Trends in Military Communications

Is Software Defined Radio ready for a new chapter?

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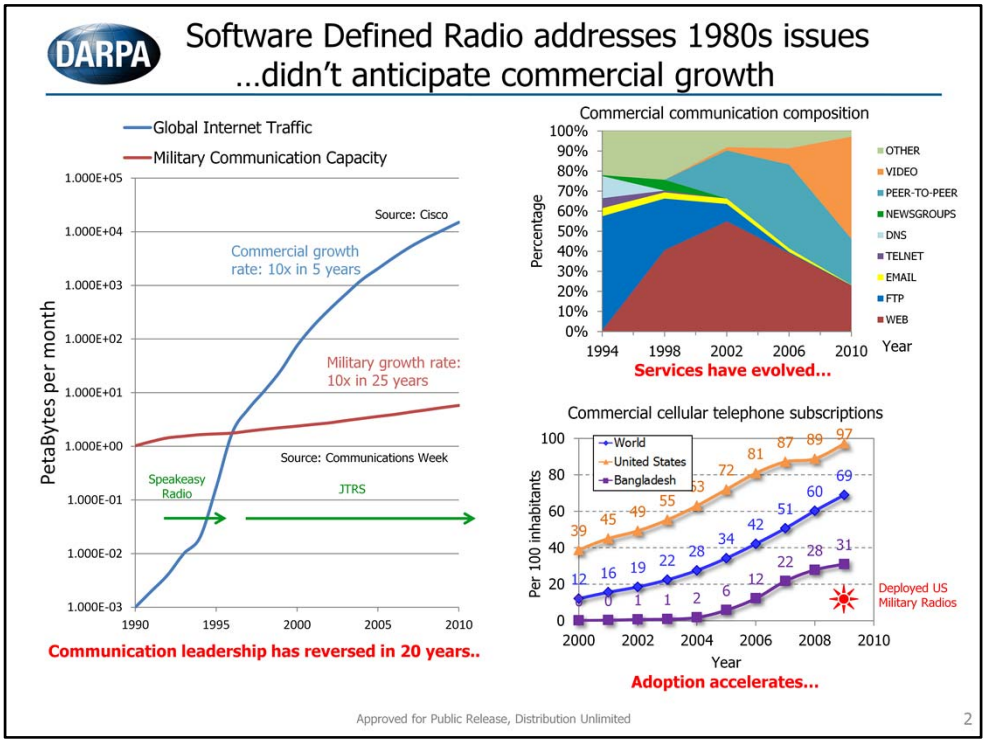
There is a perception that military comms is not as good as commercial

1) Soldiers are buying cell phones in the Kabul market that work better than the radios they get from the military

2) Why don't we just give soldiers iPhones?

3) We are giving soldier the same radios we used in training 20 years ago



In fact, communication leadership has reversed

In 1990, Military comms capacity (red line) was 1000x all commercial traffic (blue line)

~10x military comms growth in 20 yrs

Situation has reversed today - 1000x more today. Each telco spends more on R&D than DoD trend is likely to continue

Commercial traffic has evolved - 1994 – file transfer, 2002 – www, 2010 - video

Today's military tech results from early 90's decisions;

90s decisions solved problems of the 80s - interoperability

DSB

Didn't predict rate, volume or diversity

Commercial Communications State of the Art

Half mini-card WiFi/BT radio module

http://www.pcprodirect.com/

7 transceivers	4@ 2.4GHz, 3@ 6GHz
5 waveforms	40 MHz BW
62 protocols	Up to 450 Mbps
Software Defined	~ 50 mm^2
Hardware Defined	~ 30 mm^2

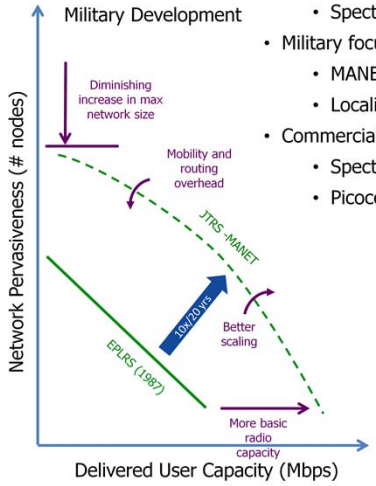
Incremental Technology Cost (2012 proj)	
WiFi	<$10
GSM/GPRS	$17
WCDMA or EVDO	$50
HSPA+	$75
LTE	$100

