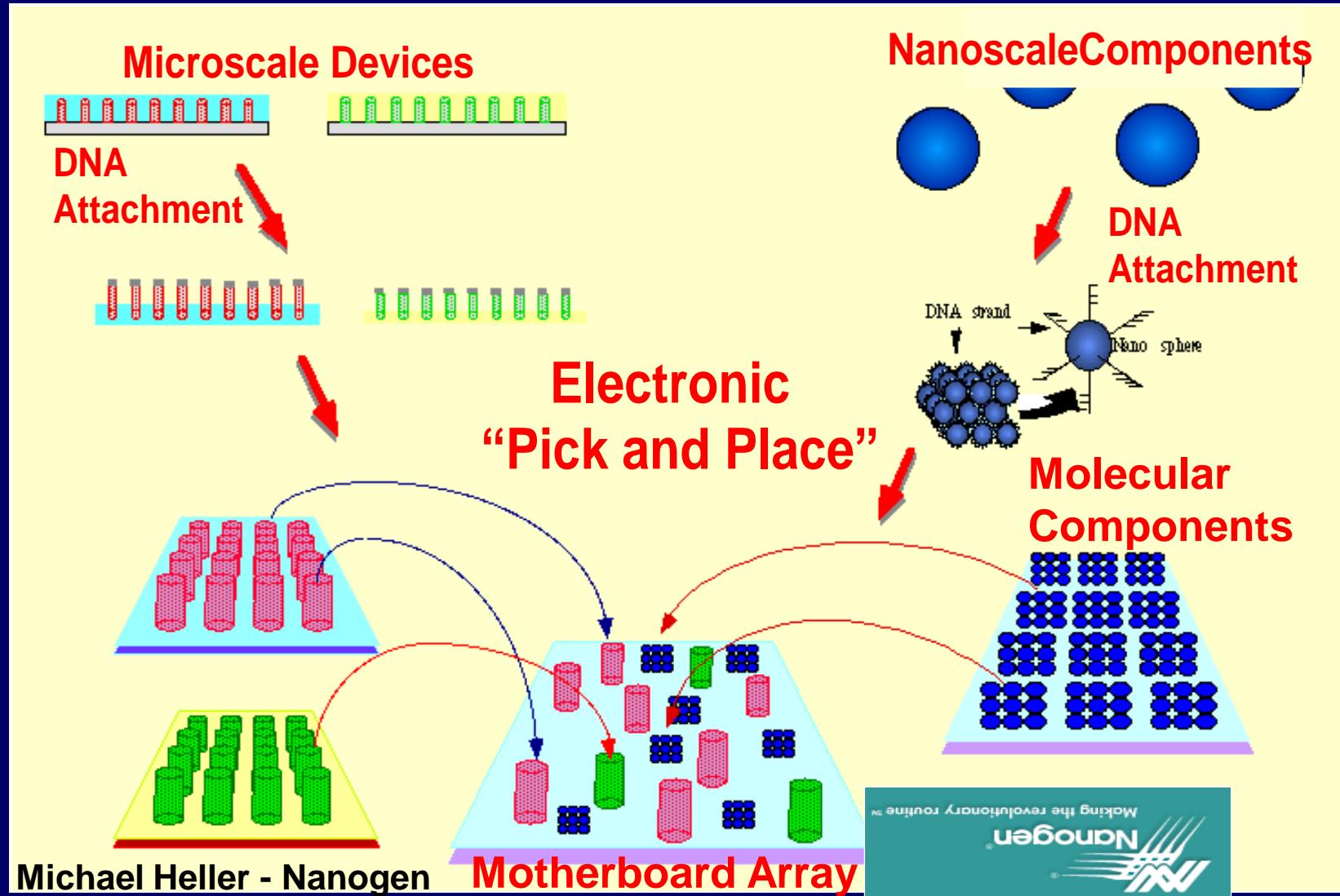
Present strategies for nanofabrication



Target future nanofabrication goals



Heterogeneous Integration Process for Micro/Nanofabrication – Synergy of Top-Down with Bottom-Up Processes



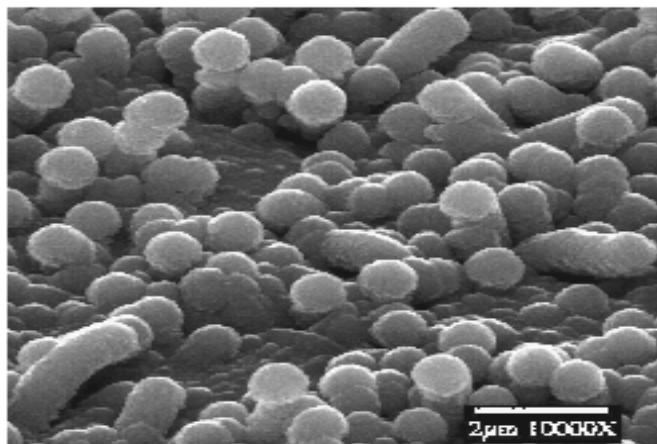
Self Assembly as a Foundry Process

Self-assembly is the most practical and realizable approach to fabricate arrays of nanodevices with the sub-100nm size features in short-term (the conventional lithographic methods of microsystem processing offer very limited control over the fabrication on the sub-100 nm scale)

Spontaneous self-assembly



This approach relies on structural disorder at the interface between the two materials with different physical properties (heteroepitaxy, fluctuations of the dopant concentration, etc.)

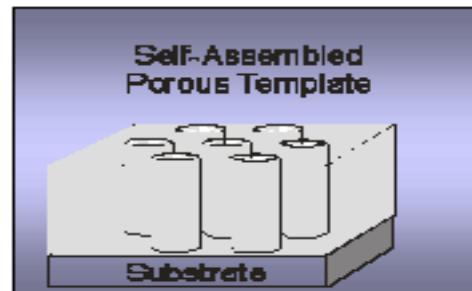


Self-assembled Si nanowires grown by magnetron sputtering

Controllable self-assembly



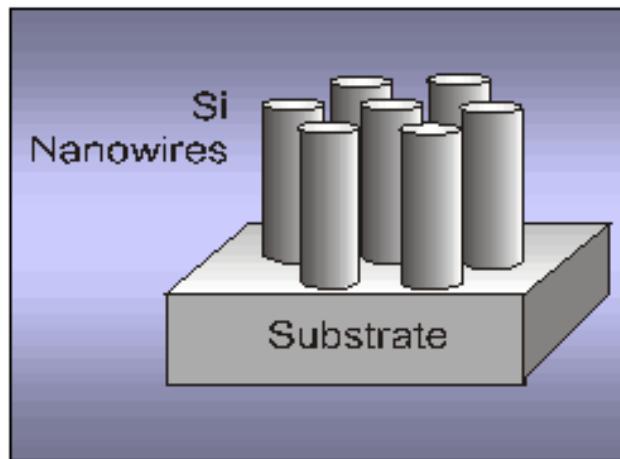
Involves self-assembly of the tools for fabrication of nanostructures and nanodevices such as masks or templates.



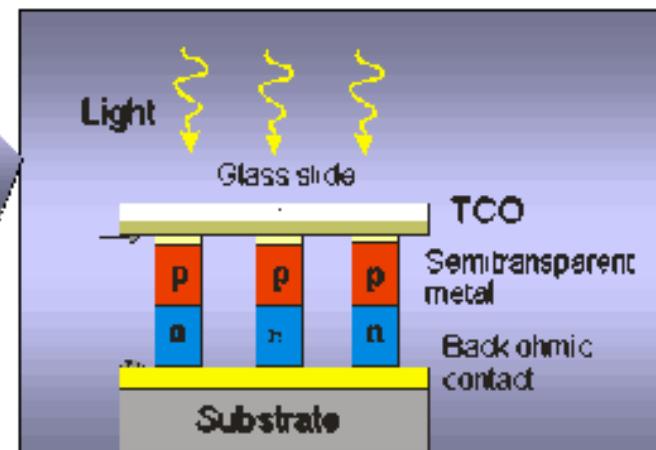
(E.A. Gulians and W.A. Anderson, "A Novel Method of Structure Control in Si Thin Film Technology," 197th Meeting of The Electrochemical Society Toronto, ON, May 2000)

Periodic Nanostructures

Some of the potential applications of periodic nanostructures are:



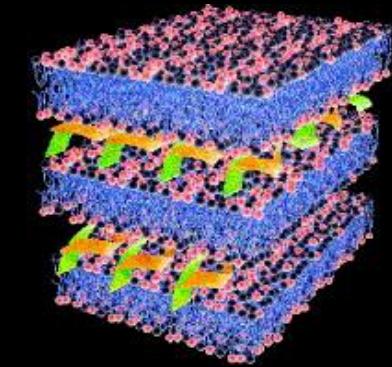
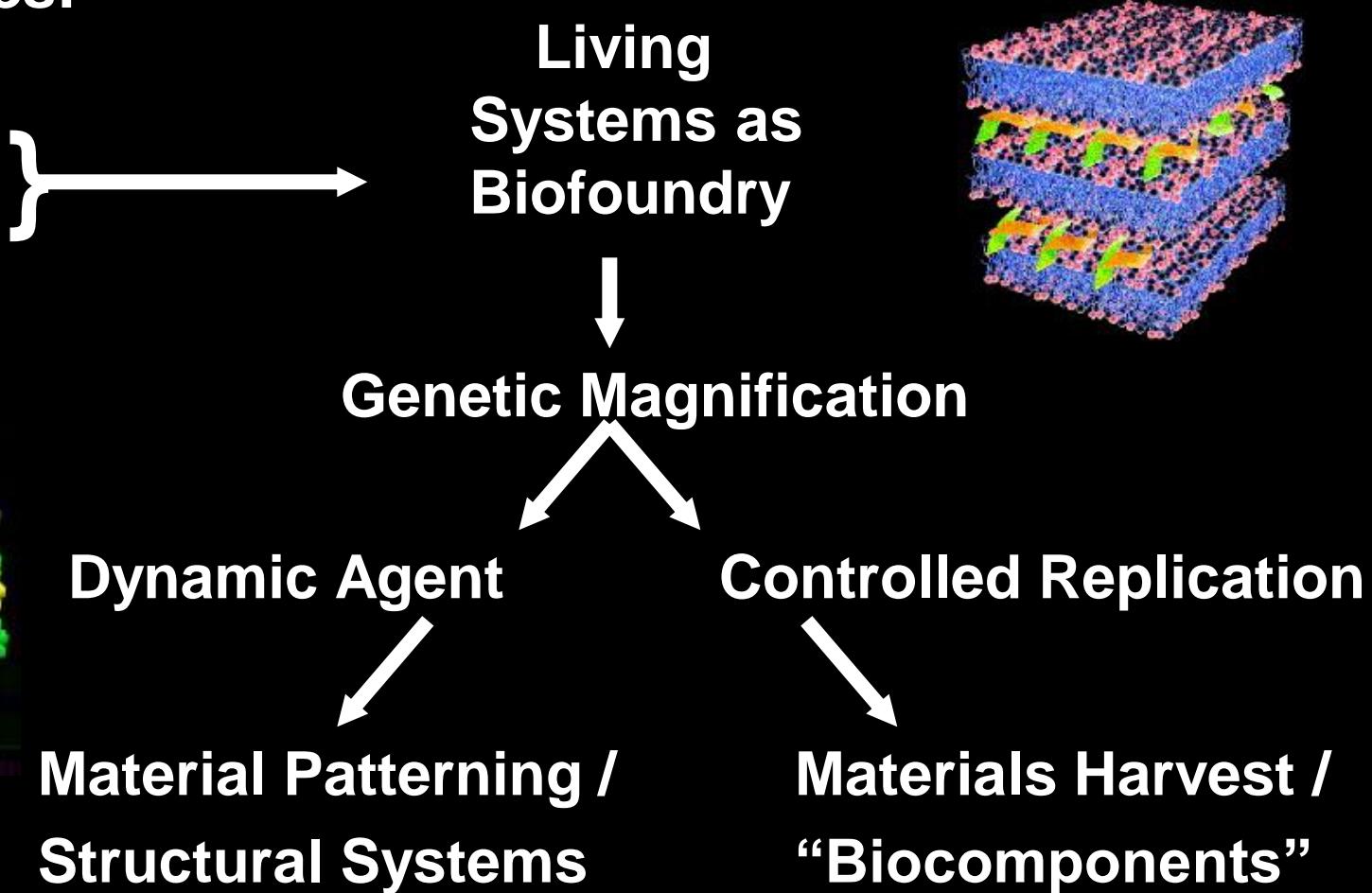
- Quantum effect dots
- Resonant tunneling diodes
- Single-domain/bit magnetic storage media
- Single electron transistors (SETs)
- Light-emitting diodes (LEDs)
- Photodetectors
- Quantum well optoelectronic devices
- Quantum cellular automata
- High-density memory



Schematic of a Si photodetector array fabricated on periodic Si nanowires

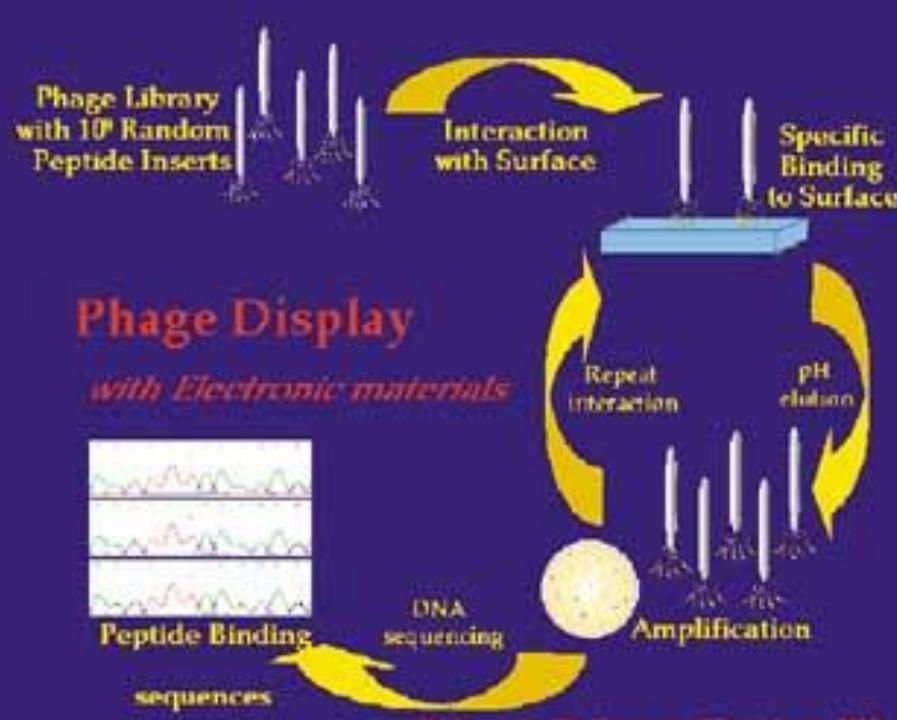
Biology as a mechanism for material production, patterning, and fabrication

