



SDR – From Radio to Applications → Cognitive Networks

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We are in a State of Transformation



***Access to Information
Anytime - Anywhere***



***There's no limit on available processing
and memory capacity***



***Human Collaboration is Driving
Social and Economic Change***



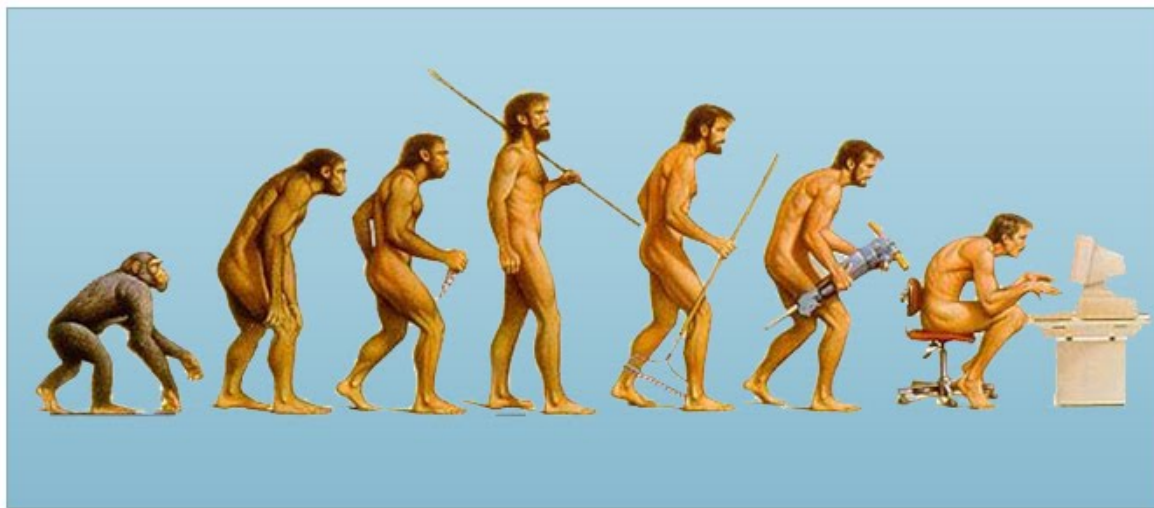
There's an "App" for everything

Transformation is not an incremental step forward – It represents an exponential rate of change

Would you believe that...



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- Chat and social media volume will exceed that of email within two years
 - Netflix, YouTube and other video streaming media will consume > 30% of the total available commercial internet capacity within 3 years
 - The WEB will “understand” spoken language within 5 years
 - There are approximately 1500 iPhone applications for accessing weather information – This is but one of a myriad of information domains!
 - Cyber crime and cyber terrorism will be one of the biggest threats to our society and welfare



“The changes in government use of technology in the next 20 years will be as great as all previous changes since the dawn of public safety radio networks”

Bill Schrier, CTO, City of Seattle

What does the future look like?



- Broadband Mobility will continue to shape every facet of our society
 - This trend speaks to communication networks
- Networked Collaboration via Social media technologies will drive social and economic change
 - This trend speaks to user's and the application paradigms they will drive
- There will be acceleration of commercial technologies into once protected spaces such as Defense, Public Safety and other Mission Critical Industries
- Successful enterprises will rely even more on leveraging vast eco-systems



Trends & Perspectives



- Emergence of wireless broadband may be the most significant technology breakthrough in the last decade
- Mission-critical industries that rely on a mobile workforce are poised to leverage this technology in ways that will significantly enhance their ability to perform their mission
- As the “game boy generation” enters the workforce they will drive their commercial experience & expectations to the workplace
- Current public safety status quo is being challenged by rapid evolution of commercial wireless
 - User experience is the dominant influence in the technology trend
 - Applications Based Technology is the focal point – the User is driving this change, no matter the mission
 - Mission-criticality is no longer just about communication – it is about access to information
 - A generational shift is taking place where we are moving from a push to a pull model of information exchange – users want information when, where and how their mission requires it
- This user-driven shift will have a profound influence on how we apply commercial technology to traditional closed eco-systems



