Defense Information Systems Agency
Department of Defense

National and International Spectrum Supportability and its Influences on Acquisition Process and Warfighter Operations

Lt Col Aaron Leong
8 May 08

Key Points

- Warfighter equipment must work in the operational electromagnetic environment worldwide
- Challenges are increasing to fielding worldwide deployable equipment
- Early spectrum supportability assessments are crucial

Agenda

- Why is Spectrum Important?
- National Factors
- International Factors
- Spectrum Supportability (SS) in the Acquisition Process
- Key Points

Why is Spectrum Important?

- Communications
- Command and Control
- Navigation
- Intelligence, Surveillance, and Reconnaissance
- Radars and Sensors
- Weapon Systems

Catastrophic Consequences

Lack of Spectrum Planning Examples

- **Enhanced Position Location Reporting System (EPLRS) and Situational Awareness Data Link (SADL): Not allowed in Germany or Korea**

- **Remote Ordnance Neutralization System (RONS): System fielded with significant limitations before system reconfiguration**

- **Global Hawk's Satellite Communication Data Link cannot be certified and must operate in exclusive non-government fixed satellite service band on a non-interference basis**

Impacts

Cost

B2 Radar - AN/APQ-181

AN/APQ-181 redesigned to conform to National Table of Allocation…

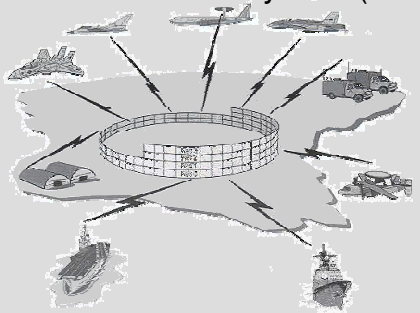
$1.3 Billion+

Schedule

15 Years of Delay

JTIDS developed in occupied band, OCONUS supportability limited

Joint Tactical Information Distribution System (JTIDS)



Performance

Near Term Digital Radio (NTDR)

NTDR not able to operate as intended, requires bandwidth well in excess of spectrum allocation scheme