Key Properties:
Photonic
Electronic
Mechanical
Chemical



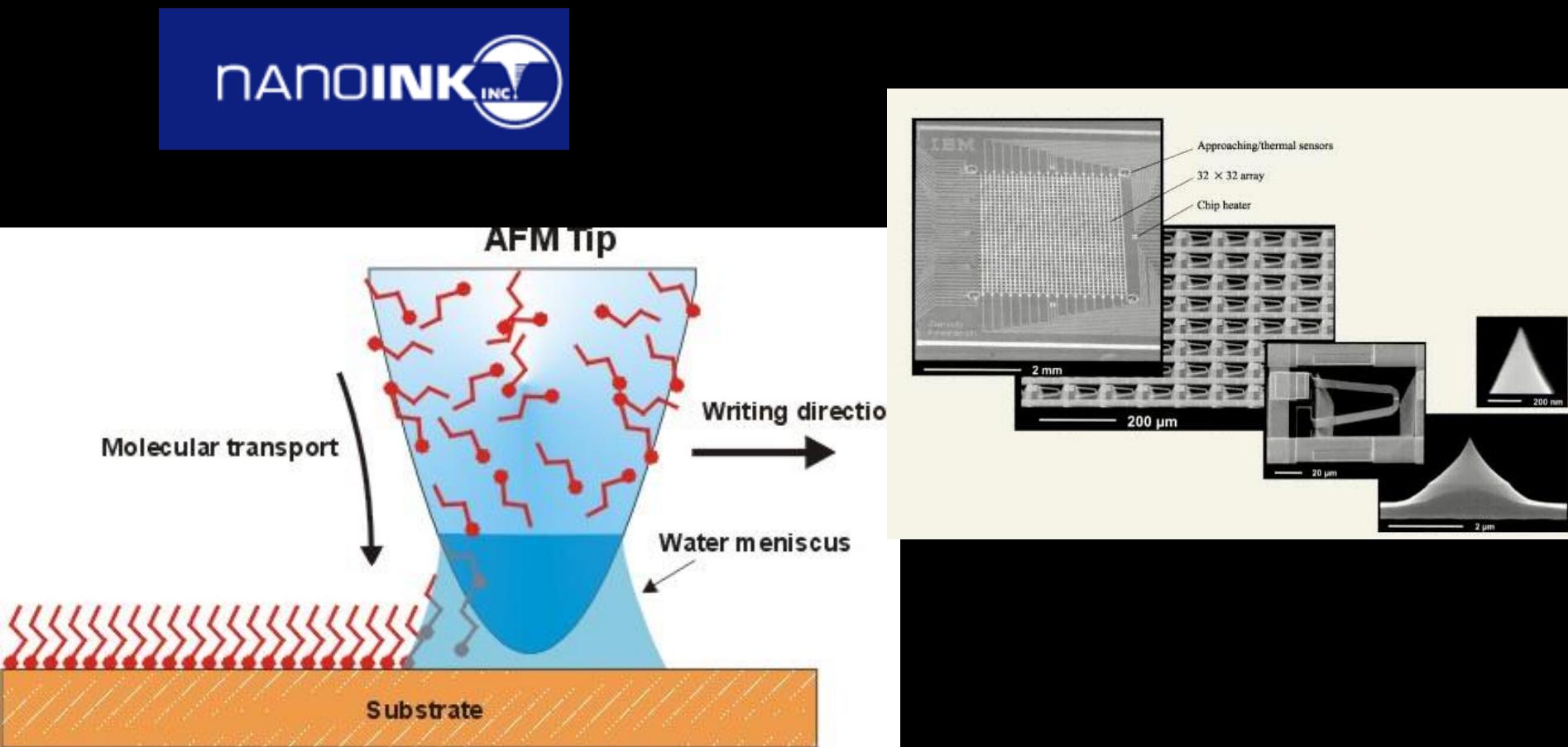


Define Foundry - Future



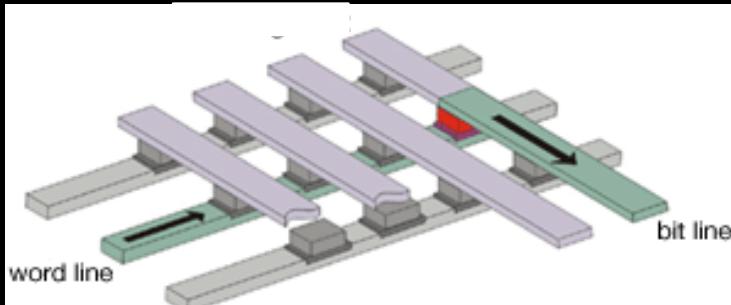
Complementary Chemistry Enabling Process Example – NanoPrinting AFM arrays

- Massively parallel molecular deposition



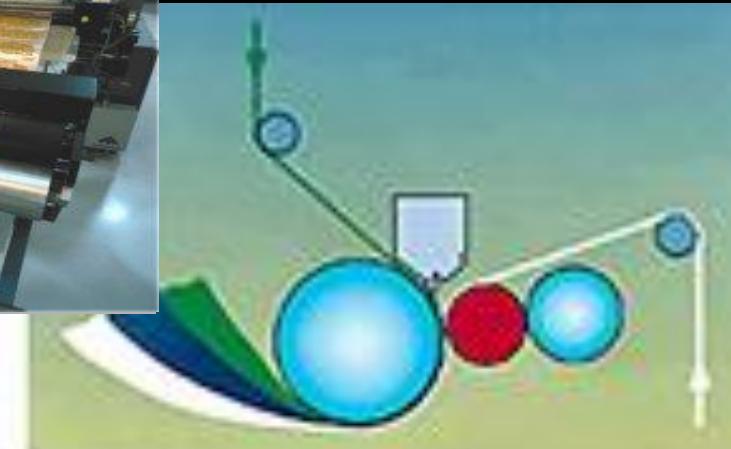
Roll to Roll NanoElectronics

> Pathway to lowcost Crossbar Memory, Reconfigurable Computing Architectures



The complexity of disk systems is replaced by a simple architecture and high-resolution lithography

A bit is represented by the presence of charge in a columnar molecular crystal
Information is written and read by application of *both* voltage and light

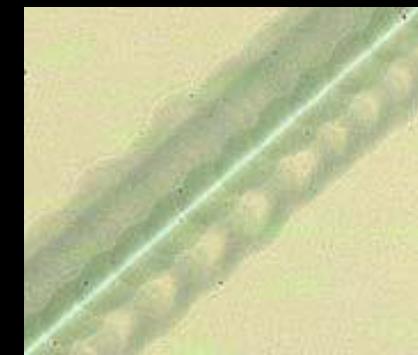
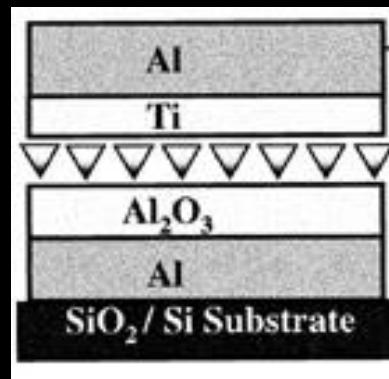
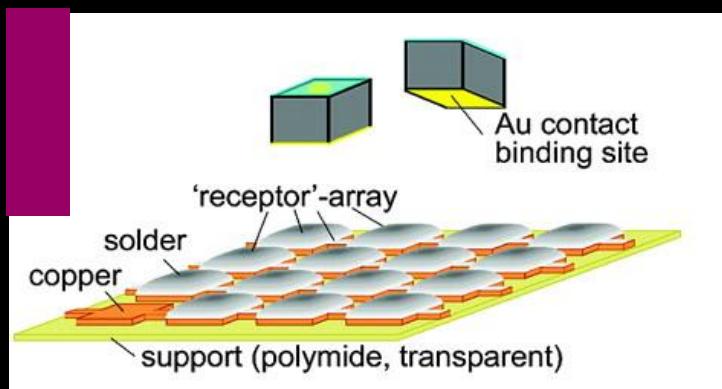
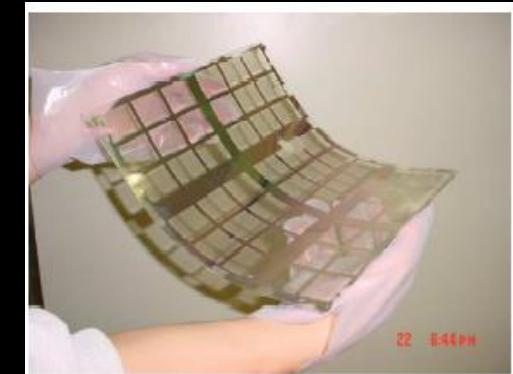
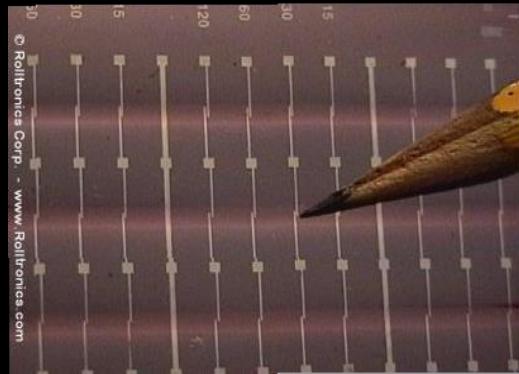


Manufacturing: ideally suited to R2R

Bring patterned electrodes together simultaneously with coating of organic medium; the electrodes can also be fabricated R2R

Web processing and Nanoelectronics

Organic electronics and self-assembly



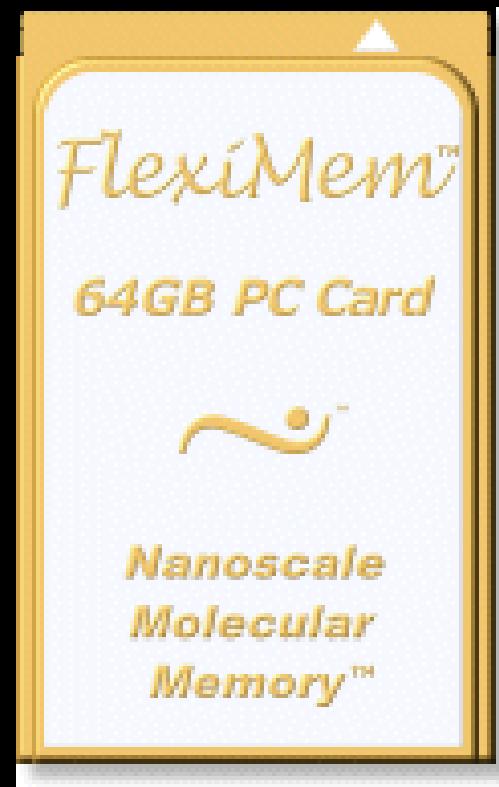
Nanoelectronics requires fluid phase (self-assembly) chemistry; \Rightarrow roll-to-roll processing is a hand-in-glove fit

Product examples



300 dpi e-paper display
~\$25-50

(generally accessible to e-paper
with flexible electronics)



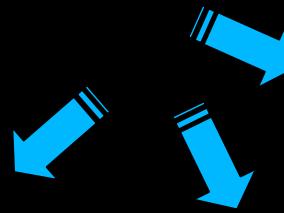
**64 GB PC Card
memory**
< \$200

***Only the cost structure of roll-to-roll manufacturing
will make most of these products (and their
markets) possible***

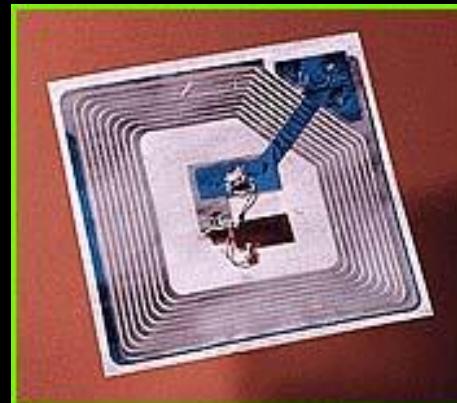
Flexible roll to roll printed nanoelectronics



Many Applications



Biometric sensors



RFID tags

Above: electronic paper concept;
Above right: recent release from E Ink

What is R2R manufacturing, and what does it have to do with electronics?



Typical web properties:

Width: 0.3 – 3 m

Length: up to 50 km

Thickness: 0.6 to 300 microns

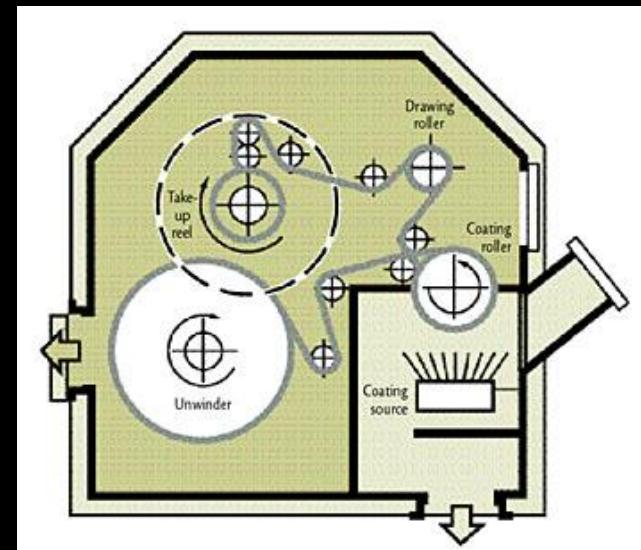
Speed: 0.1 – 1000 m/min.

Coating properties:

Thickness: <0.1 to 100 microns

Processes: evaporation, sputtering, PECVD (vacuum);
gravure, slot die, etc. (liquid); inkjet

Thin film processing on a moving web of flexible substrate. A complete device may require several chambers.

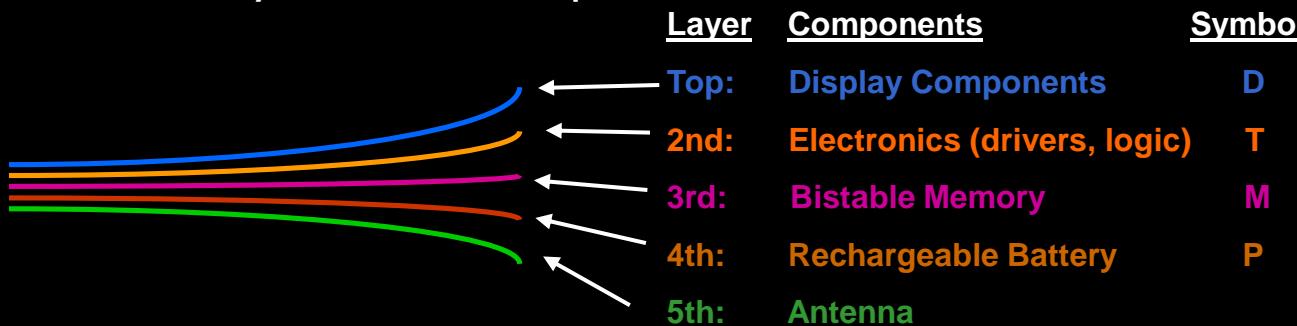


A simple vacuum web evaporator

For further technical details, see: J.R. Sheats, *SPIE Proceedings*, Vol. **4688** (2002), paper#27

General Architecture of Information Appliances

- R2R processing allows the lamination of separately fabricated devices into a single thin, flexible product
- Elements can be chosen as needed by the designer; the four elements ("D,T,M,P") cover a huge gamut of possibilities (a "DNA code" for appliances)
- Self-assembly processes provide further options for integration of widely different capabilities at low cost



Success requires unique chemical and physical processes uniting microfabrication, self-assembly, and mechanics; these are the bases of Rolltronics' developing IP.