Technology Implications



- Moving from Radio → Network → Application-Centric Focus
 - Battlefield Wideband is now being deployed
 - Broadband is emerging in Public Safety & the Battlefield
 - Wideband/Broadband connectivity is enabling Convergence – “Apps on the Move”
 - Edge device is more than Comms – it’s a termination point for Apps
 - Video is becoming a “Universal App” like Voice



- Commercial technology leverage is escalating
 - iPad, iPhone, Google are redefining user expectations
 - Generational influence is driving change based on user’s “commercial experience”
 - Expectations for ubiquitous access to information – *There’s an app for everything*
 - User-developed apps for Battlefield Cellular Networks are emerging
 - Next generation Public Safety network mandate for commercial 4G LTE
 - Large commercial ecosystems driving development of Cellular Waveforms, Devices & Application Platforms



- Network complexity will challenge today’s Mission Planning capabilities
 - Missions require complex multi-technology solutions
 - Increased emphasis on Self Forming & Self Optimizing technologies
 - Ease of use is critical to acceptance by users on the critical edge



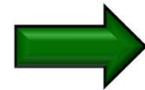
Applications Drive the Need for Broadband



System Evolution – Roadmap for Public Safety Migration



Today



Mid-Term



Long -Term

Multiple Technologies Disparate Networks

LMR & Paging
Systems



Commercial
Cellular Data
Services

Hybrid Network

Legacy LMR &
Paging Systems



Voice
Interoperability

700 MHz Public
Safety LTE
Network



- Roaming
- Asset Leverage
- Services

Commercial
Cellular Data
Services
(3G & 4G)