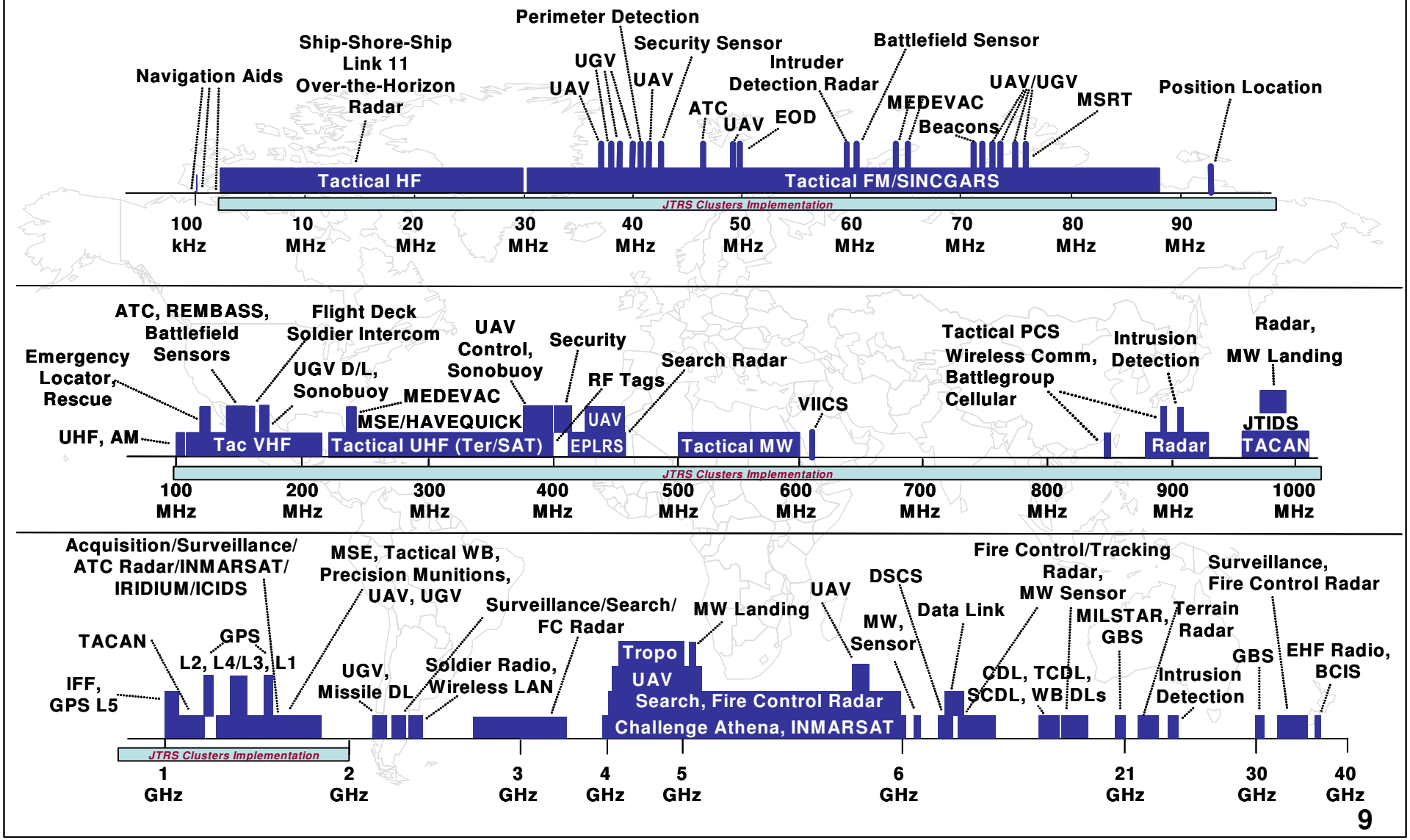
Degraded Performance

Growing DoD Spectrum Needs

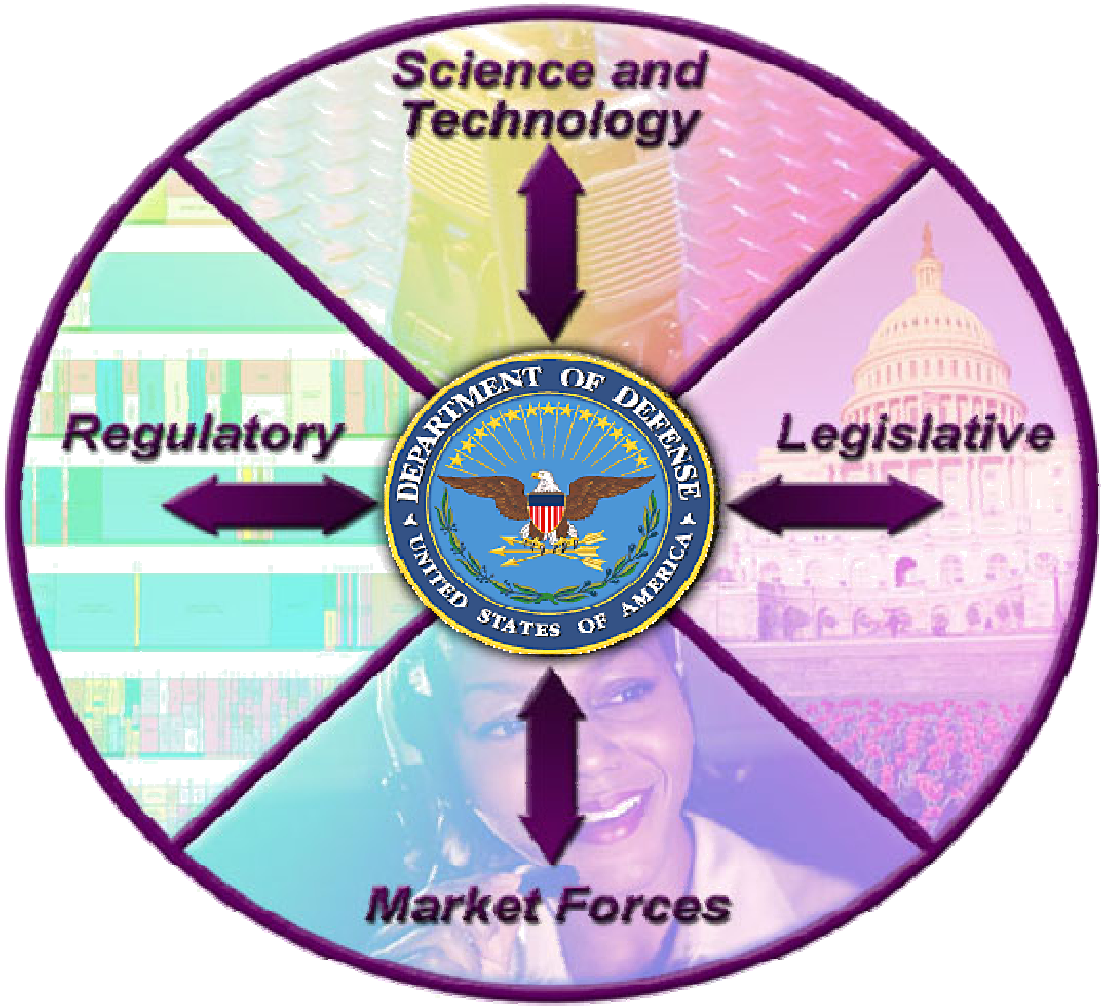
- DoD relies on spectrum for Global Operations
  - Communications
  - Sensors
  - RADARs
  - Unmanned Air Vehicles (UAV) & Unmanned Ground Vehicles (UGV)
- Greater bandwidth requirements will be the rule in acquisitions, not the exception
  - Net-Centric Warfare
  - Higher bandwidths
  - Greater mobility
  - Greater agility
  - Higher tempo

Photos: http://www.af.mil/photos/

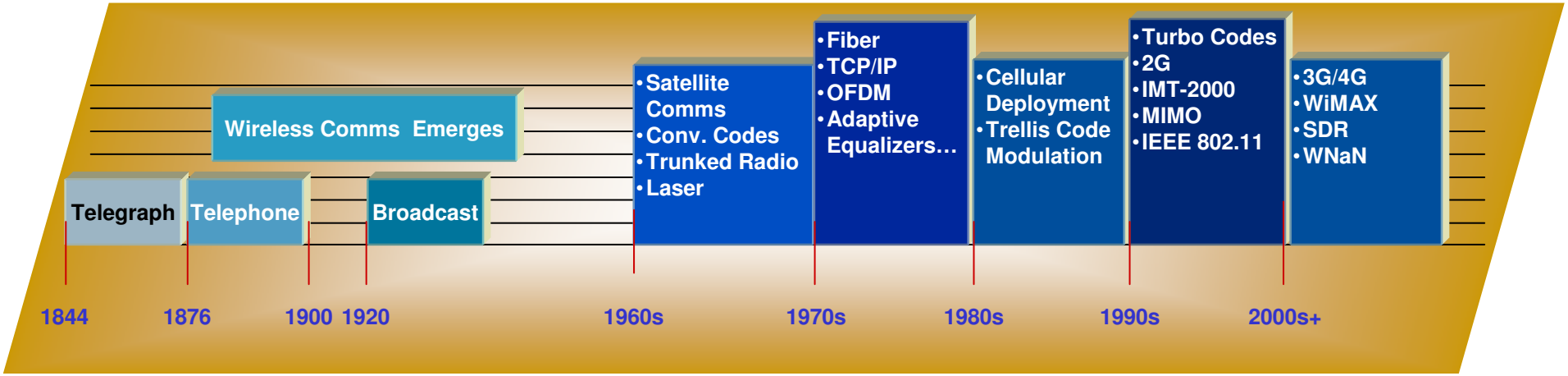
DoD Spectrum Use



National & International Influences Affecting Supportability



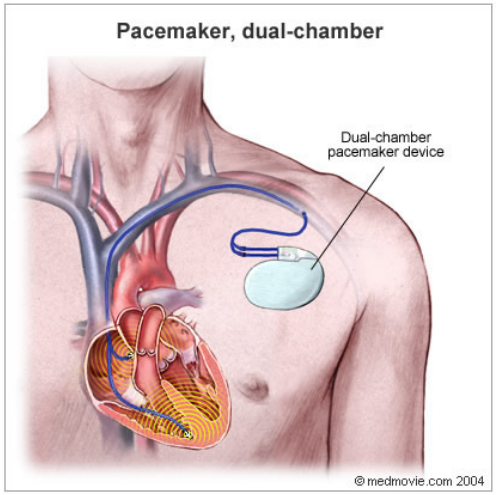
Science & Technology

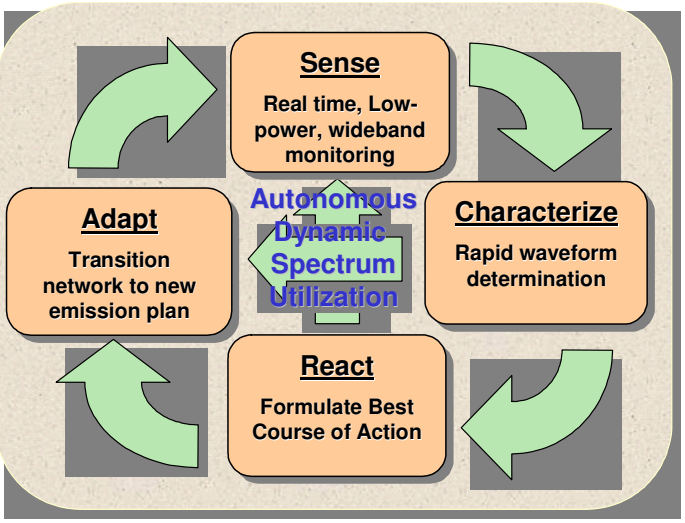


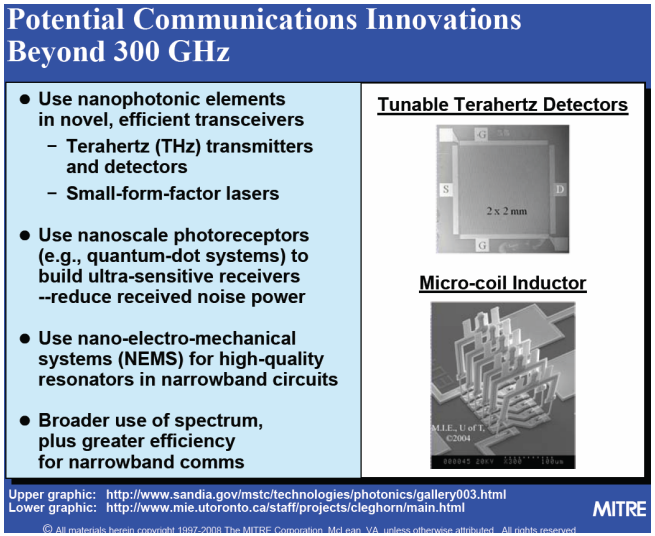
- **Five decades of rapid wireless technology development**
  - **From early satellite communications to today's wireless cell phones and access to the internet**
  - **Technology is driving the exponential growth of demand for wireless applications**

Science & Technology

- **Emerging wireless technologies**
  - **Biotechnology**
  - **Nanotechnology**
  - **Dynamic Spectrum Access**
  - **Cognitive Radios**