Roll to Roll Nanoelectronics

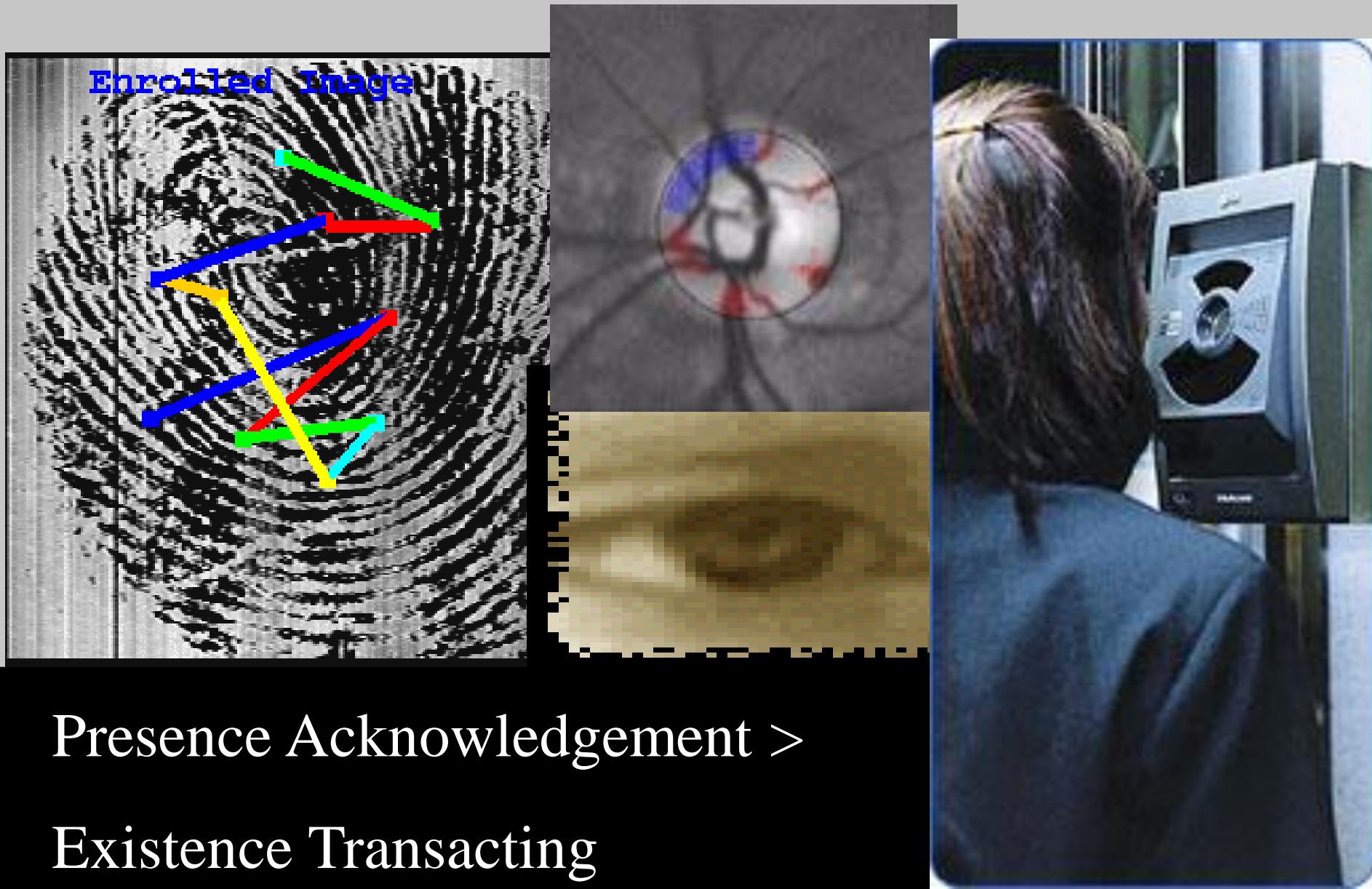
Requirements for R2R Nanoelectronics:

- ◆ Cleanliness and defect control
- ◆ Dimensional stability and control
- ◆ Precise mechanical control
- ◆ Controlled surface chemistry
- ◆ Ability to apply a wide variety of chemical processes

Rolltronics' developing core competencies:

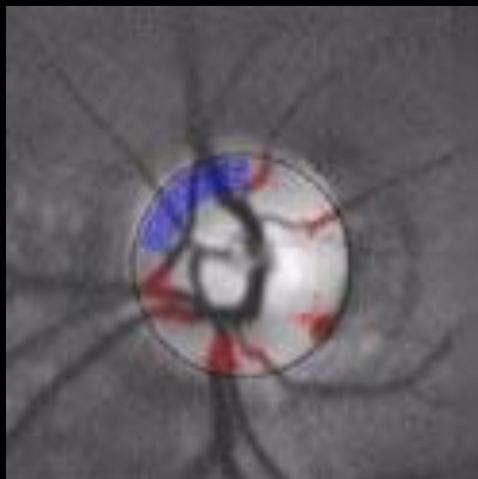
- ◆ 10 micron scale lithography with economical equipment
- ◆ Cleanliness and defect densities pertinent to this feature size
- ◆ Overlay accuracy of a few microns roll-to-roll
- ◆ A wide array of lamination, delamination and surface processes
- ◆ Vacuum, fluid deposition; printing; various direct writing techniques
- ◆ Capability for managing feature alignment across a meter wide web

Biometric Recognition and Acknowledgement



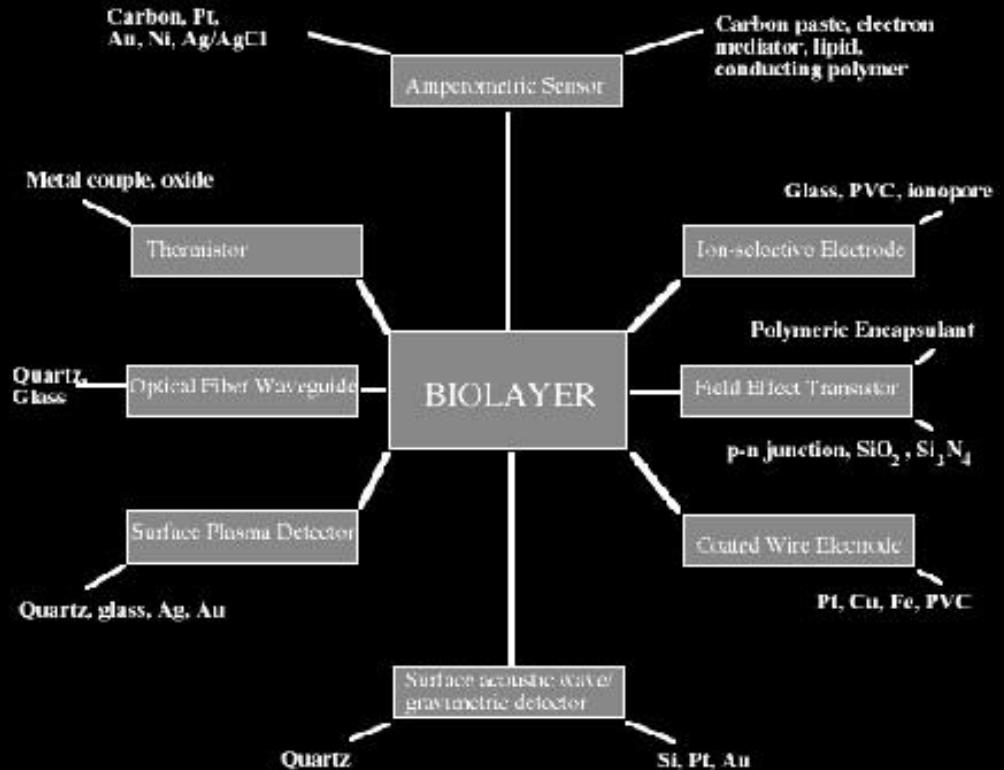
Ubiquitous Access Portals

- Biometric Transaction Coupling
- Optional Process Integration
- User Transparency



Biometric Methodologies

- Face / Multimodal
- Fingerprint
- Retinal
- Hand and Finger Geometry
- Vein Patterns
- Handwriting
- Thermography
- Iris
- Voice
- Future - Integrated Biosensing



Biometric Technology Providers

Retinal:

Eyedentify Inc.
Retinal Technologies, Inc.
Hand and Finger Geometry:
BioMet Partners
Recognition Systems
DERMALOG

Vein:

AdvancedBiometrics, Inc.
neusciences (formally NCS)
VeinID

Iris:

British Telecom; Keeping an eye on Iris
and Personal Secure Access to
Networked Applications - the use of
Iris Recognition for User Validation
EyeTicket, Inc.
Iridian Technologies (formerly IriScan)
IriScan (see Iridian Technologies, above)
Sensar (see Iridian Technologies, above)

Face:

AcSys Biometrics
A4Vision SA
Attrasoft
Aurora Ltd.
Banque-Tec
BioCom
Biometrica Systems
BiometriKa
Cognitec Systems GmbH
C-VIS Computer Vision and
Automation GmbH (FaceSnap)
DERMALOG
eTrue
Face Detection HP
Face Recognition Homepage
FACE Technologies (PTY) Ltd.
IdentAlink Ltd.
Image-Metrics, Ltd.

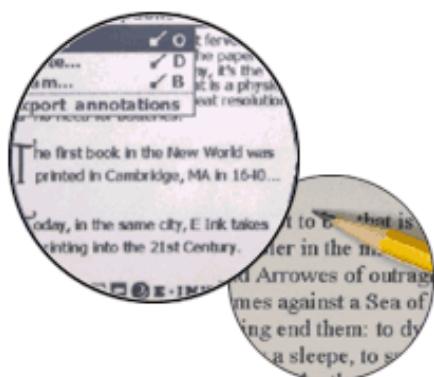
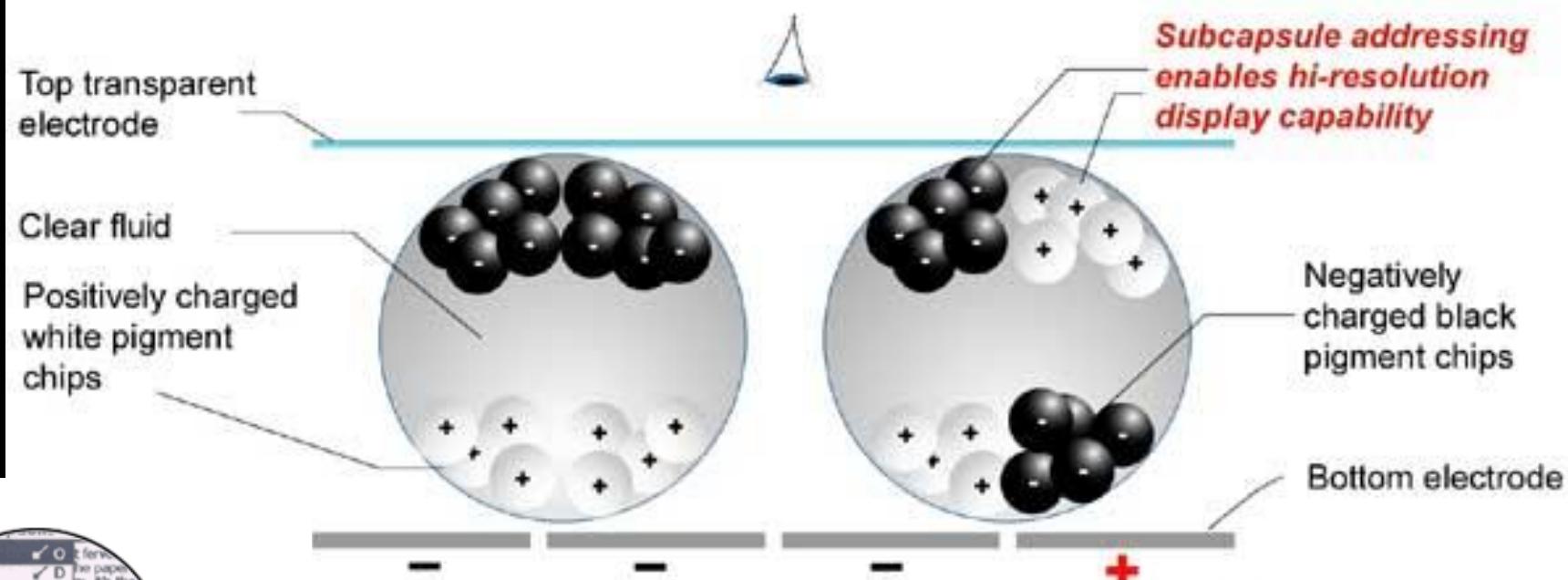
Imagis Technologies, Inc.
ImageWare Systems, Inc.
Keyware Technologies
MIT Media Laboratory Vision
Modeling Group
Neurodynamics
neusciences (formally NCS)
Plettac Electronics
Polaroid
Ringdale
Sintec Co., Ltd.
SpotIt
TechObject Corp.
USC's Laboratory for
Computational and
Biological Vision (VCBV)
Viisage Technology
Visionics
VisionSphere Technologies
ZN VisionTechnologies AG

Various/Others:

AiT Corporation
AuthX Document Protection
System
Bell Identification
Biometric Partners, Inc. -
Touchless Fingerprint, Palm
and Hand Sensors
BioNetrix Corporation
DataCard Group
DataTreasury Corporation
Imaging Automation, Inc.
Mitretek Systems - Biometric
Identification
Net Nanny (BioPassword -
keystroke verification
software)
Neurotechnologija, Ltd.
(fingerprint, iris recognition
software)
Siemens