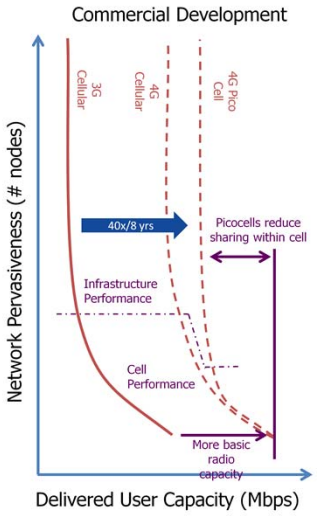
World Cellular Market – 430 Million/qtr
US Military Handheld Market – 190,000 (total)
Entire US Military volume = 45 minutes production

Technology is capable, cheap and readily available…
Communication modules not radios

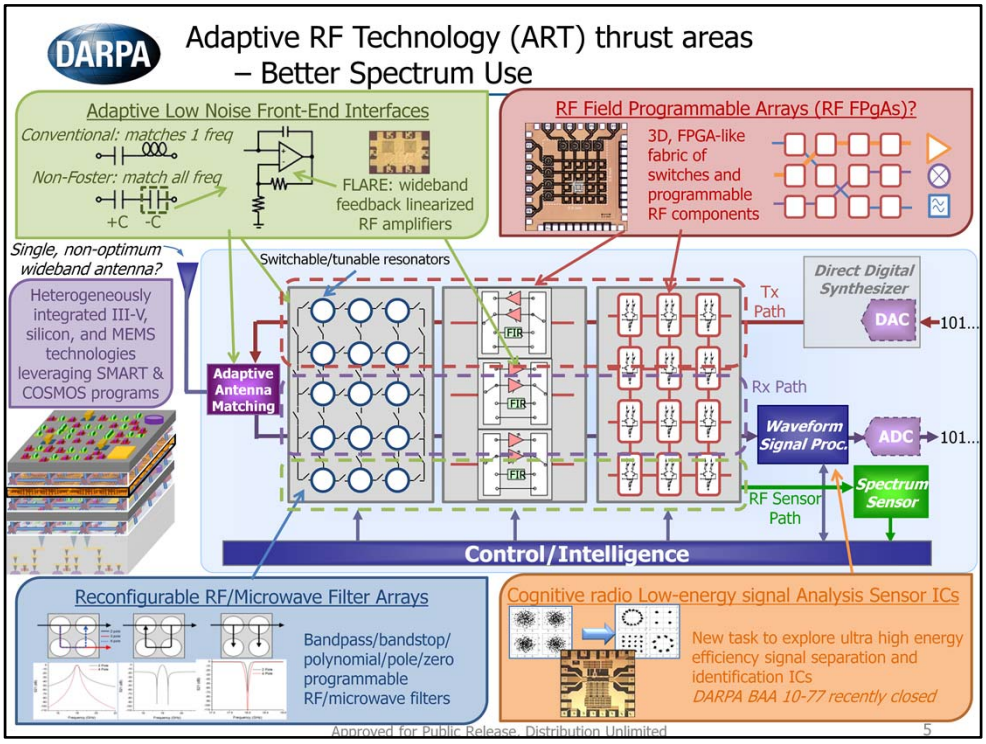
Development focus in the last decade

- Everyone wants more capacity
  - Spectrum, Space-Time processing
- Military focus on System Capacity
  - MANETs and Scaling
  - Localized Routing
- Commercial focus on User Capacity
  - Spectrum
  - Picocell, Femtocell





Where is the next innovation?