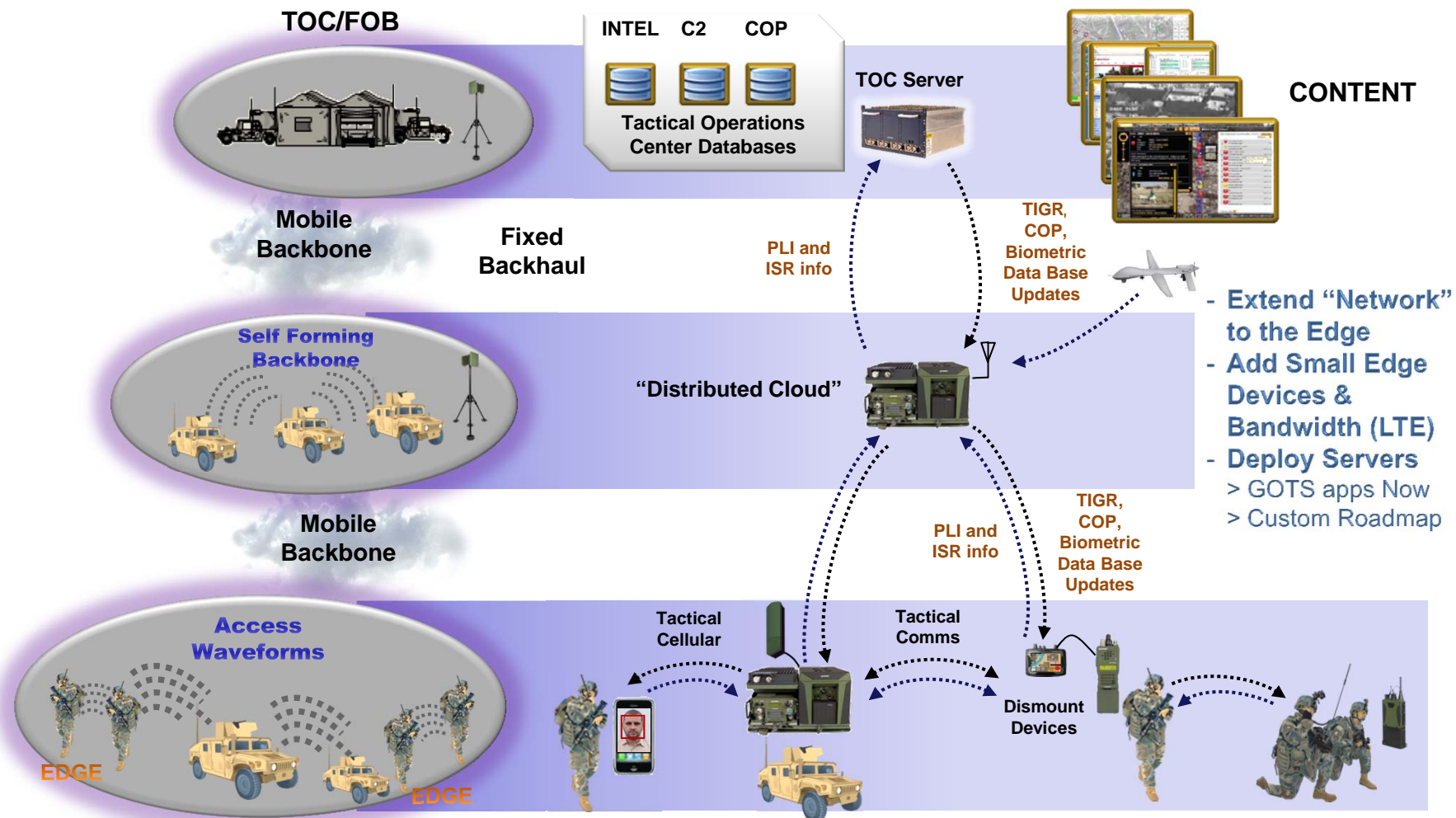
Converged Network

National Public Safety LTE
Network Supports:

- Mission Critical Voice & Data
- Nation-wide Roaming
- Public Safety Grade – Availability & Service Levels
- Interoperability with Relevant Alternate Technologies



Bringing Cloud Services to the Battlefield Edge

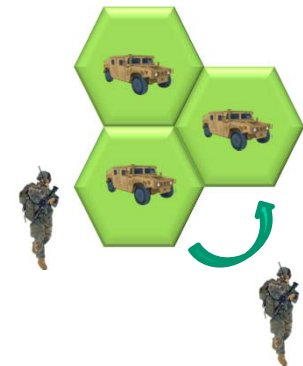


Solves Distributed and Disruption-Tolerant Content Delivery

Battlefield: Cellular- The need to address commercial technology gaps



- “Apps on the move”
 - Seamless availability of Cloud Provided and Locally Provided Services
 - Interoperating across diversity of military waveforms
 - Content-based Mobile Edge Networking
- “Cells on the move”
 - Self forming and optimizing cellular configuration
 - Performance implications without benefit of high profile sites
- Information Assurance
 - Demand for Information is ahead of Security Policy
 - Dealing with a global supply chain
 - Transport Network – Gap between traditional C4 security policies and commercial capabilities
 - Managing Secure Mobile Application Data Stores



Autonomous Networking Technology Evolution



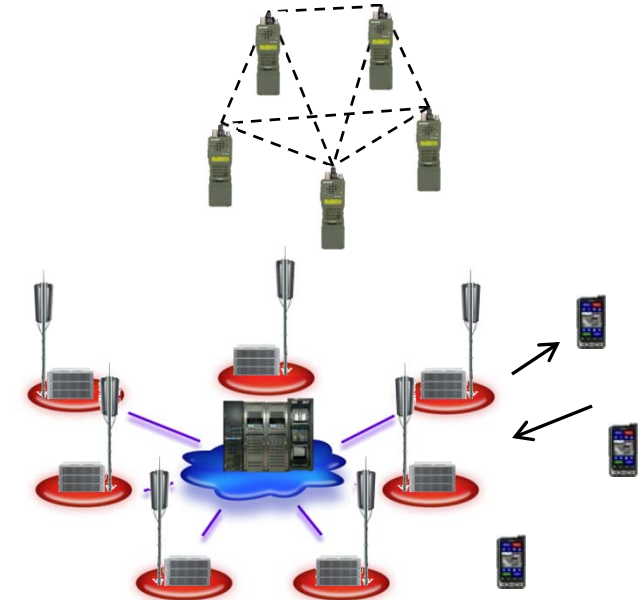
- Self Forming Ad-Hoc networks – MANET technologies form networks through collaboration at the radio-level
- LTE Self Organizing Networks – SON Technologies form, optimize and heal network infrastructure through collaboration between radios and the infrastructure
 - Self-configuration –Network expansion by 'plug-and-play'
 - Self-Optimizing – Infrastructure parameters autonomously adapt to environmental conditions (loading, interference, etc.)
 - Self-healing – Infrastructure isolates failures and adapts other elements to compensate
- Introduction of LTE into Defense and Public Safety will drive the need for self-forming cellular networks – “Cells on the Move”