Smart “Documents” – Sense, Transact, Acknowledge, Verify

Cross-Section of Electronic-Ink Microcapsules

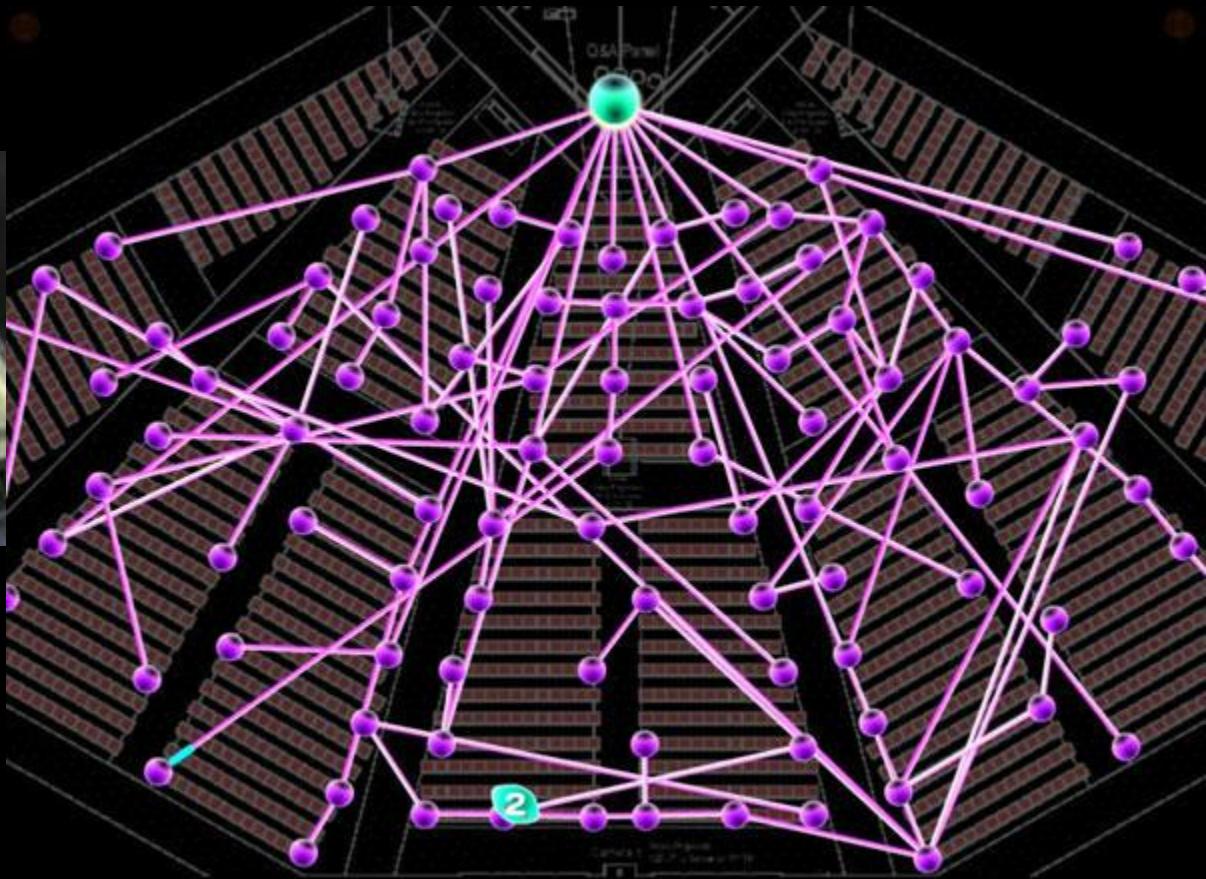
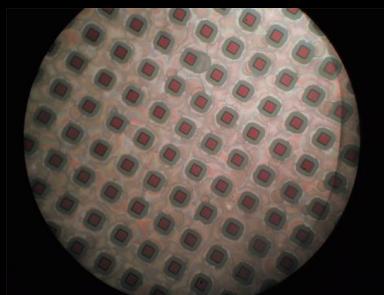


E · I N K

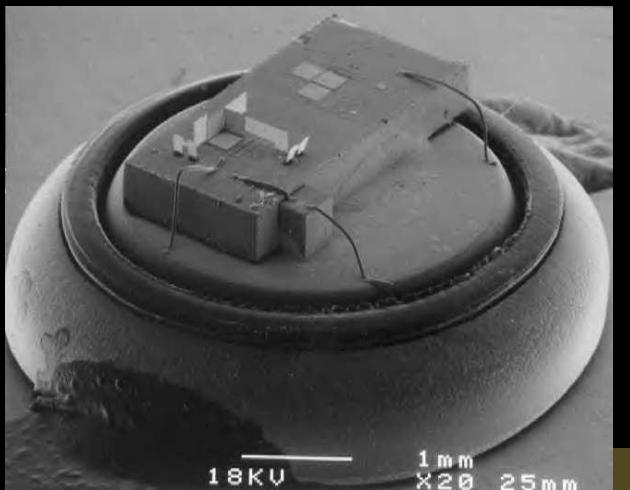
“Electronic Ink”

Future Biometric Immersion

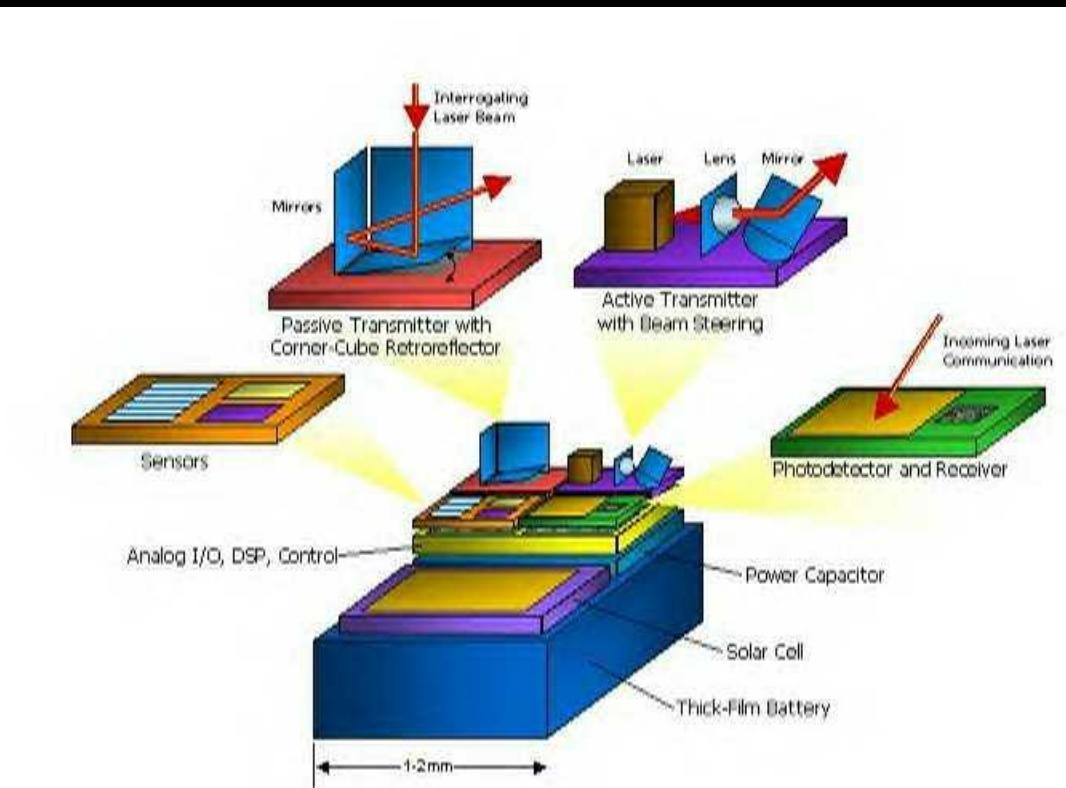
- Sensor “Swarms”



Future Biometric Immersion

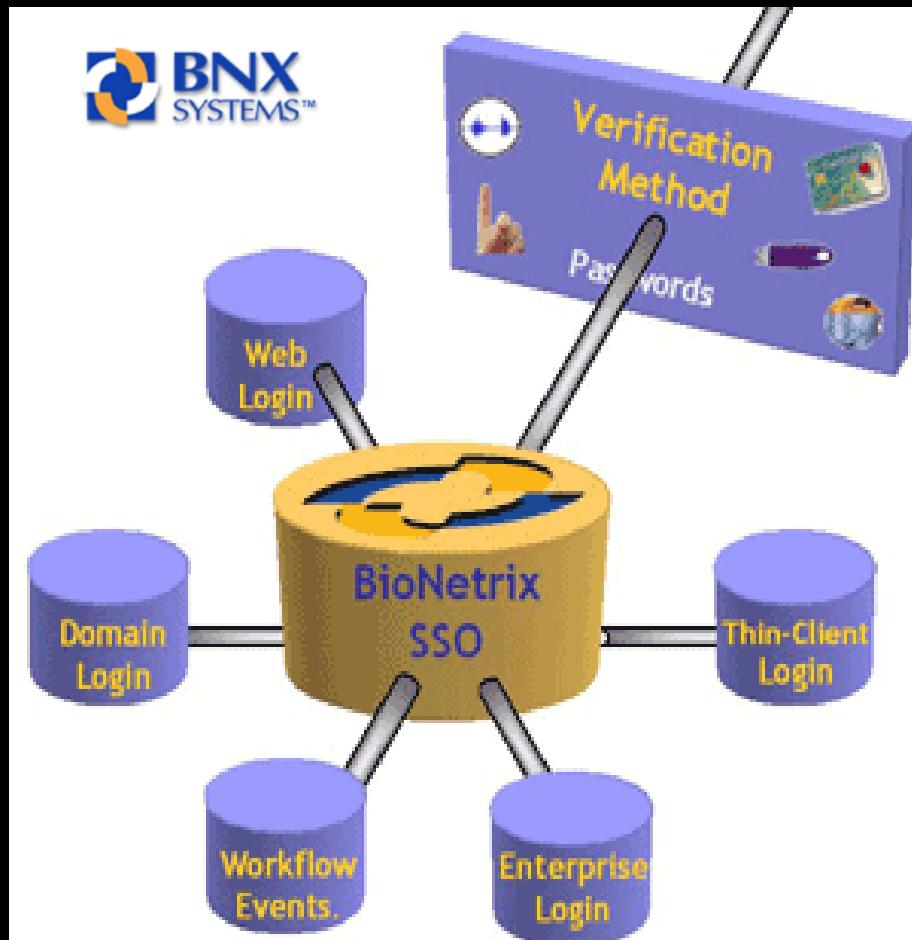


- Autonomous Distributed Entities
- Ubiquitous Presence Monitoring



Biometric Process Management

- Process Transceiving portal
- Presence Acknowledgement
- Process Access / Distribution
- Definable Boundary Porosity
- Sovereign Knowledge Domains
- Scalable POT (Point of Transaction) Performance Metrics



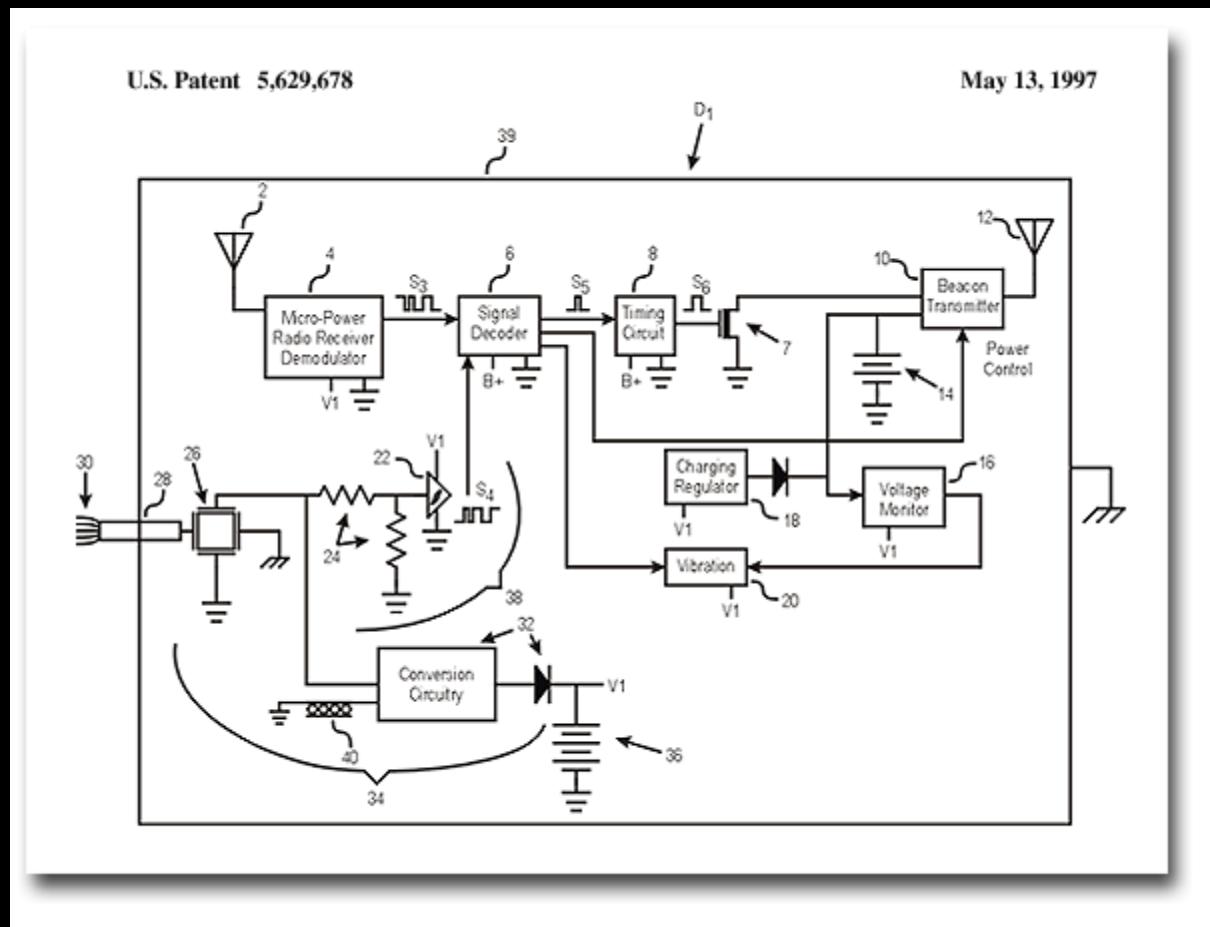
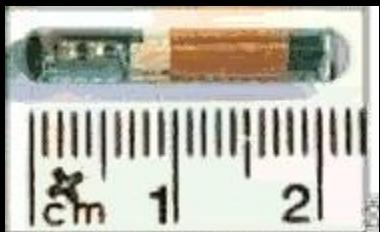
Future Biometric Immersion