DARPA
Adaptive RF Technology (ART) thrust areas
– Better Spectrum Use
Adaptive Low Noise Front-End Interfaces
Conventional: matches 1 freq
Non-Foster: match all freq
+C -C
FLARE: wideband feedback linearized RF amplifiers
RF Field Programmable Arrays (RF FPgAs)?
3D, FPGA-like fabric of switches and programmable RF components
Single, non-optimum wideband antenna?
Heterogeneously integrated III-V, silicon, and MEMS technologies leveraging SMART & COSMOS programs
Switchable/tunable resonators
Adaptive Antenna Matching
FIR
FIR
FIR
Tx Path
Direct Digital Synthesizer
DAC
101...
Rx Path
Waveform Signal Proc.
ADC
101...
RF Sensor Path
Spectrum Sensor
Control/Intelligence
Reconfigurable RF/Microwave Filter Arrays
Bandpass/bandstop/ polynomial/pole/zero programmable RF/microwave filters
Cognitive radio Low-energy signal Analysis Sensor ICs
New task to explore ultra high energy efficiency signal separation and identification ICs
DARPA BAA 10-77 recently closed
Approved for Public Release, Distribution Unlimited
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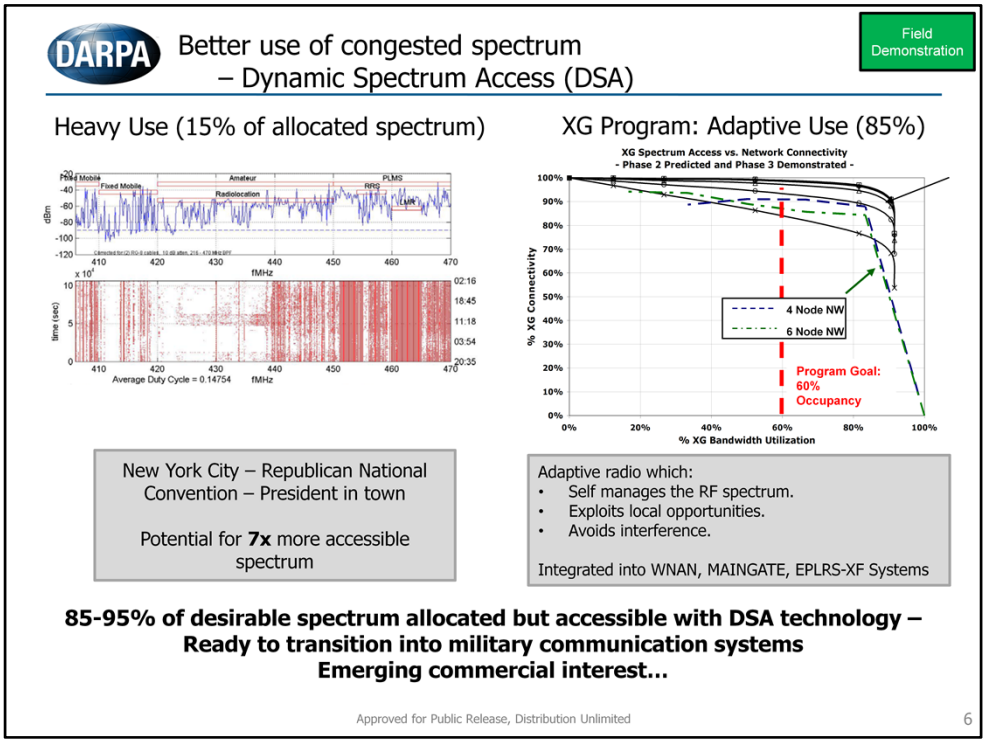
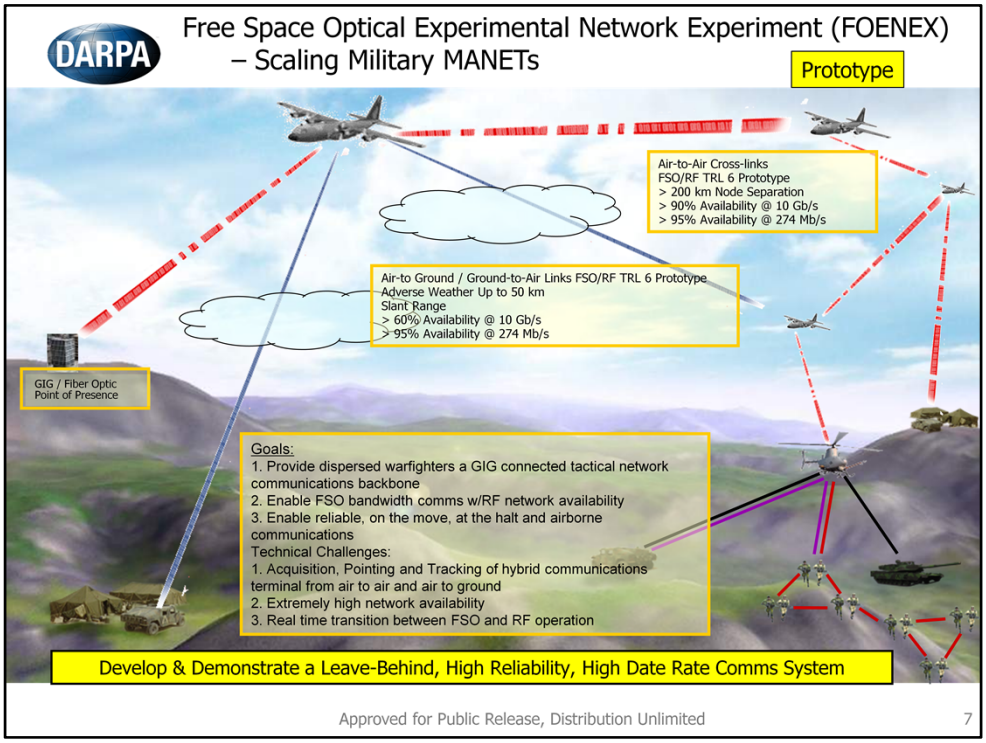


Explain, quantify investment opportunity. Translate information

Policy issue?