Self Forming Backbones

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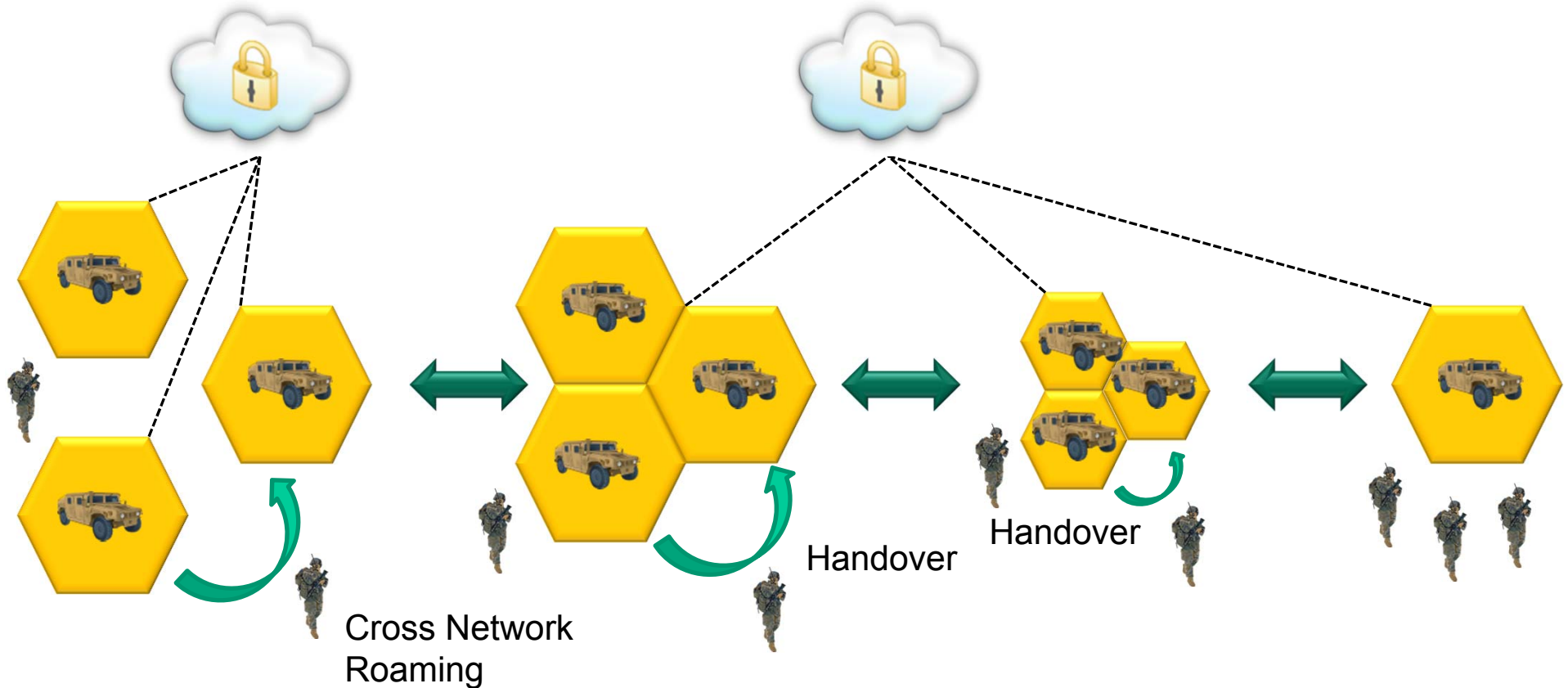
Dynamic Cell Formation & Optimization

= Cognitive Networks



- uE's are sensors that measure the environment
- Cells(eNodeB's) Instruct uE's to measure neighboring cell link parameters
- Maintains Automatic Neighbor Relation databases, configuration and optimization of cell parameters