- Biochip Implants
- Distributed Sensors
- “Smart Dust”
- Molecular Sensors

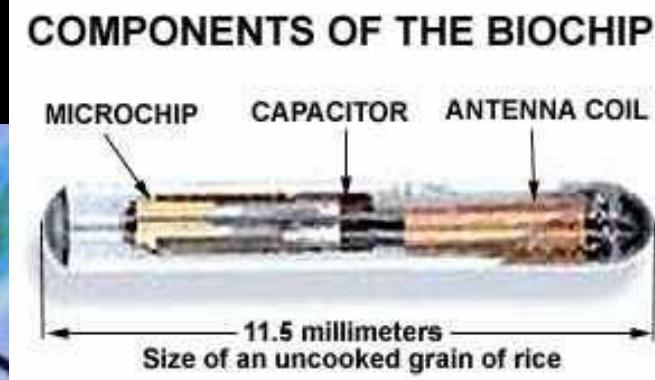
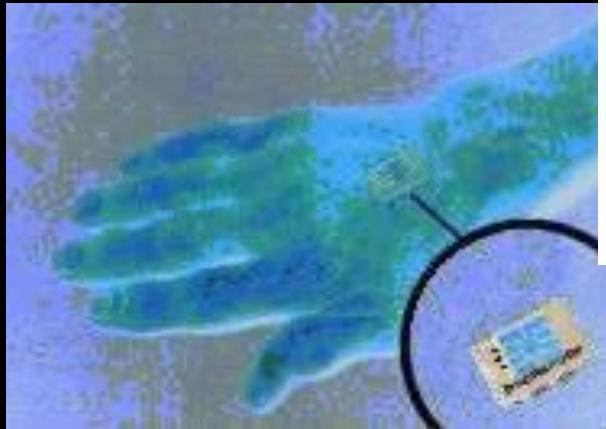
Ubiquitous Immersion

Implantable Biochip



Ubiquitous Immersion

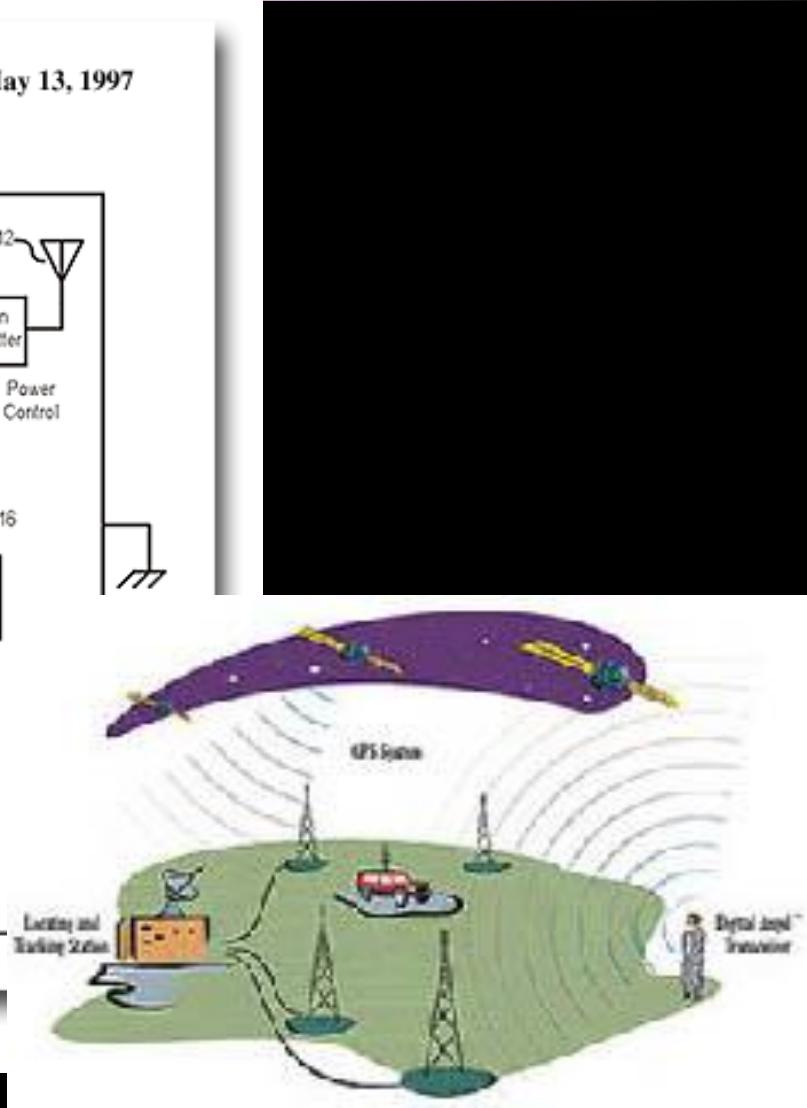
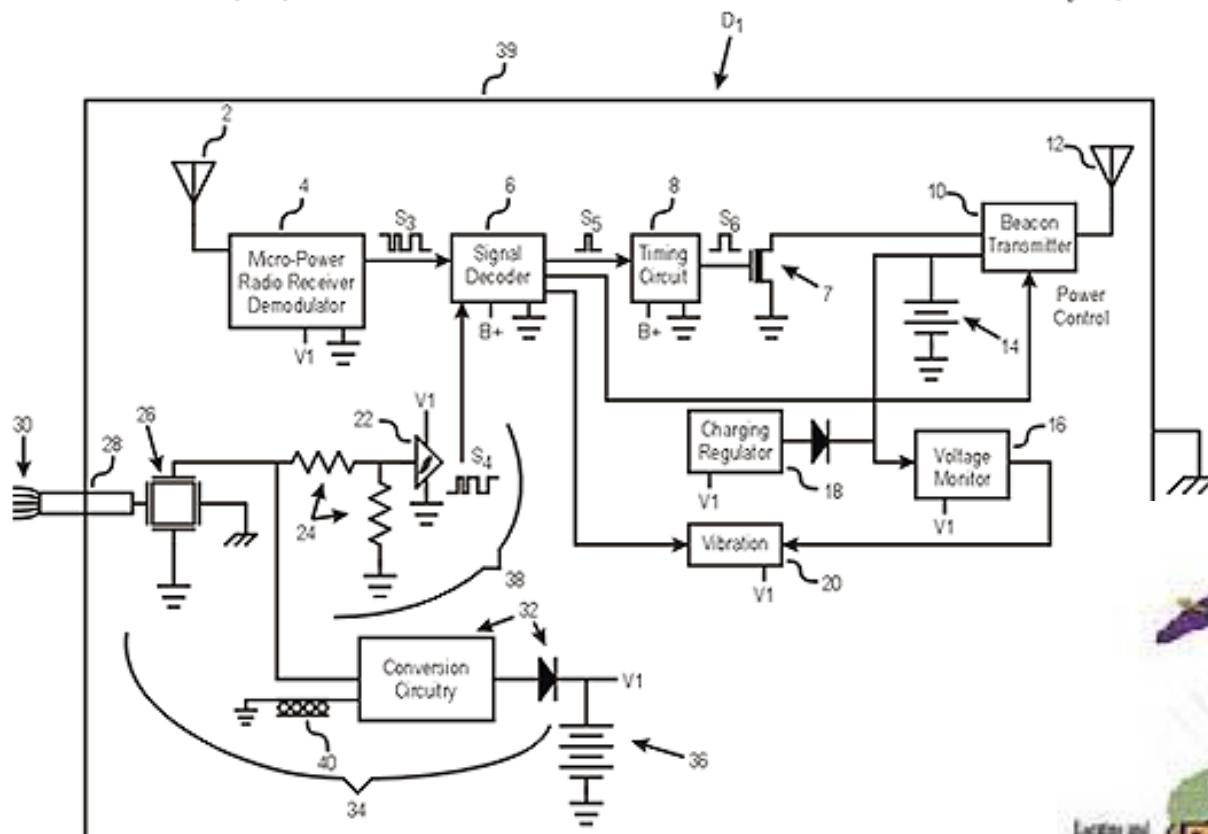
- Transition from exobiometrics
- Mandatory Process Integration