DARPA
Free Space Optical Experimental Network Experiment (FOENEX)
– Scaling Military MANETs
Prototype
Air-to-Air Cross-links
FSO/RF TRL 6 Prototype
> 200 km Node Separation
> 90% Availability @ 10 Gb/s
> 95% Availability @ 274 Mb/s
Air-to Ground / Ground-to-Air Links FSO/RF TRL 6 Prototype
Adverse Weather Up to 50 km
Slant Range
> 60% Availability @ 10 Gb/s
> 95% Availability @ 274 Mb/s
GIG / Fiber Optic
Point of Presence
Goals:
1. Provide dispersed warfighters a GIG connected tactical network communications backbone
2. Enable FSO bandwidth comms w/RF network availability
3. Enable reliable, on the move, at the halt and airborne communications
Technical Challenges:
1. Acquisition, Pointing and Tracking of hybrid communications terminal from air to air and air to ground
2. Extremely high network availability
3. Real time transition between FSO and RF operation
Develop & Demonstrate a Leave-Behind, High Reliability, High Date Rate Comms System
Approved for Public Release, Distribution Unlimited
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Wireless Network after Next (WNaN) – Scaling Military MANETs

Affordable networked radios for every warfighter and vehicle

Frequency	900 MHz to 6 GHz
Power	1W per channel
Data Rate	Adaptable from 90 Kbps to 2 Mbps
Range	>1KM per hop

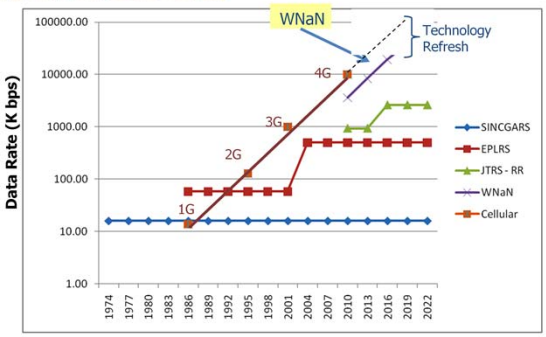
WNAN today v2.2

2.6" x 2.1" x 6.1"