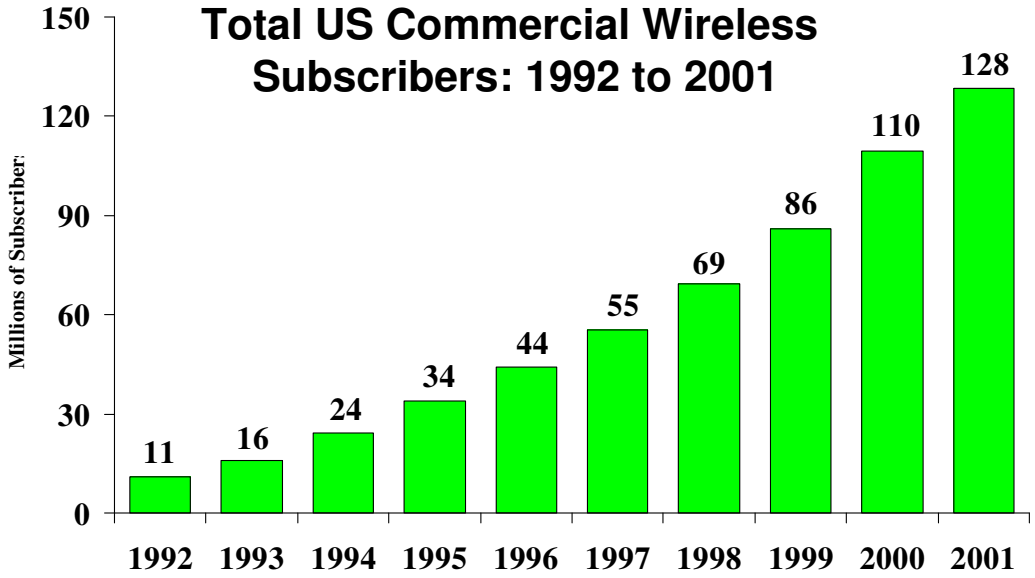






Market Forces

- **Wireless Explosion**
  - Cell phones
  - Internet access
  - GPS & other wireless navigation
  - Medical applications
  - Business applications
  - Commercial demand for transportation, communication, entertainment, and internet access
- **Broadband**
  - Wi-Fi
  - WiMAX



Source: Cellular Telecommunications & Internet Association, 2002.

Legislative

- Omnibus Budget Reconciliation Act of 1993 reallocated 235 MHz
- Balanced Budget Act of 1997 reallocated 20 MHz
- GAO Report
  - Congressional decisions to reallocate government spectrum will be costly to the DoD unless the potential impact to operations is properly assessed:
    - Costly financially
    - Costly to readiness
    - Costly to the DoD's ability to conduct Joint spectrum planning

US Spectrum Regulatory Management
Organizations & Relationships

United Nations

International Telecommunication Union (ITU)

World Radio Conferences (WRCs)

US Federal Government

Congress
Civil Sector Spectrum

Dept of State

President
Federal Spectrum

Coordination

FCC
Chair (Pres appointee)

NTIA
Asst Sec'y of Commerce

Commercial

Liaison

IRAC
19 Federal Agencies

MILDEPs
Army Navy
Air Force

DoD

JCS
MCEB FP

Unified Commands
(COCOMs)

Allied
Nations

ASD / NII

DISA

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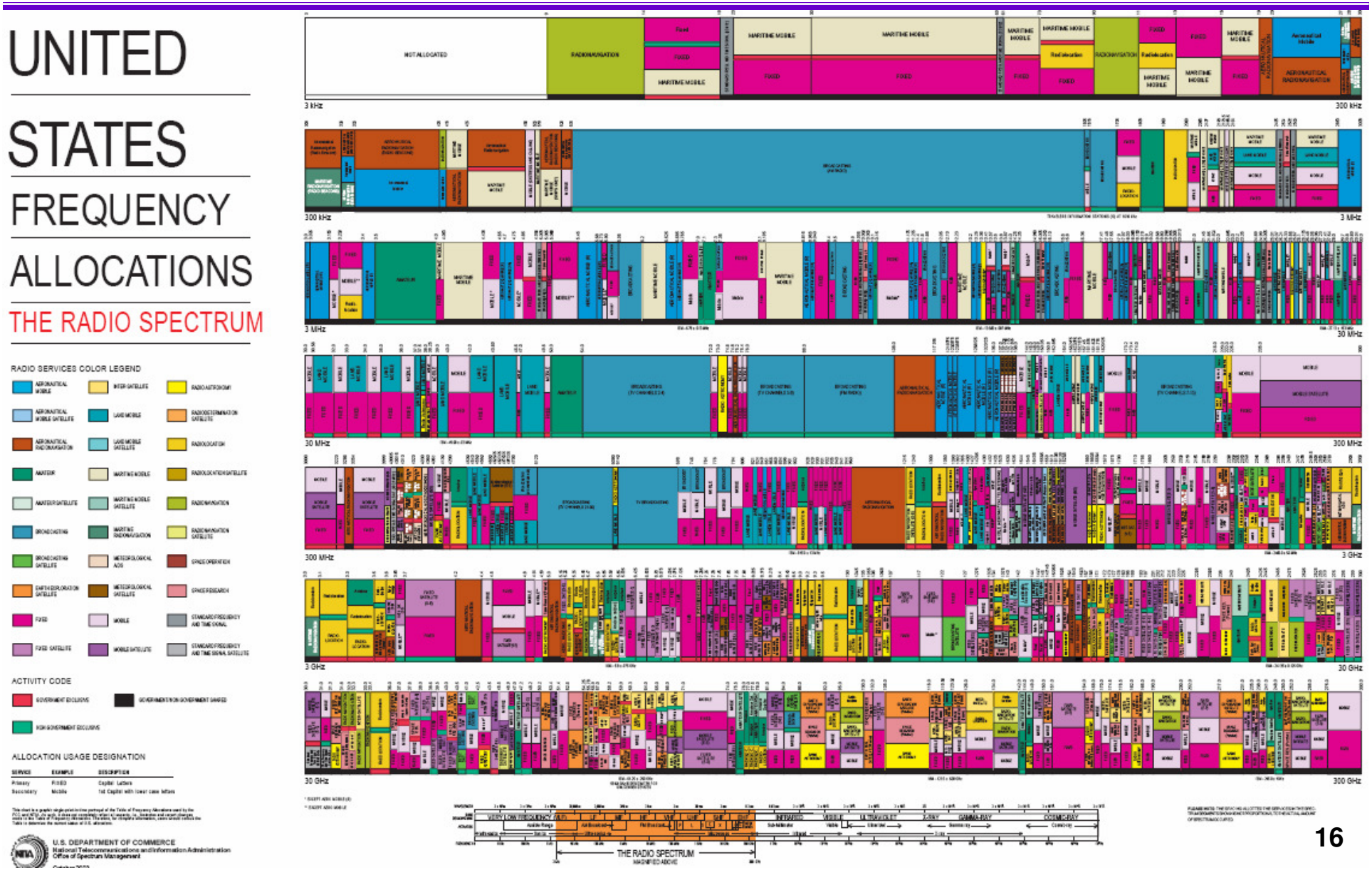
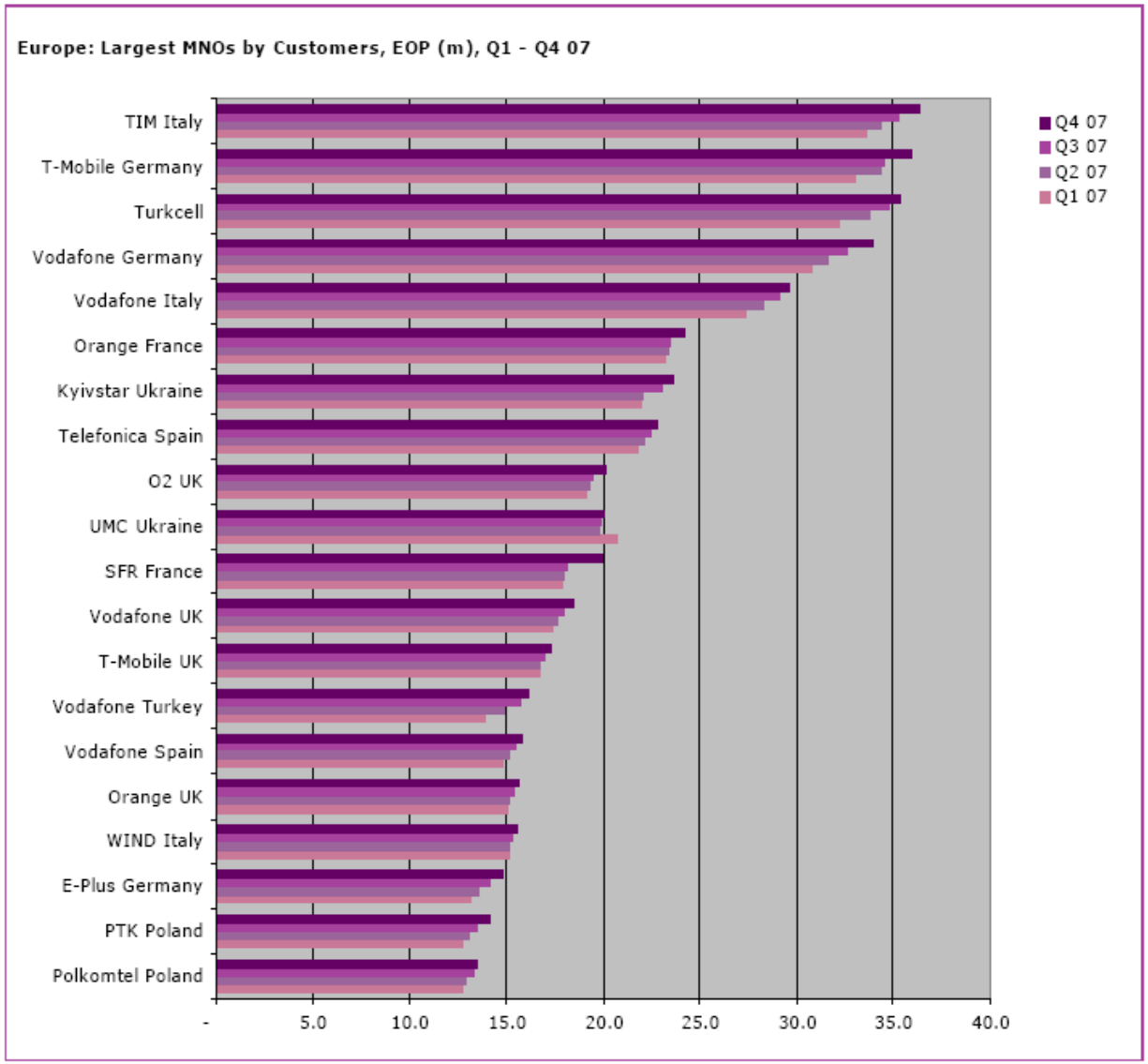
High Demand for Spectrum