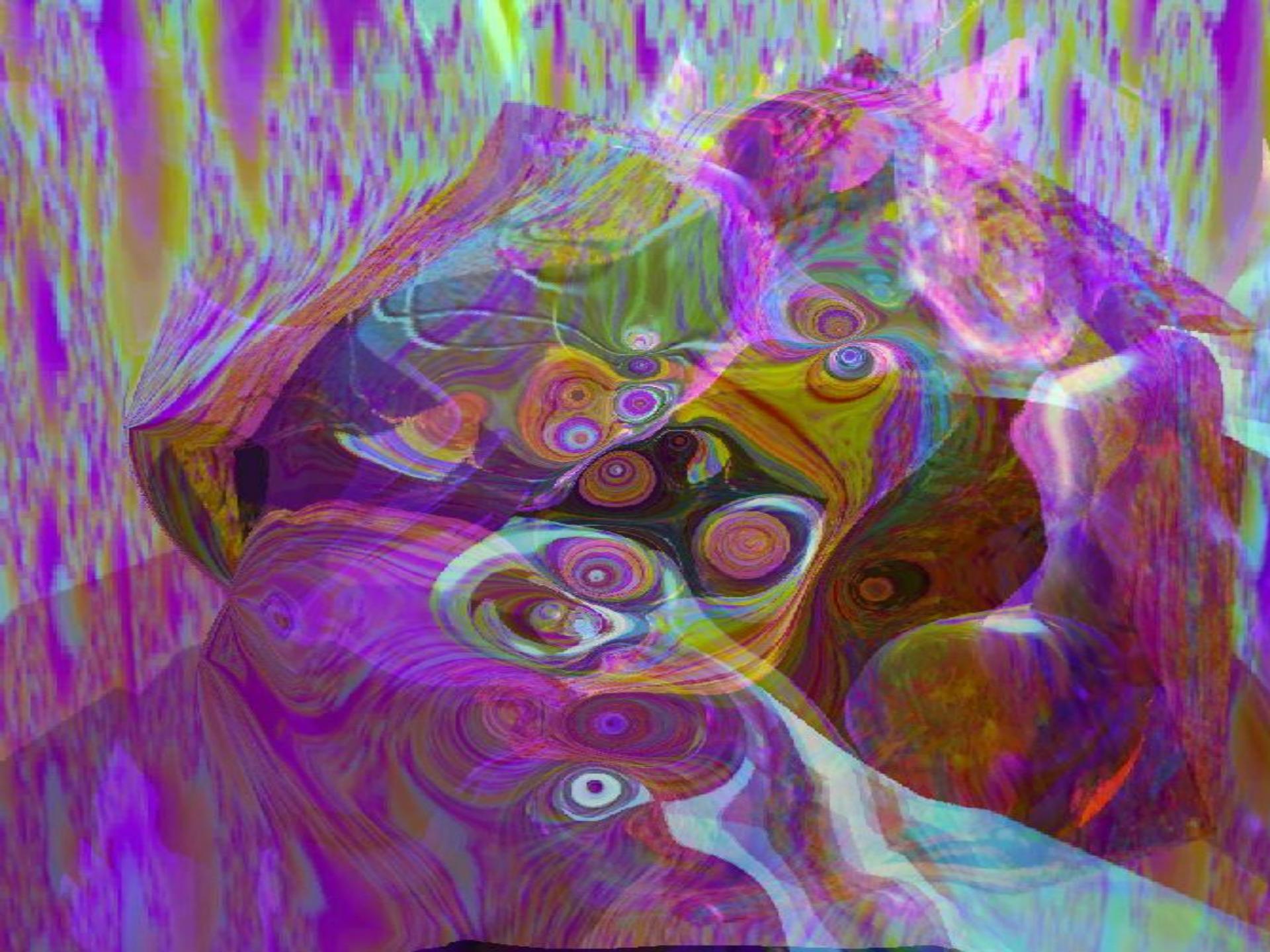


Ubiquitous Existence Transaction

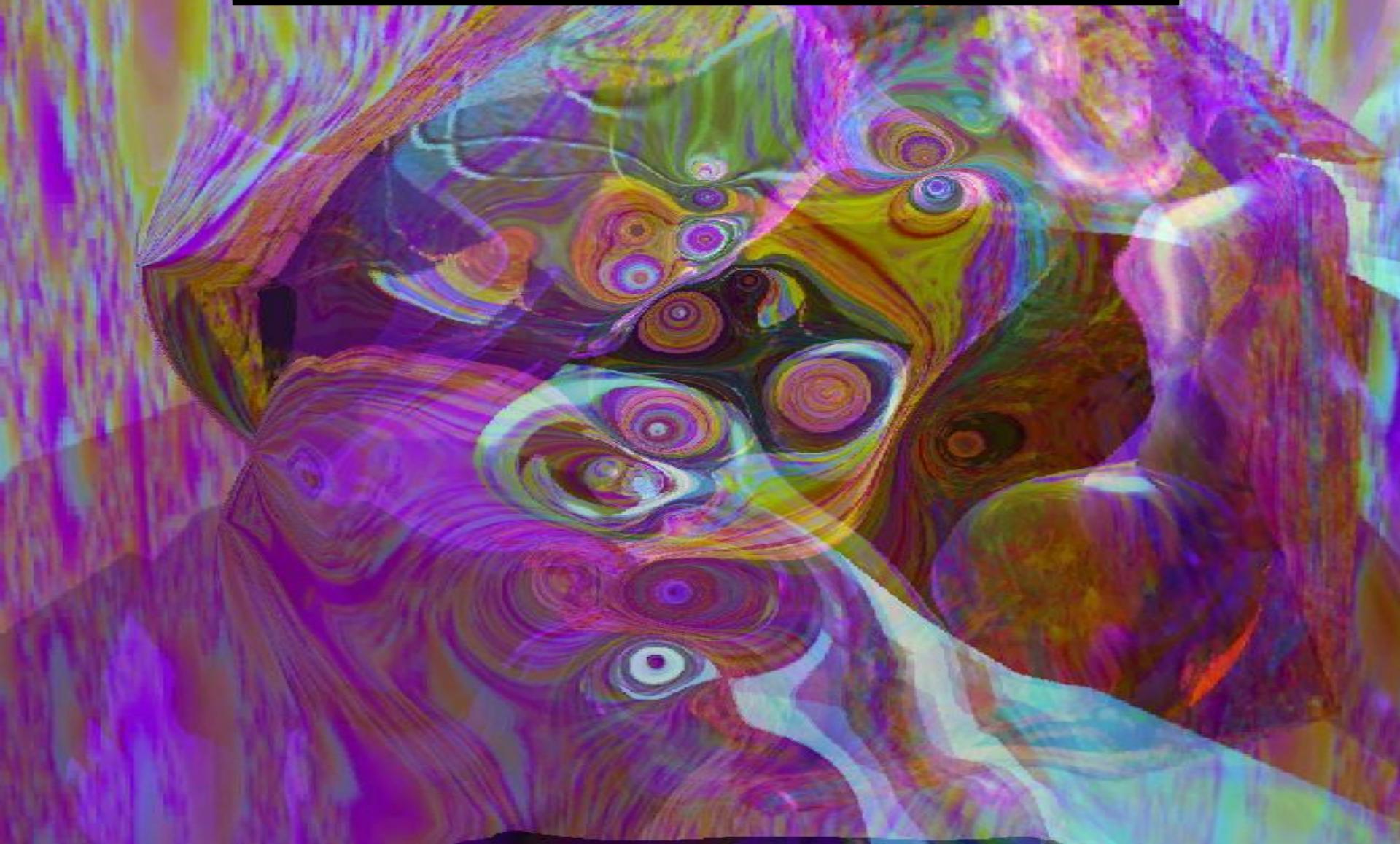
U.S. Patent 5,629,678

May 13, 1997



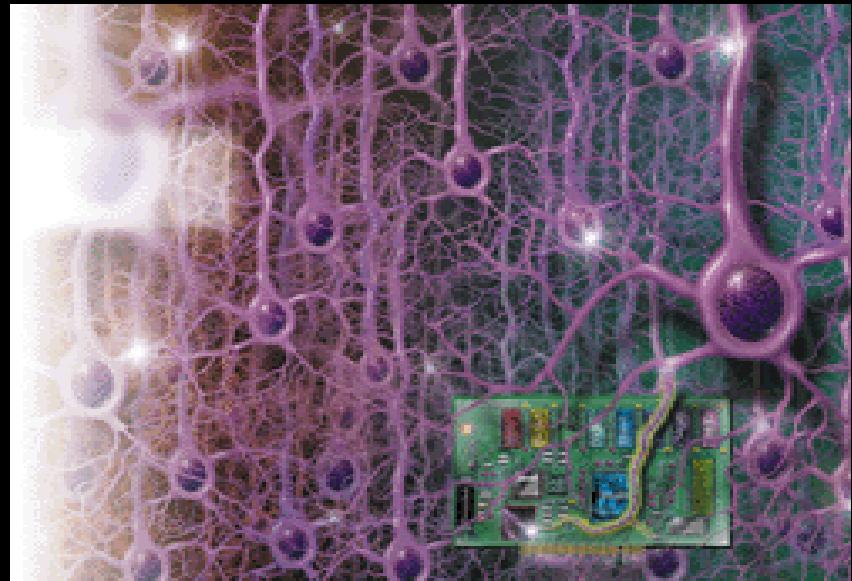
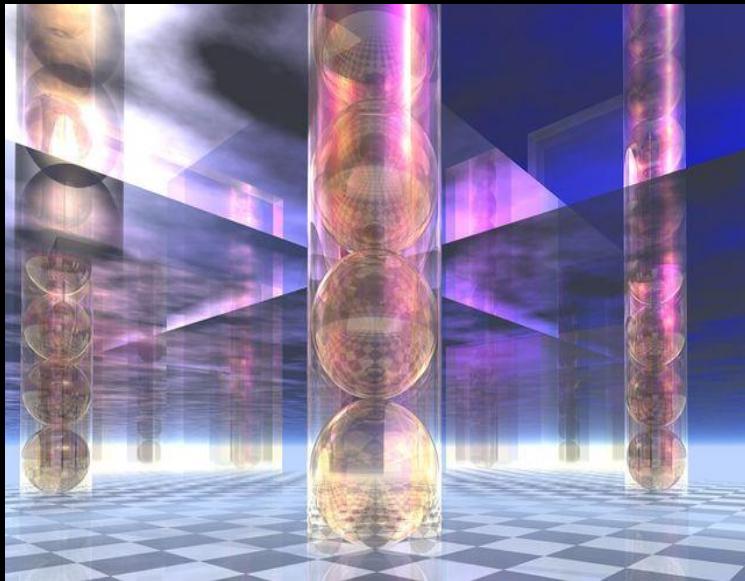


Concluding Thoughts for Consideration . . .



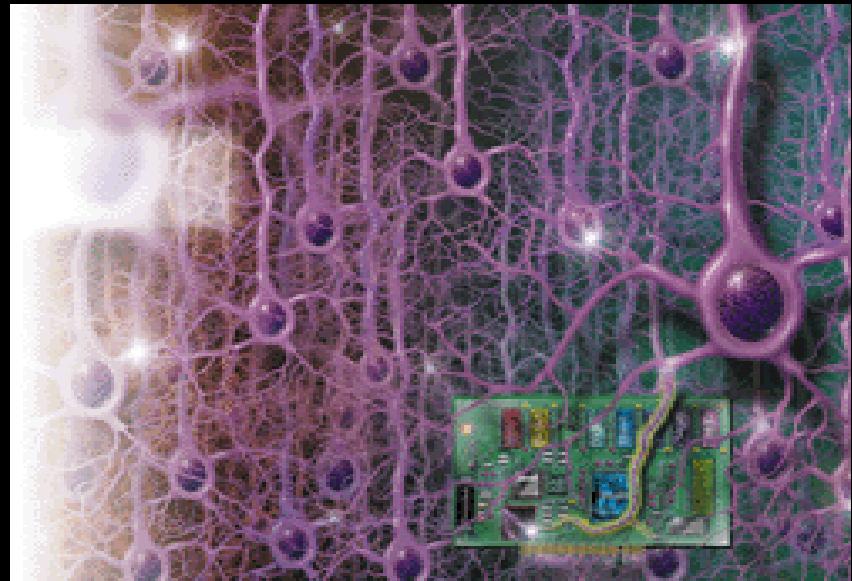
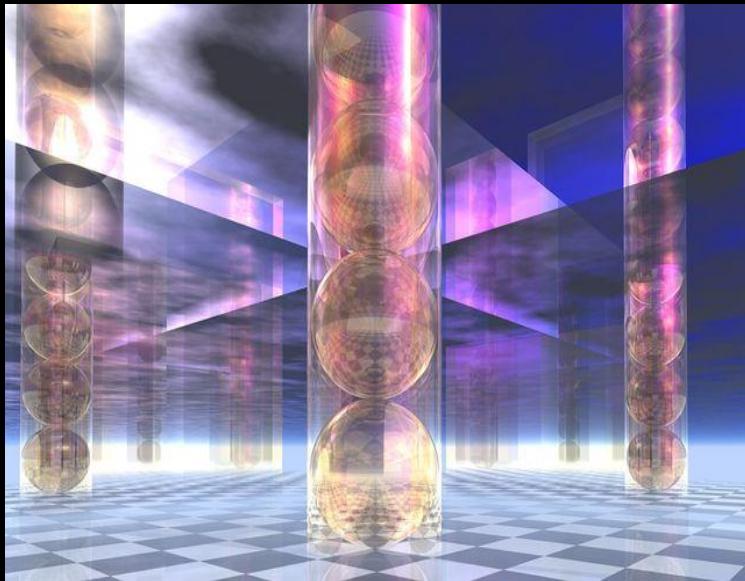
Emergent Evolutionary Eventstream - Operational Ecology Continuum

- Knowledge complexity, scale, and velocity is exceeding human capacity for mission critical decision rendering compressed into ever shortening time scales.
- Development and deployment of complex metasystems of artificial autonomous entities, synthetic lifeforms, and emergent intelligences becomes the acceptable if not mission critical “culture norm” of the near future.
- Perceived boundaries of the “synthetic” and organic, the “virtual” and the real, are becoming enmeshed into an operational ecology continuum.



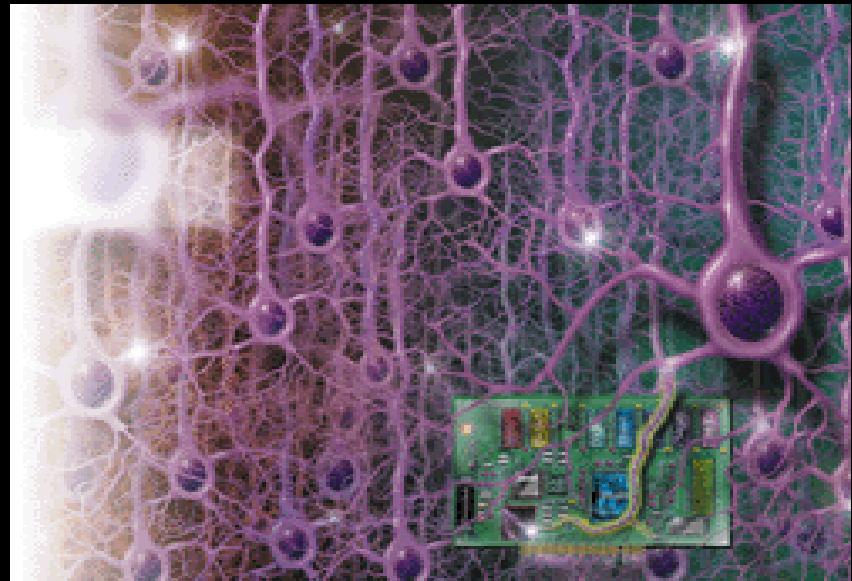
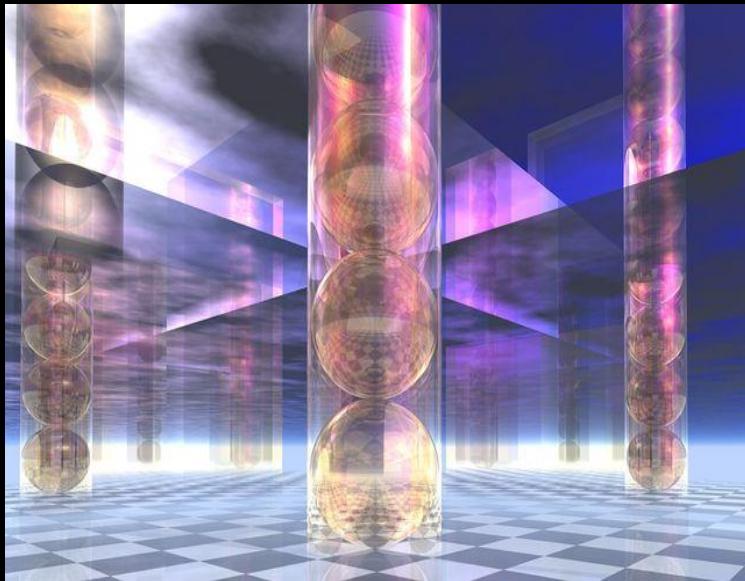
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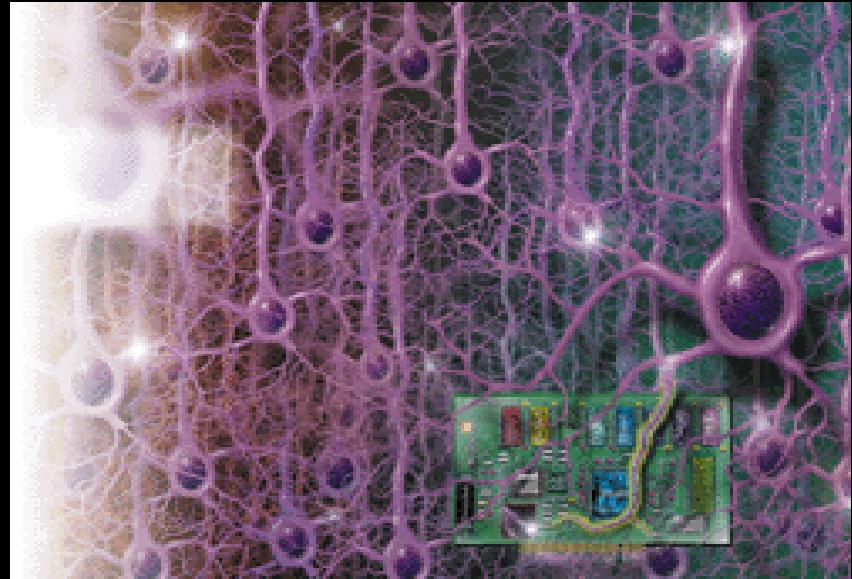
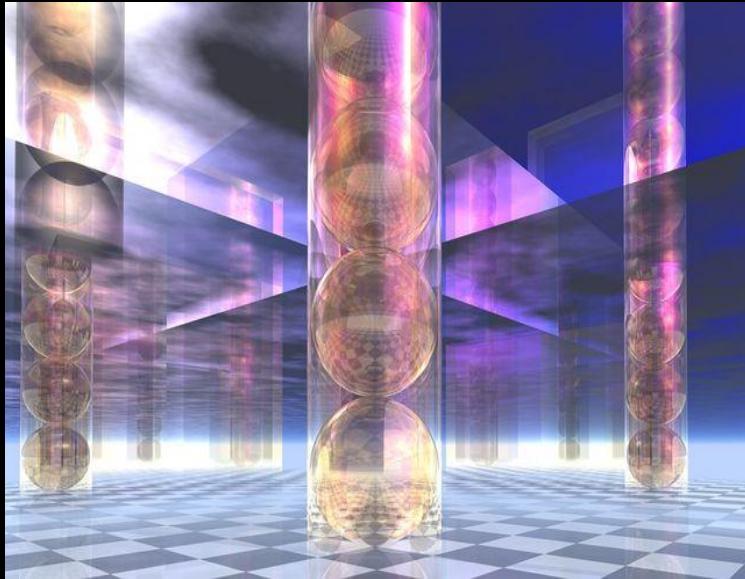
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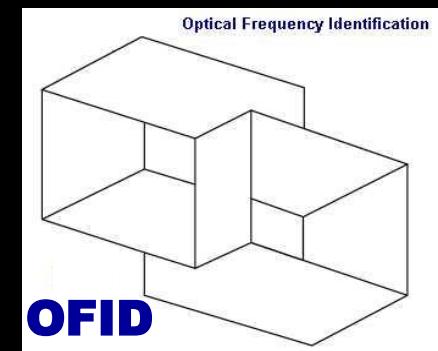
Special Thanks to the Following Contributors:



Nanoplex Technologies Inc.



DNA SECURITY SOLUTIONS



Nano Electronics & Photonics Forum

NanoElectronics & Photonics Forum Conference

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www.technofutures.com/charles1.htm

www.NanoSIG.org/nanoelectronics.htm

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Catalyzing the next industrial revolution spawned by the convergence of
interrelated domains of applied nanotechnology in electronics and photonics.