Self Forming Cellular Networks

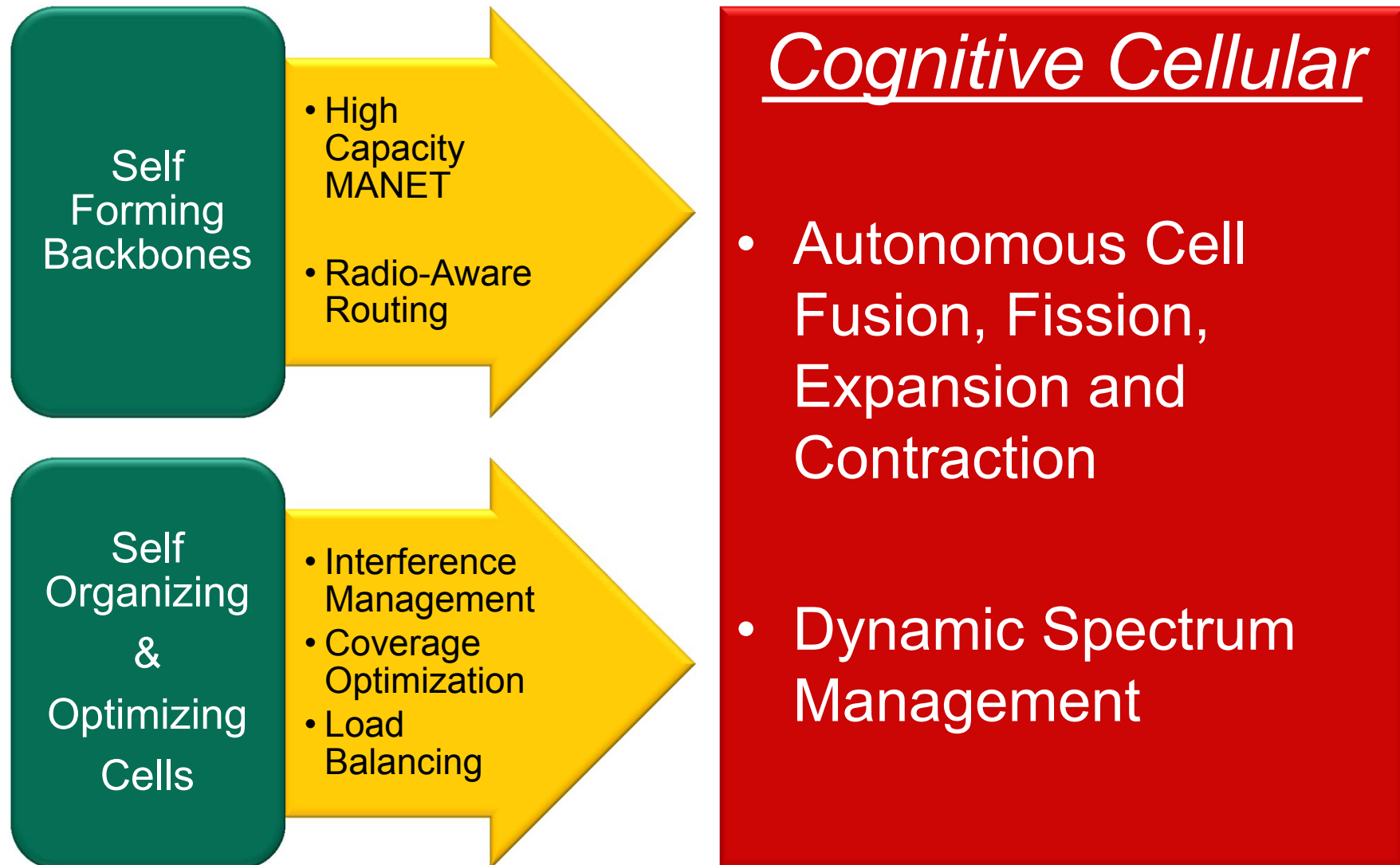


3 Independent Networks

1 Network – 3 Micro Cells

1 Network – 3 Pico Cells

1 Network

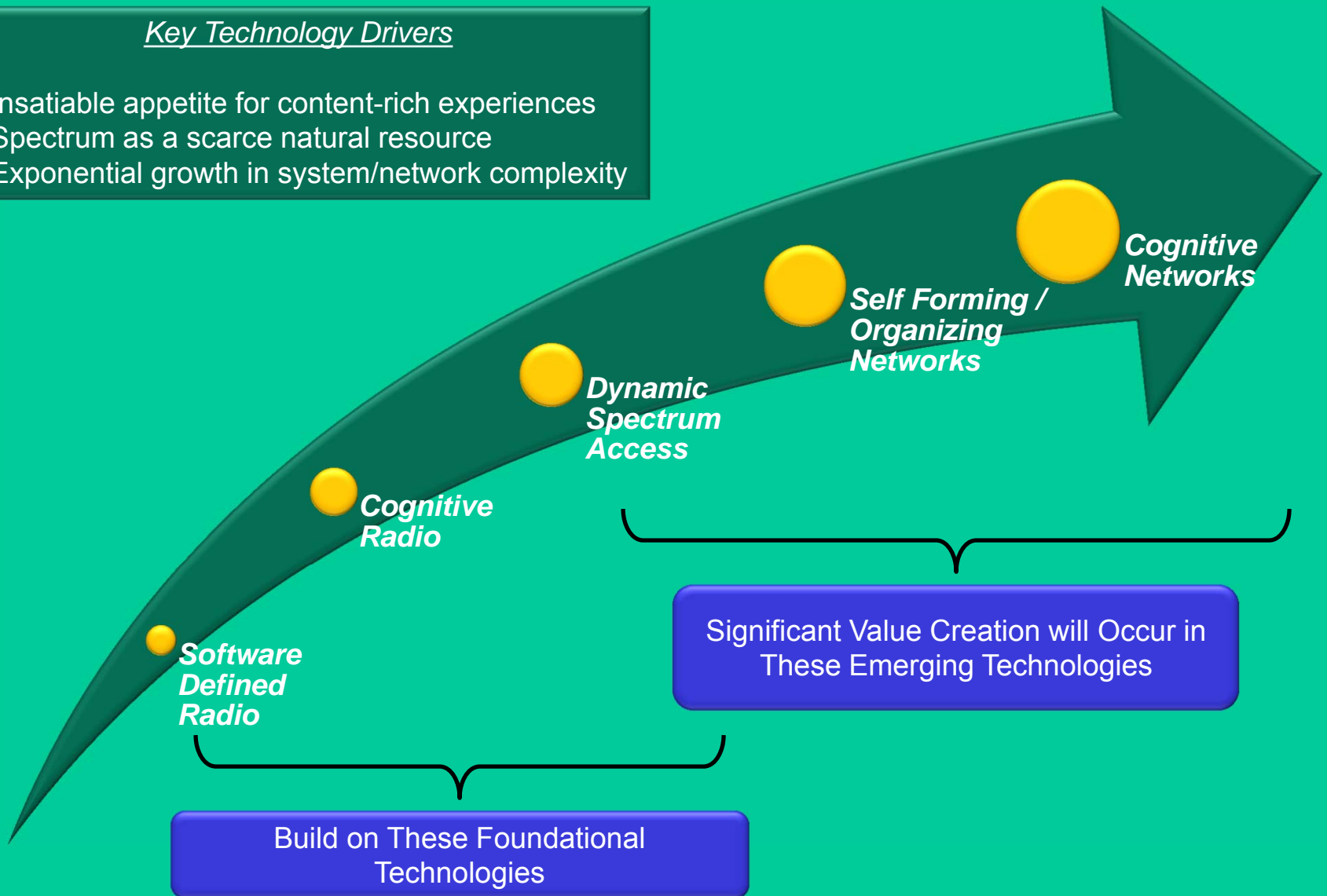


The Wireless Technology Value Chain will Shift



Key Technology Drivers

- Insatiable appetite for content-rich experiences
- Spectrum as a scarce natural resource
- Exponential growth in system/network complexity



Take Away-s



- The pace of technology evolution is accelerating
- Focus is shifting from Radio to Network to Application Centricity- It's about the user experience
- Technology Value Chain will drive Radio & Network Automation Technology



Thank You