International Market and Technology Forces

- **Market Forces**
  - Commercial demand for transportation, communication, entertainment, and internet access
  - Military requirements versus global spectrum usage trends
    - Case study: RADAR in 3.3-3.7 GHz band
  - Wireless growth in developing countries
  - Bilateral coordination agreements (most often for satellite operations, but also for terrestrial)
  - Development of the international satellite services market – frequency coordination and orbital slot issues
- **New and Emerging Technologies**
  - WiMAX
  - Ultra Wideband
  - Cognitive Radios
  - Adaptable Antennas

International Commercial Wireless



Extracted from The Mobile World Briefing, the weekly newsletter from The Mobile World

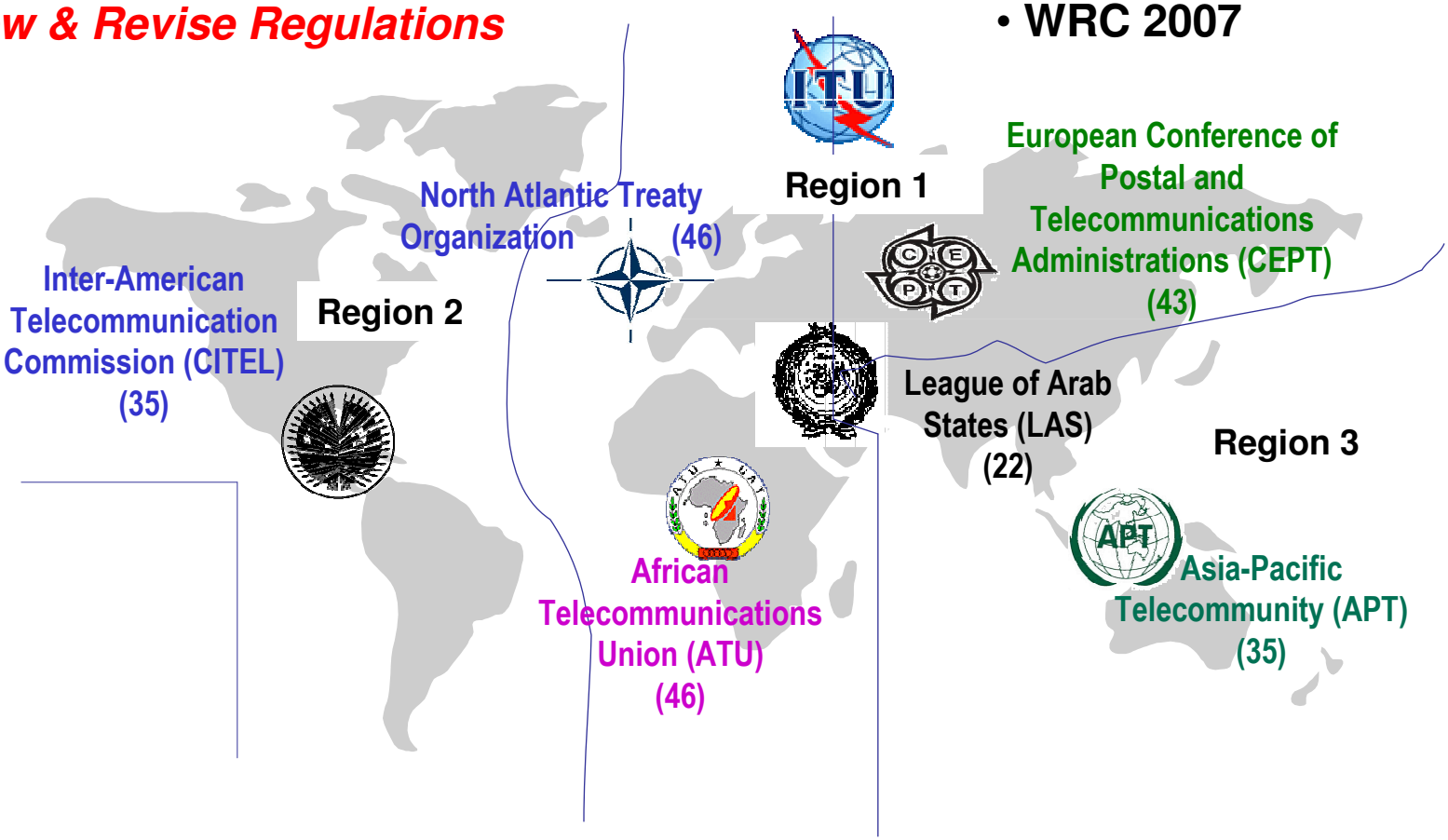
International Regulatory

International Telecommunication Union (ITU)

Review & Revise Regulations

World Radio Conference

- **192 UN Members**
- **WRC 2007**



Each Nation has Sovereignty Over the Use of its Spectrum

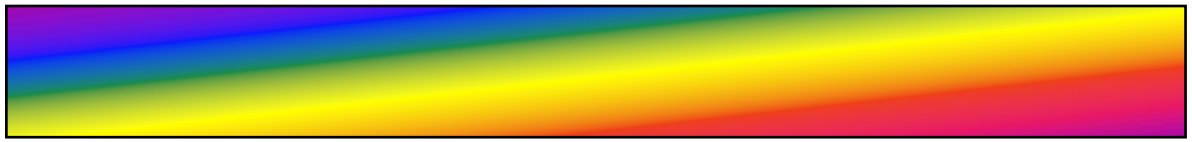
What is the World Radio Conference?