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www.NanoSIG.org/nanoelectronics.htm

Cambrios - Dr. Michael Knapp Bio-assembled electronics / integrated devices

Integrated Nano-Technologies – Dr. Mark Nance DNA enabled electronic bio-sensors

U of Illinois, Urbana-Champaign - Prof Ralph Nuzzo Self assembling nano-electronics

Knowmtech - Alex Nugent Nanotechnology-based neural networks / integrated devices

Nanomateria - Prof Samuel Stupp, Northwestern U Self assembling bio-material systems

Sandia Lab – Dr. John Shelnutt Photosynthesis as a biofoundry platform for nanostructured materials

University of Toronto / MIT - Prof. Edward (Ted) H. Sargent Quantum dots utilized in low cost infrared CCD array

OFL Devices - Phillip Langton Next generation nanotech enabled “smartdust” distributed sensors, “spray on” computers

Office of the President, University of California - Dillon Auyoung, Principal Analyst, Industry-University Cooperative Research Program

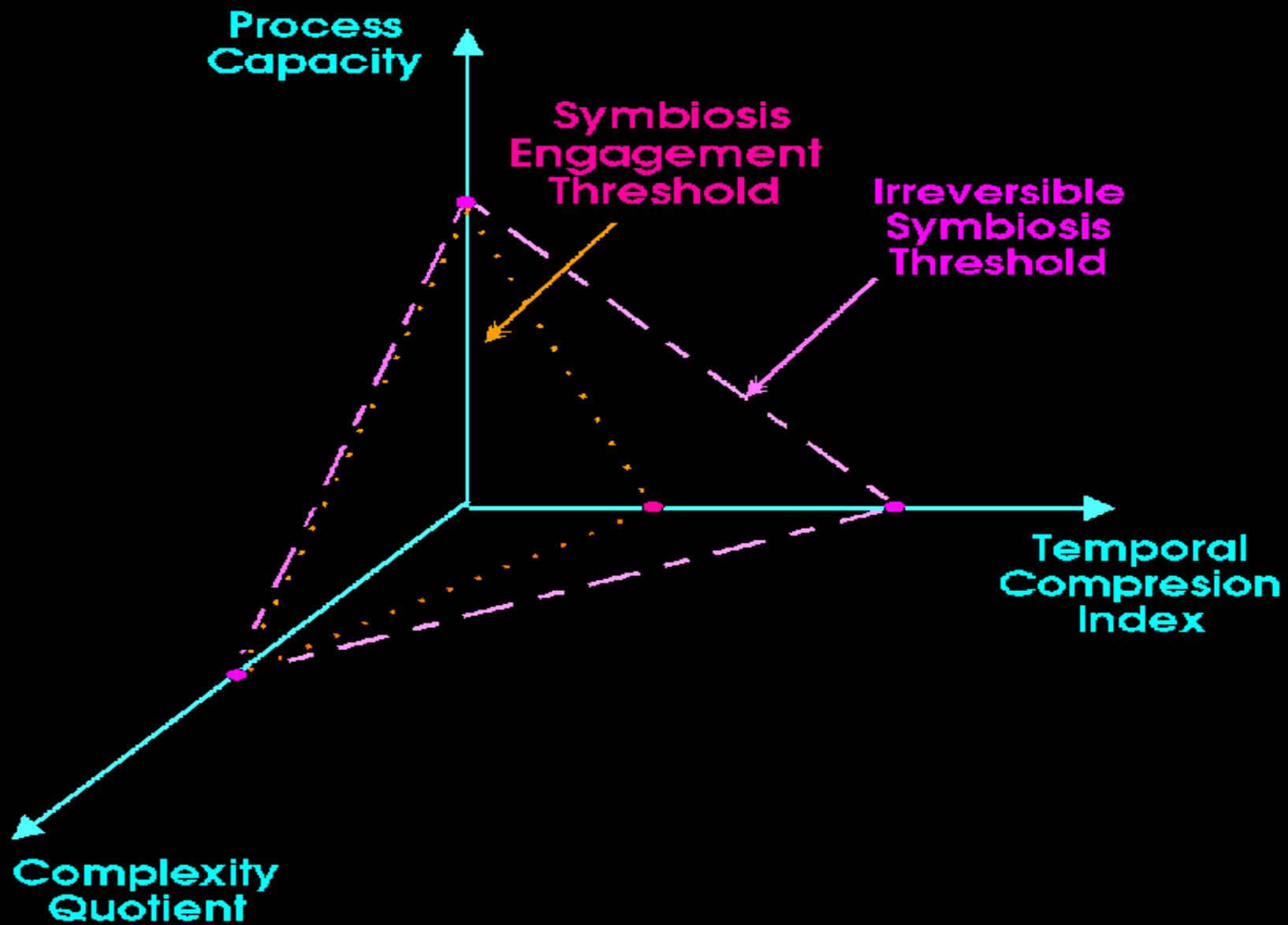
Institute for Global Futures, Silicon Valley Nano Ventures - Charles Ostman Understanding the value proposition of applied nanotechnology in electronics, photonics, integrated systems

Draper Fisher Jurvetson - Alexei Andreev

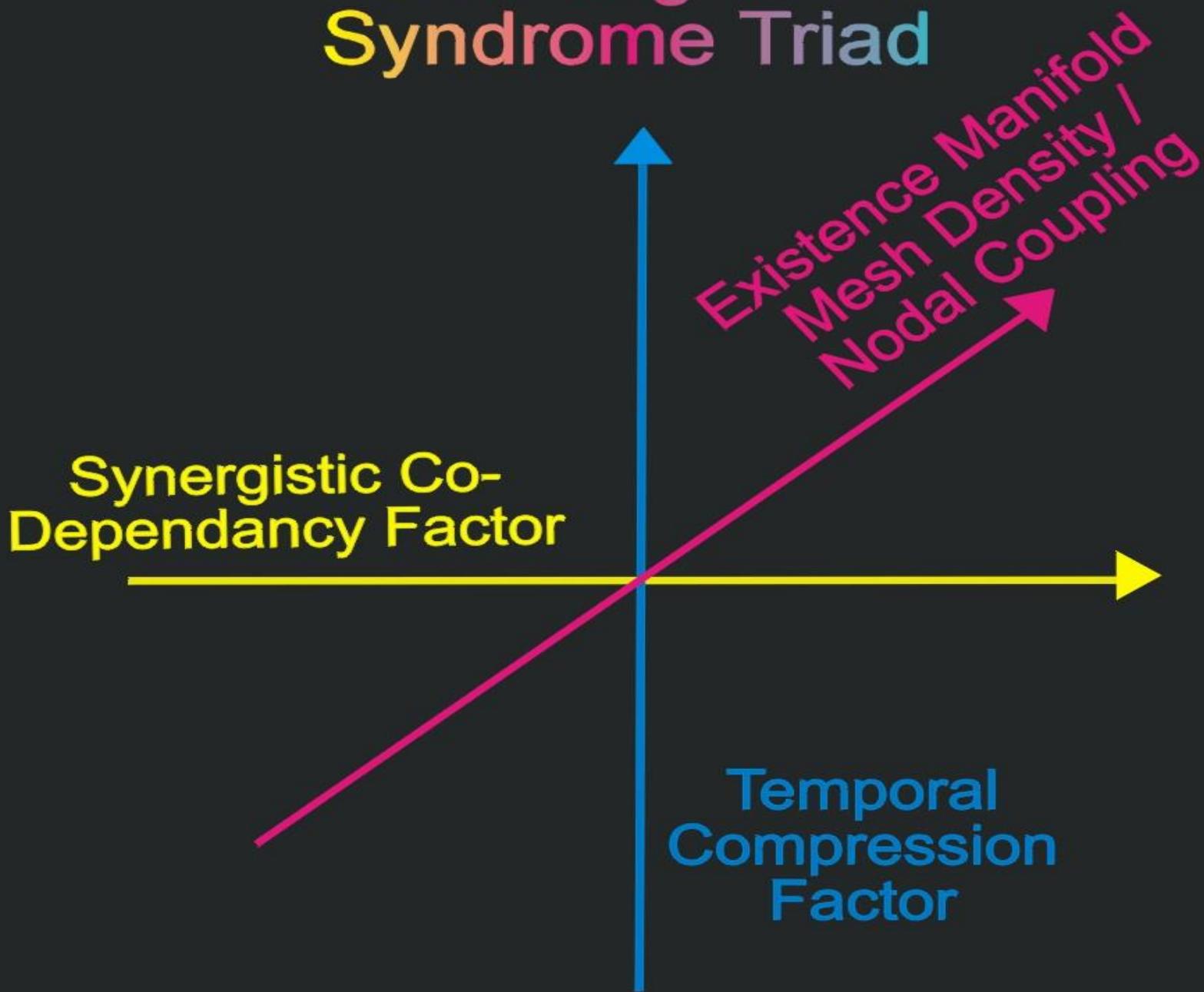
DotEdu Ventures - Asha Jadeja`

Catalyzing the next industrial revolution spawned by the convergence of interrelated domains of applied nanotechnology in electronics and photonics.

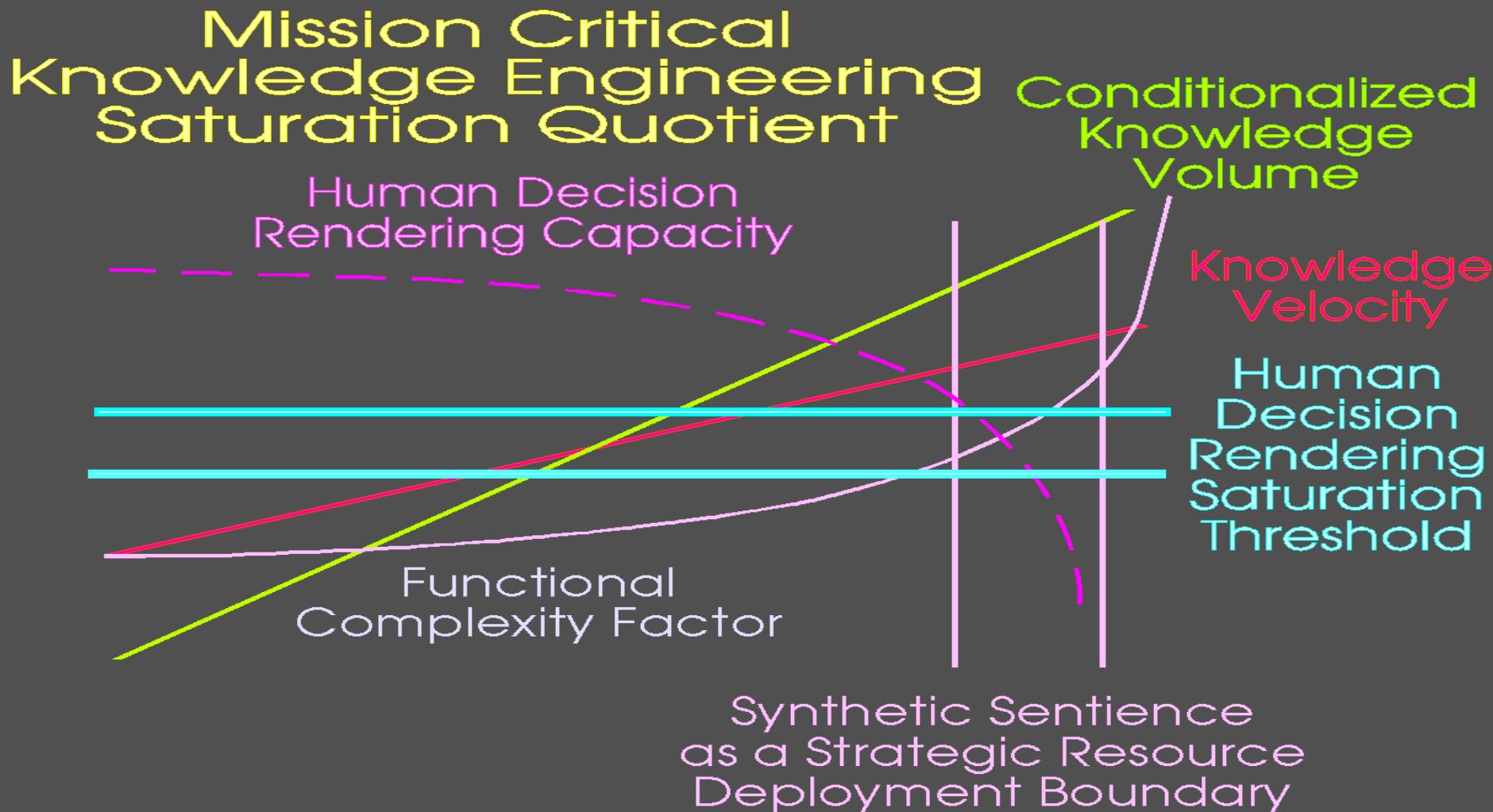
Emergent Synergistic Co-Dependency Manifold



Convergence Syndrome Triad



Synthetic Sentience Threshold



Biometric Convergence



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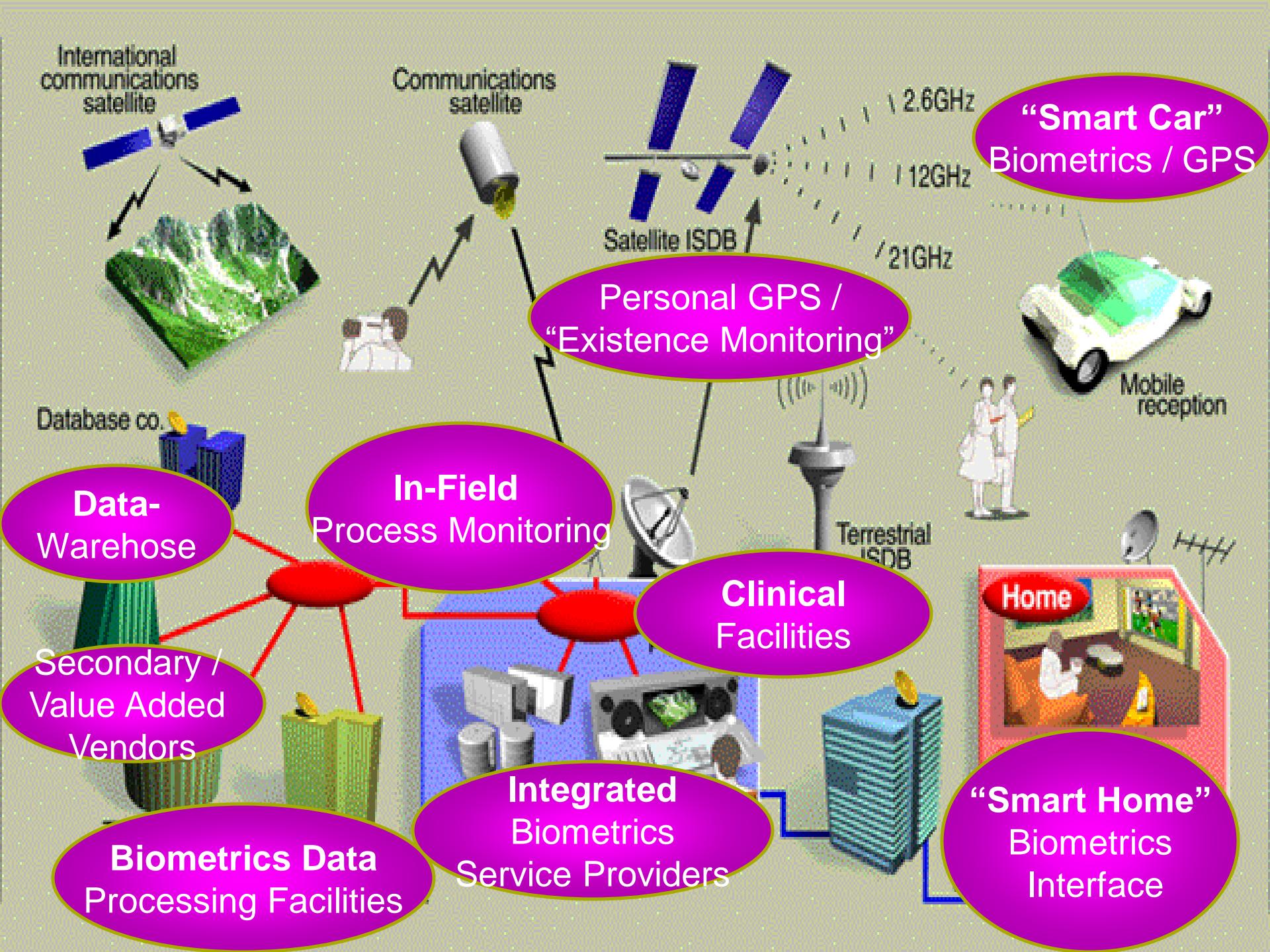
Integrated Airport ID Security System