WNAN 2012 v4.x

>15% Reduction

Low per unit costs—Leverages COTS components

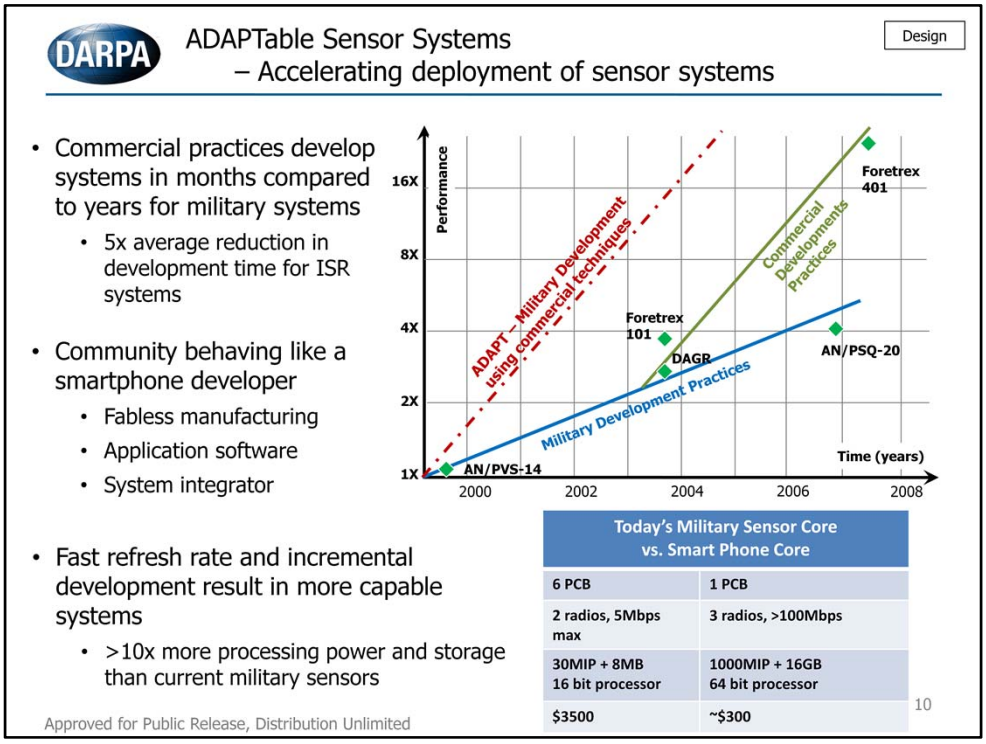


Radio Features

- 4-Transceiver node, member of four simultaneous subnetworks
- Wide frequency coverage
- Dynamic spectrum access (DSA)
- Self forming, ad hoc peer to peer network
- Disruption tolerant networking (DTN)
- IP for interoperability w/ legacy radios & networks
- Hazy sighted link state routing (HSLS) for low network overhead

What are the gaps?

- Explosive growth in Sensors
- Infantry Combat Team Priorities
  - 1 – interconnect the squads
  - 2 – interconnect the "cloud" of platoons
  - 3 – long range, secure communication to Company Command
- New definition of "secure"
  - Must be easy to use
  - Protect the information
  - …but also protect the use of communication – anti-exploitation



Military Sensor Developments suffer in two ways – 1) military technology develops slowly because of its complexity and lack of commercial R&D investments and 2) because commercial development practices return products in ~ 1 -1.5 years opposed to the ~5-7 years required by military development practices.

AN/PSQ-20 has 4x the performance of the AN/PVS-14 it replaces (adds 320x240 TE and improves resolution of II) in a seven year interval. The DAGR produced using military product development practices reach the market about the same time as the commercial Garmin Foretrex 101 GPS receiver. The Foretrex -401 improved more than 8x over DAGR performance in 4 years (8x size, 8x cost, 8x power, 5x weight, 3x TTFF).

Commercial rapid refresh allows for the incorporation of the latest technology producing a much more capable sensor system at lower cost.

For comparison, an iPhone4 has orders of magnitude more processing power and memory than today's military unattended ground sensors.

Adaptability is created from a fabless development process where the sensor system designer brings together the most appropriate technologies, Original Design

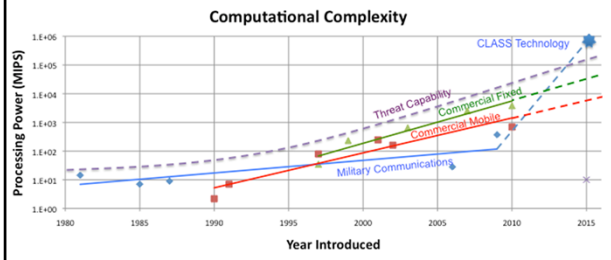
Manufactures (ODM), common software environments and software applications from different ecosystem partners.

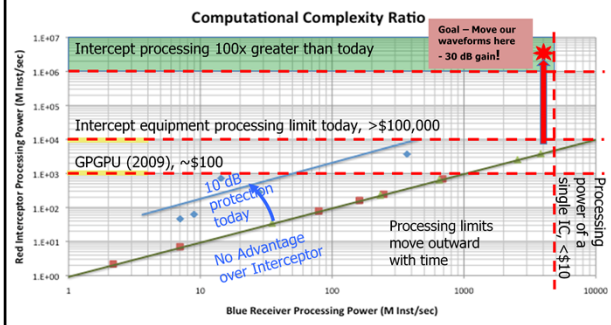
Efficiency is created from everyone in the processes doing what they do best.

This enables the rapid development of high-performance, low-cost multi-sensor systems that can be tailored to meet current mission needs.

Computational Leverage Against Surveillance Systems (CLASS) – EP using distributed radios

Concept





- **Technical Issue**
- The US losing advantage over adversary intercept threat
- new approach to protecting signals needed

- **Technical Objectives**
- Maximize adversary computational complexity
- Blue forces use a $10 receiver chip; adversary needs a "Super Computer"

- **Enablers**
- Techniques providing >1000x computational complexity ratio (30 dB)
- Radio modules to be integrated in conventional military radios (WNAN or JTRS)
- Integrated chipset for signals protection

- **Key Challenges**
- Development and implementation of:
  - Waveform Complexity,
  - Spatial Diversity and
  - Interference Exploitation
- Meeting 30dB differential computational complexity performance goals

Future trends in communications

- Communication is a function
- Communication is distributed
- Architecture is integrated