- Held by the ITU, the United Nations agency for telecommunications
- Global forum, held every four years to update/modify the international Radio Regulations
- The international Radio Regulations form the basis on which individual countries and regions develop their own radio regulations
- Ability of our deployed forces to gain access to spectrum is therefore often dependent on the outcomes of WRCs

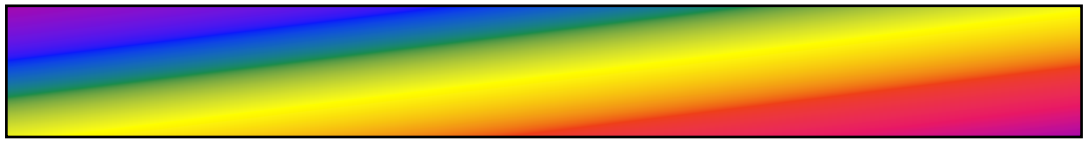
DoD Objectives For WRCs

- To Inform
  - US spectrum decision makers need to understand future impact on military operations
  - Changes in radio regulations will heavily influence acquisition, system effectiveness, and operational decisions
- To Influence
  - Negotiate modifications to the radio regulations to maximize U.S. military access to spectrum
  - Develop close relationships with military and civilian spectrum managers in other administrations

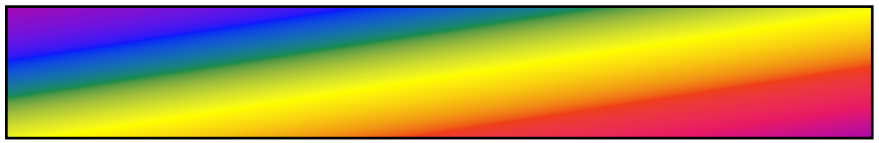
Cumulative Effect of Reallocation



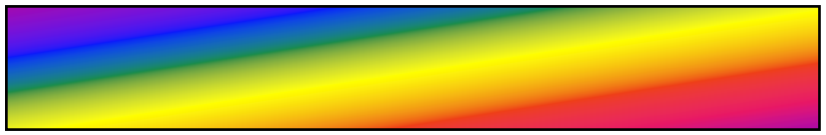
Relative spectrum available prior to 1992



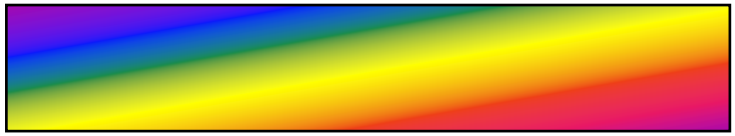
World Administrative Radio Conference 1992 reallocated 91.5 MHz



Omnibus Budget Reconciliation Act of 1993 reallocated 235 MHz



World Radiocommunication Conference 1995 reallocated 66 MHz



Balanced Budget Act of 1997 reallocates 20 MHz

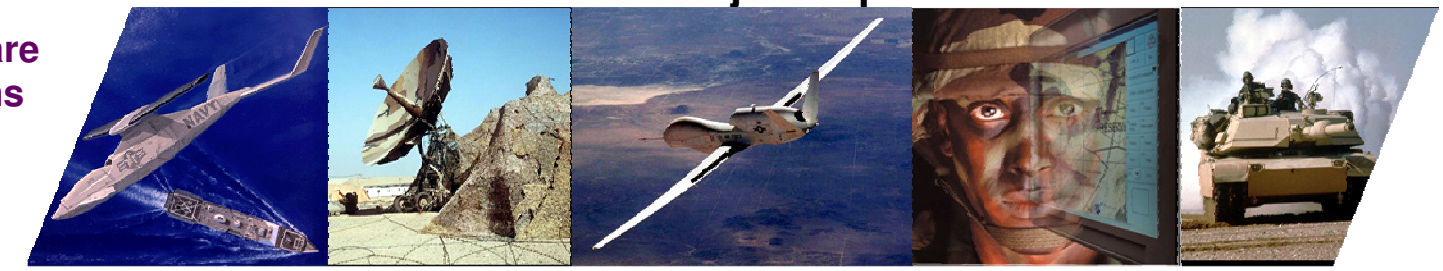
World Radio Conference 2011+ reallocates…?

Since 1992, spectrum relocations have reduced DoD spectrum access 412.5 MHz.

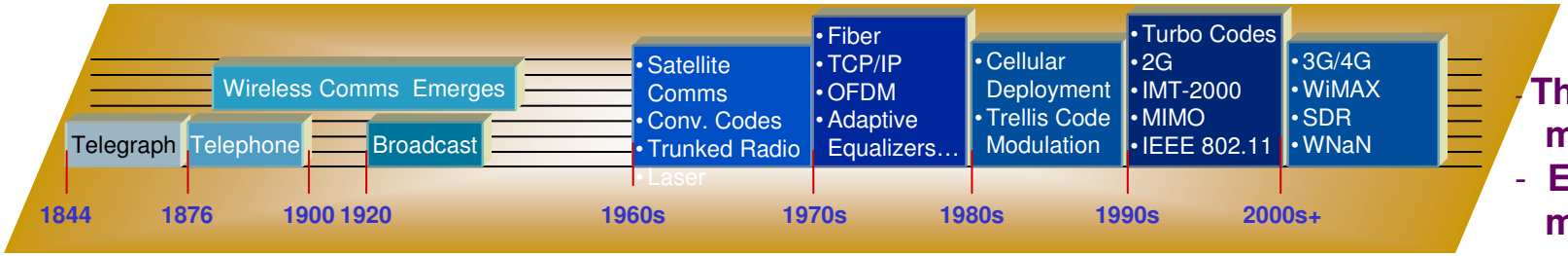
DoD Spectrum Challenges

OPERATIONAL: Net-centric joint operations

- Net-Centric Warfare
- Higher bandwidths
- Greater mobility
- Greater agility
- Higher tempo



TECHNICAL: Five decades of rapid wireless technology development



- The need to access more spectrum
- Encroachment on military bands

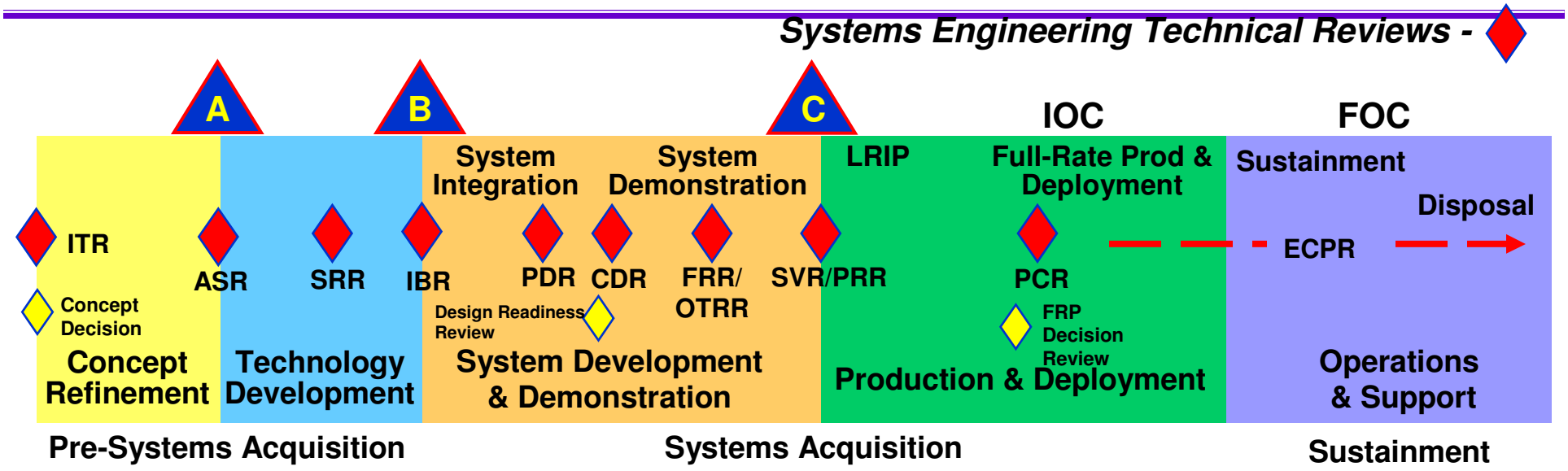
REGULATORY: Increased need for more spectrum, harmonization, etc