Voter Registration *Coming Soon!*

Voter Registration Photo ID System

National Id & License *Coming Soon!*

License & National Photo ID System



Evolutionary Eventstream Imperative

- Emergence of “synthetic entities” as a culture norm
- Peer to peer tele-existence streaming
- Hybrid biological systems integration

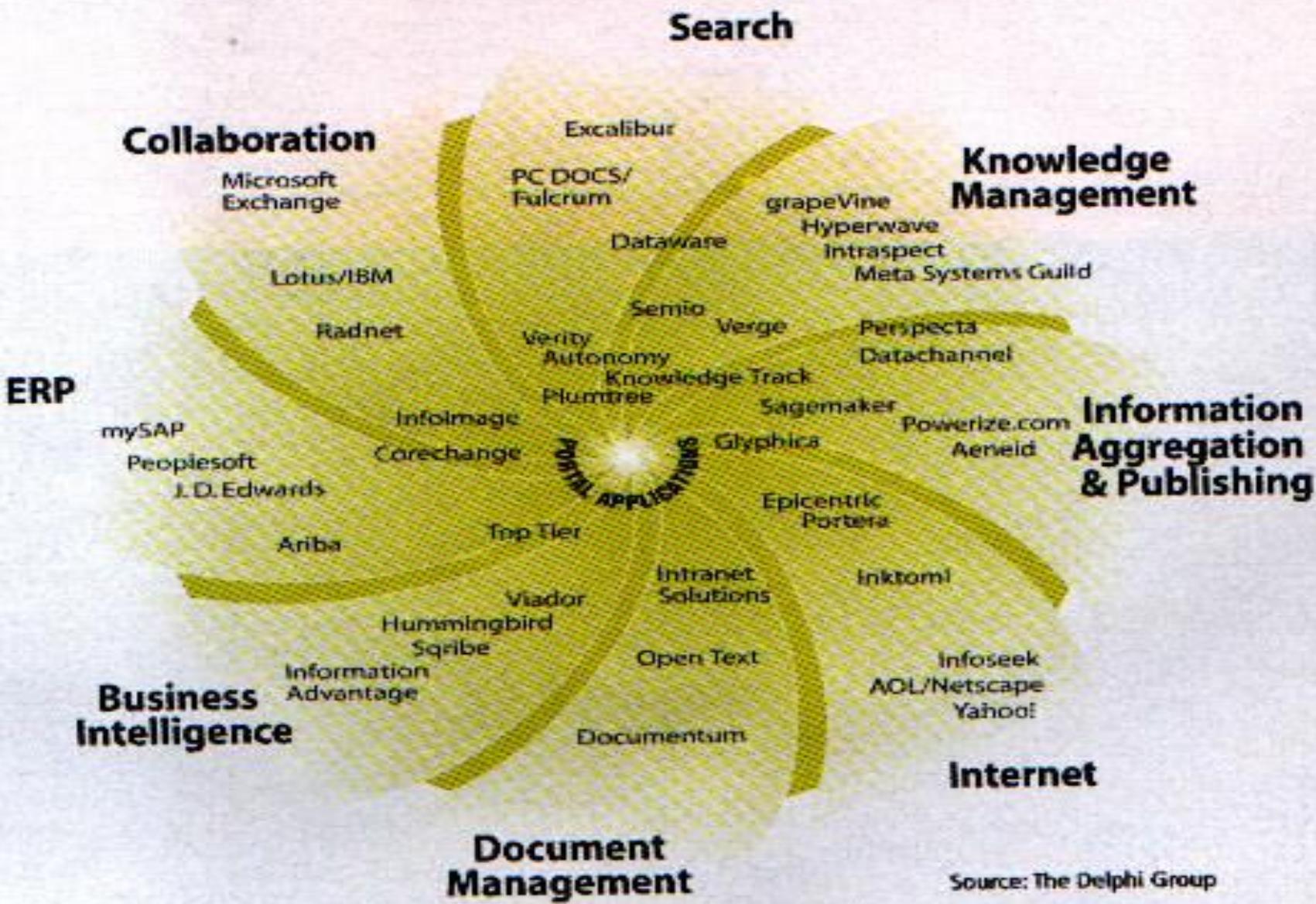


Ananova:
Who is she and
what makes her tick?

Virtual Humans - This is “Sylvie”

- She can market products, be a secretary, a help aid
- She can have any face, a programmable personality
- She is a connection interface to a higher, scalable intelligence





Source: The Delphi Group

Portal applications can serve as the hub for organizing various types of KM activities and related products.



“Virtual Human” Entity Interface



Ubiquitous Access Portals



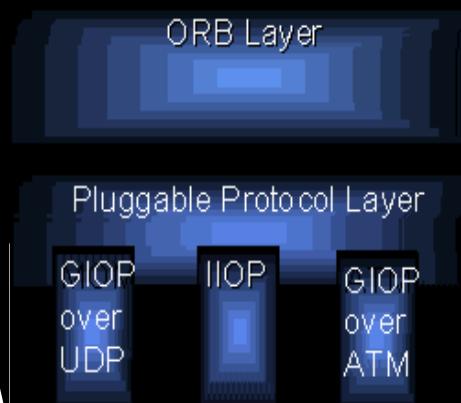
Smart Sensors Everywhere



Process Convergence

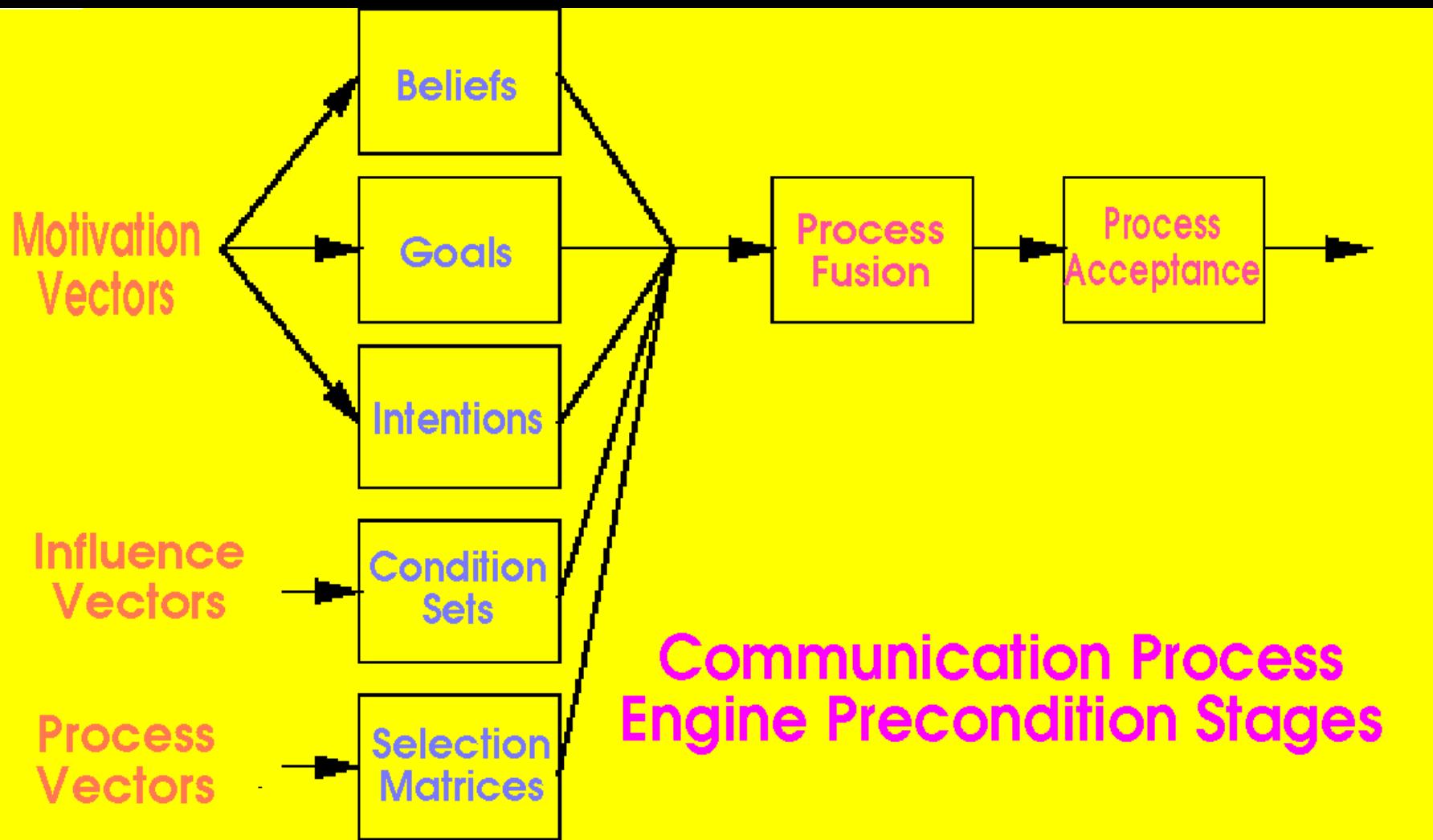


Intelligent Agent Hierarchies

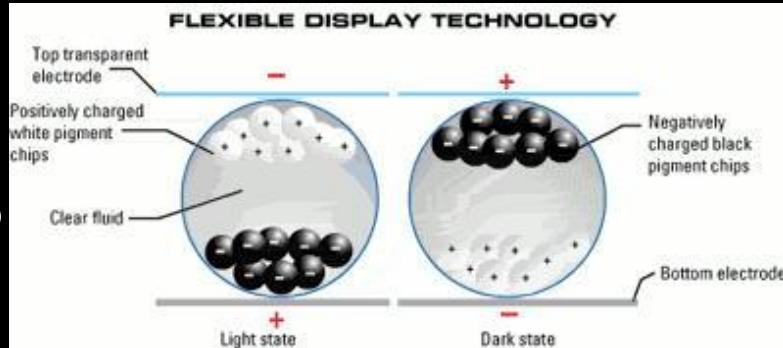


Process Brokeraging Architectures

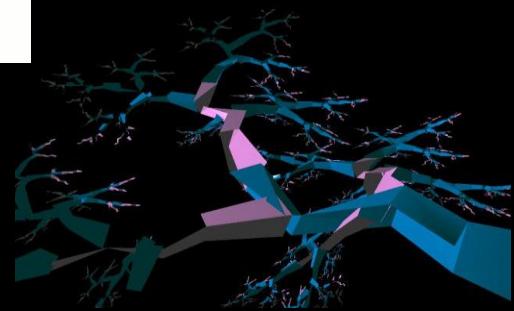
Artificially Enhanced Complexity Management - Process Control



Computers



Networks



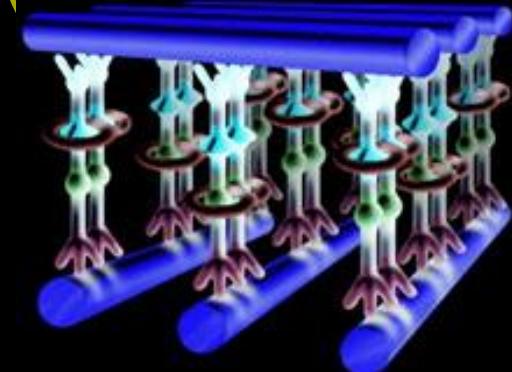
**Primary elements
of the emergent
operational
ecology**

Biotech



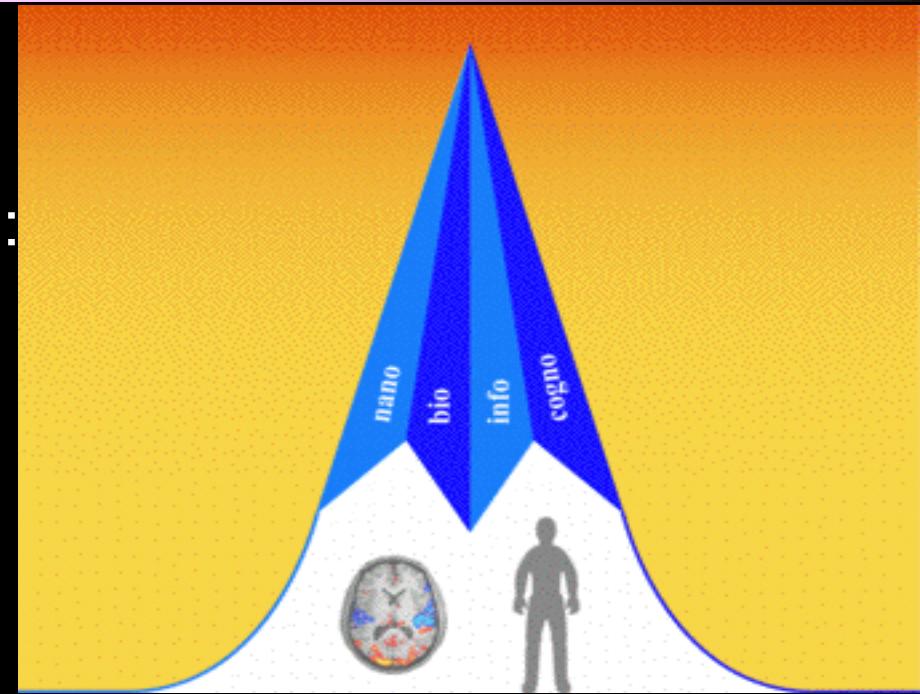
Flexible PET substrate using single crystal silicon NanoBlocks and sputtered aluminum Interconnects

Nanotech



The Emergent Infotech / Biotech / Nanotech / Cognotech Operational Ecology

NBIC Conference
Converging Technologies
for Improving Human Performance:
Nanotechnology, Biotechnology,
Information Technology and
Cognitive Science
NSF/DOC-sponsored report
<http://www.wtec.org/ConvergingTechnologies>



Most Important Key Features of Nanotechnology

- It is not necessarily about nano-widgets or “tiny machines”
- It consists of an ever expanding collection of interrelated fabrication processes and systems that operate with the controlled manipulation of atoms and molecules.
- Nanotechnology is the gateway to system integration

Ubiquitous Distributed Adaptive Intelligence Resources