- Demands for sharing and harmonization
- Host nation sovereignty
- World Radiocommunication Conference (WRC) impact

Spectrum Supportability Vision

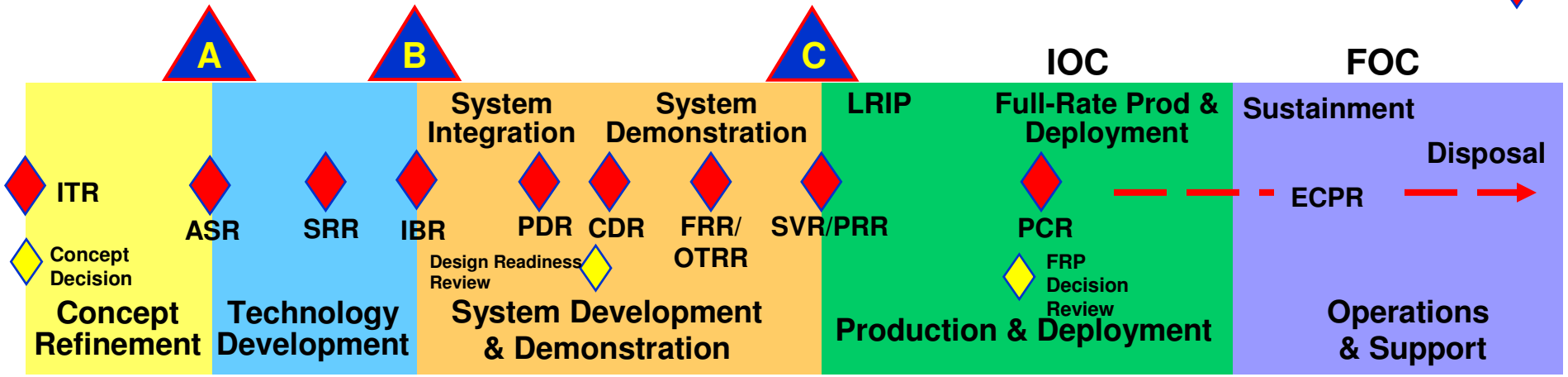
All systems fielded can obtain spectrum assignments and operate in such a way as to provide the capability (the warfighter) needed when the requirement was generated.

DoD Acquisition Process



Spectrum Supportability & E3 in the DoD Acquisition Process

Systems Engineering Technical Reviews -



Spectrum Supportability and E3 Processes

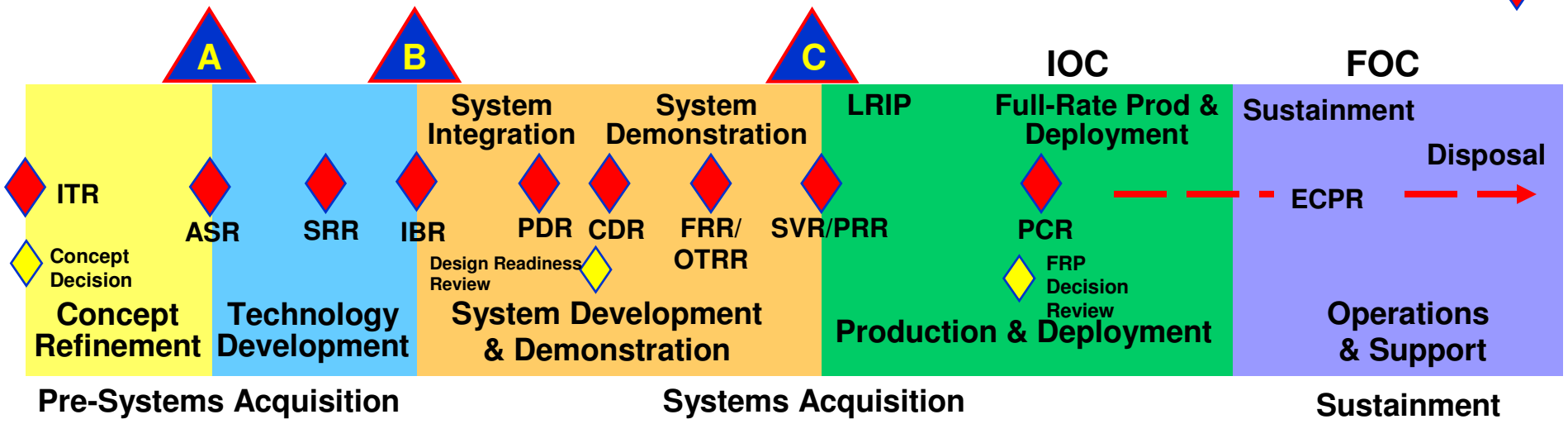
Spectrum Supportability Analysis	Band Selection	EMC and E3 Analyses/Testing	Full E3 Testing	Deployed Support
E3 Req Definition	E3 Req Definition	Mitigation Measures	Initial Perm Freq Assignments	Perm Freq Assignments
	Start HNA Coord	Continue Host Nation Coord	Host Nation Authorization	ECP upgrades and P3I
	Define EME	Update EME as Required	Update EME as Required	Update EME as Required

E3IAR, E3VR, and/or E3VP

The key is early assessment of Spectrum Supportability

DD 1494 Stages in the DoD Acquisition Process

Systems Engineering Technical Reviews -



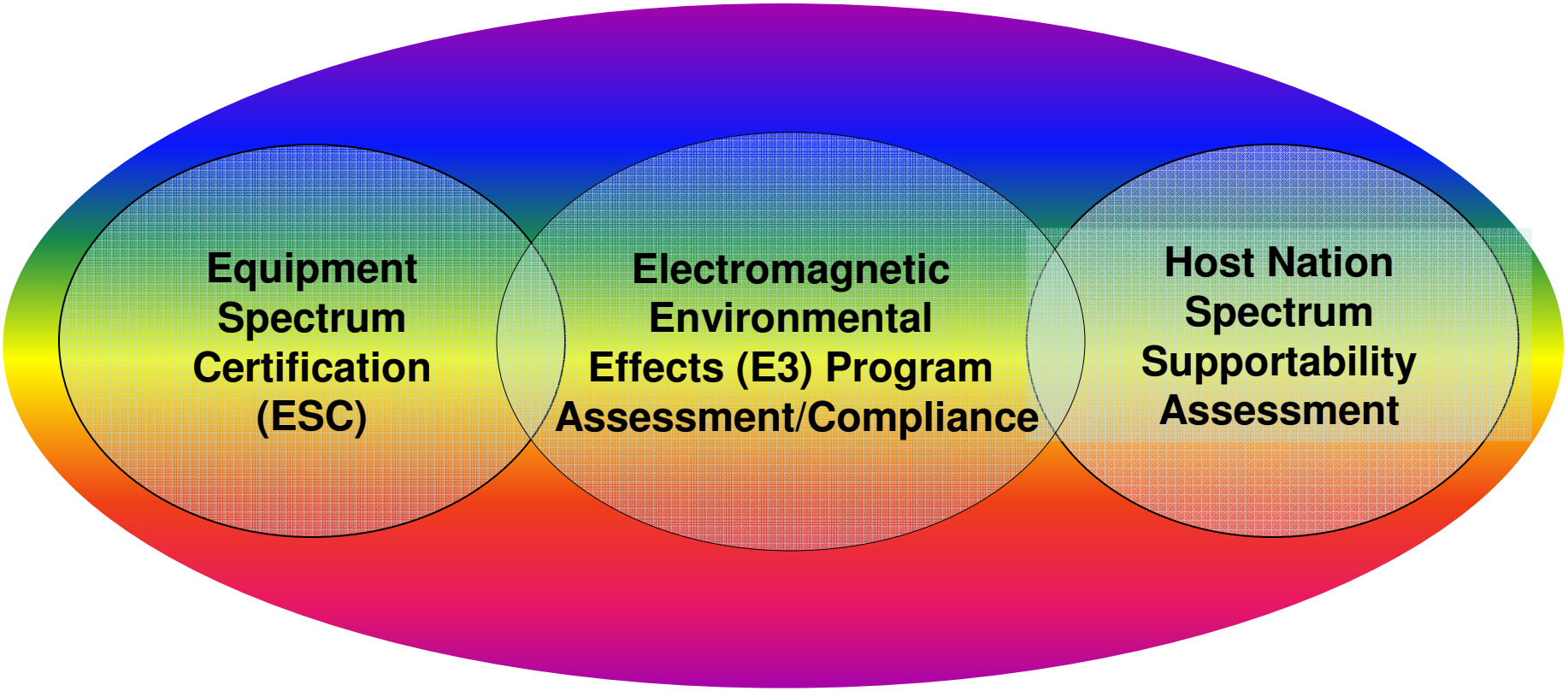
Spectrum Supportability and E3 Processes

Spectrum Supportability Analysis E3 Req Definition	Band Selection E3 Req Definition Start HNA Coord Define EME	EMC and E3 Analyses/Testing Mitigation Measures Continue Host Nation Coord Update EME as Required	Full E3 Testing Initial Perm Freq Assignments Host Nation Authorization Update EME as Required	Deployed Support Perm Freq Assignments ECP upgrades and P3I Update EME as Required

DD1494 Stages

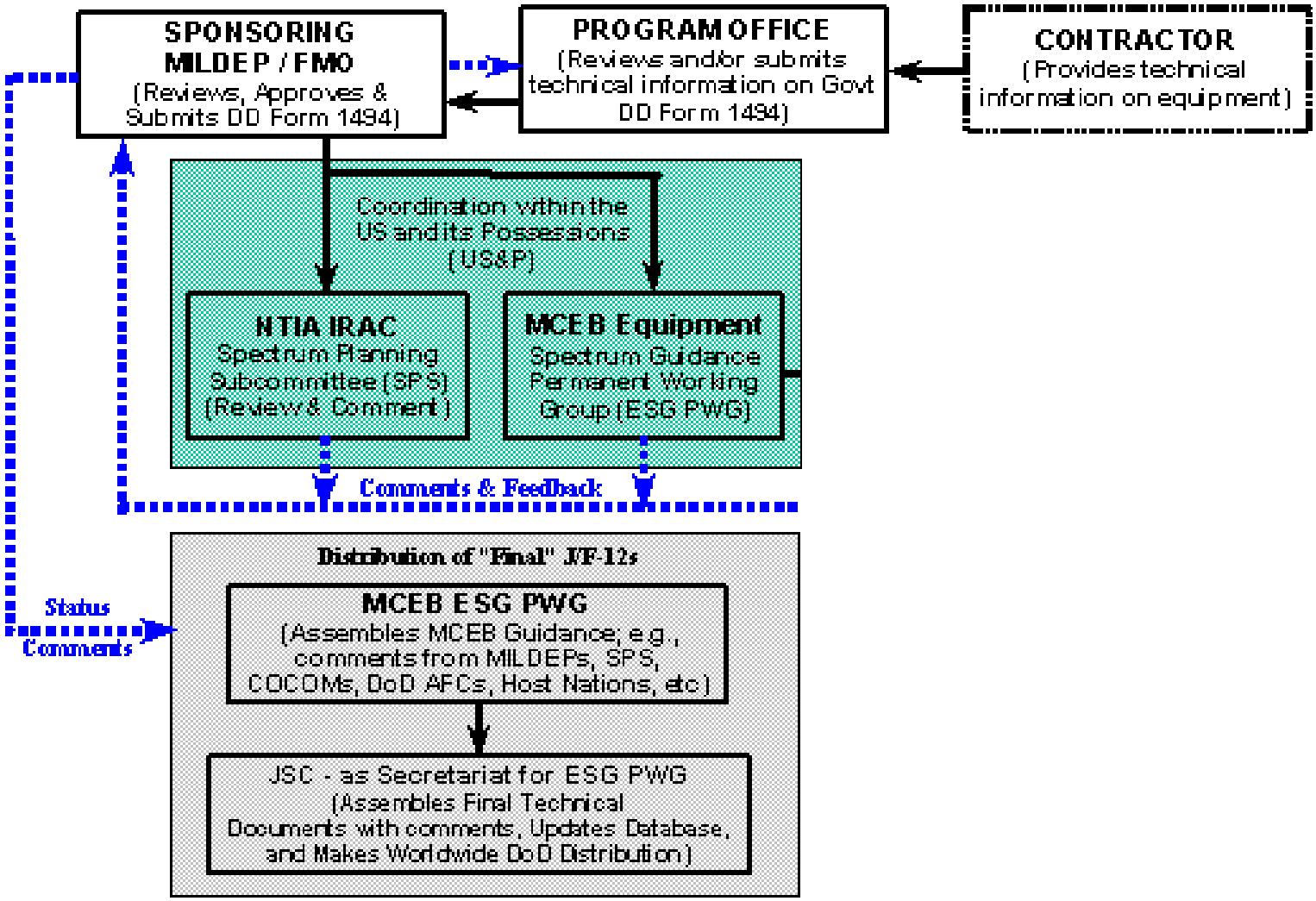
Stage 1	Stage 2	Stage 3	Stage 4	Stage 4

What is Spectrum Supportability?



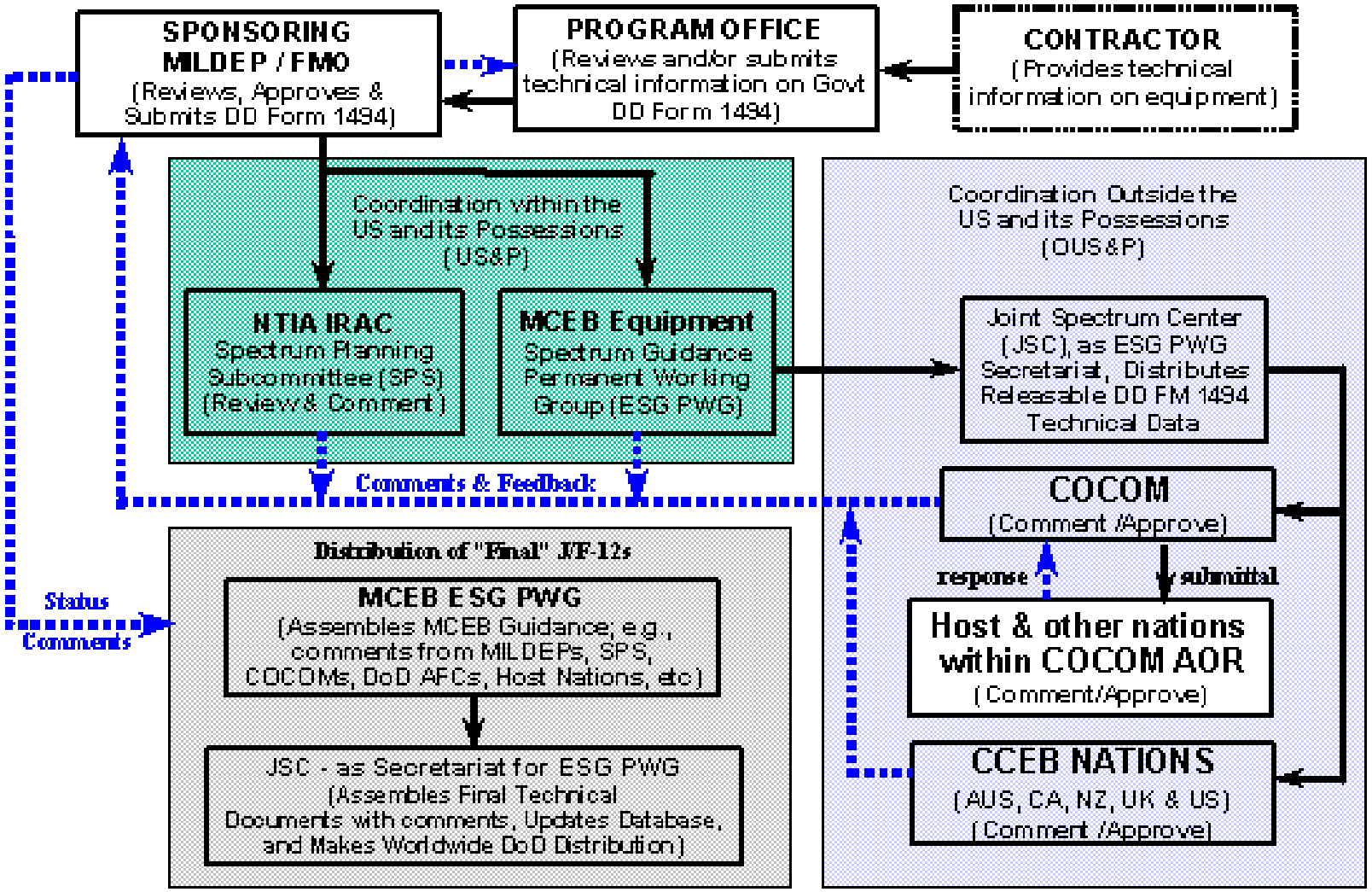
The assessment as to whether the electromagnetic spectrum necessary to support the operation of a spectrum-dependent equipment or system during its expected life cycle is, or will be, available. (DoDI 4650.1 Draft 2008)

Equipment Spectrum Certification (ESC) National



Defense Acquisition Guidebook Figure 7.6.4.1.1.1. DoD Equipment Spectrum Certification Process

Equipment Spectrum Certification (ESC) International



Defense Acquisition Guidebook Figure 7.6.4.1.1.1. DoD Equipment Spectrum Certification Process

Host Nation Spectrum Supportability Assessment Approach

- **Determine the "radio service" for each RF system**
- **Obtain intended HN national allocation tables**
- **Compare HN allocations to each RF system's radio service**
  - Host Nation Spectrum Worldwide Database Online (HNSWDO)
- **Obtain COCOM comments**
  - Joint Staff Action Process (JSAP)
- **Display regulatory results as "stop light" charts**
- **Generate lists of co-band systems**

Host Nation Spectrum Supportability Assessment Results Example

Program			Combatant Commands																
			NORTHCOM			EUCOM/AFRICOM				PACOM			CENTCOM			SOUTHCOM		
RF Sub-system	Frequency (MHz)	Radio Service	US	MEX	CAN	UK	GER	Slovak	S A	Japan	Korea	Austr.	Iraq	UAE	AFG	VEN	COL	Brazil
A	1350 - 1390	Mobile																
B	1755 - 1850	Mobile				1	1	1			1	1		1				1
C	2400-2483.5	Mobile																
D	4400 - 4990	Mobile																
E	5470 - 5725	Mobile																

= Little chance of host-nation approval, or approval with many operational and regulatory restrictions

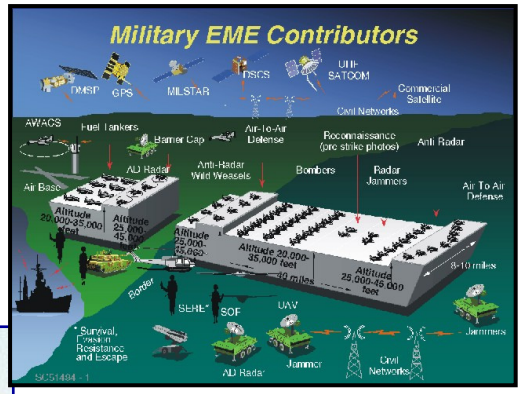
= Operation allowed only with geographic, frequency, and/or operational restrictions

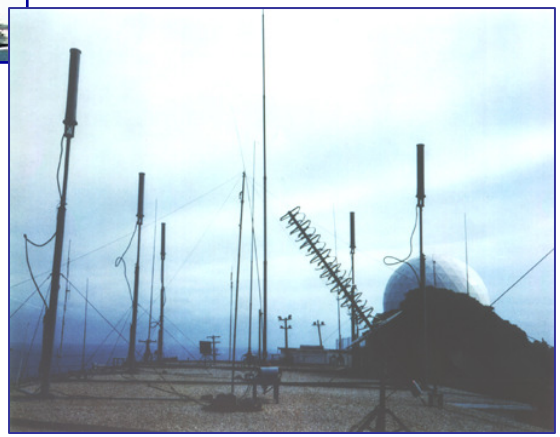
= Good chance of host-nation approval with few operational and regulatory restrictions

1. Adopted the GSM-1800 personal communications standard

Electromagnetic Environmental Effects (E3) Assessment

- **Intersite Analysis**
  - Can the system perform compatibly in its intended operational environment?
- **Cosite Analysis**
  - Will the system be located in close proximity with other high power transmitters?
- **RADHAZ**
  - Could the system cause unintended damage to ordnance, personnel, or fuels?





Spectrum Efficiency Scorecard

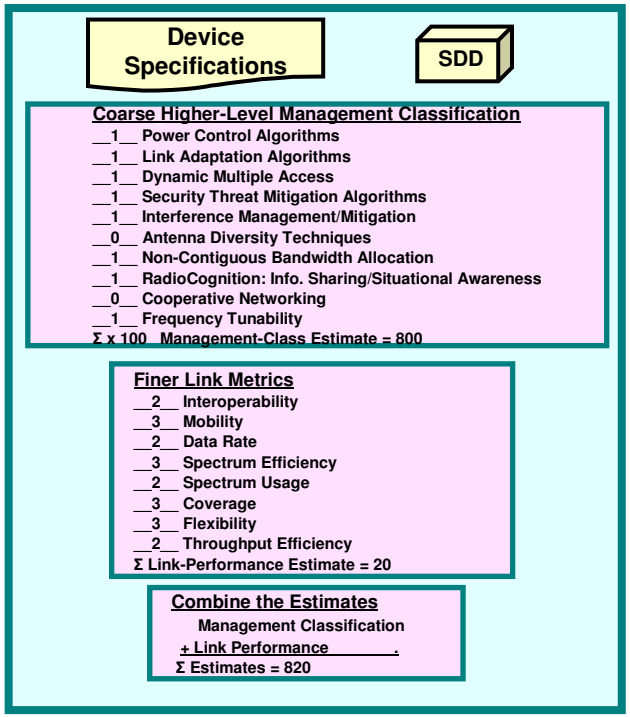
Purpose

- **To develop a system engineering methodology to promote consideration of spectrum efficiency, effectiveness, and supportability.**

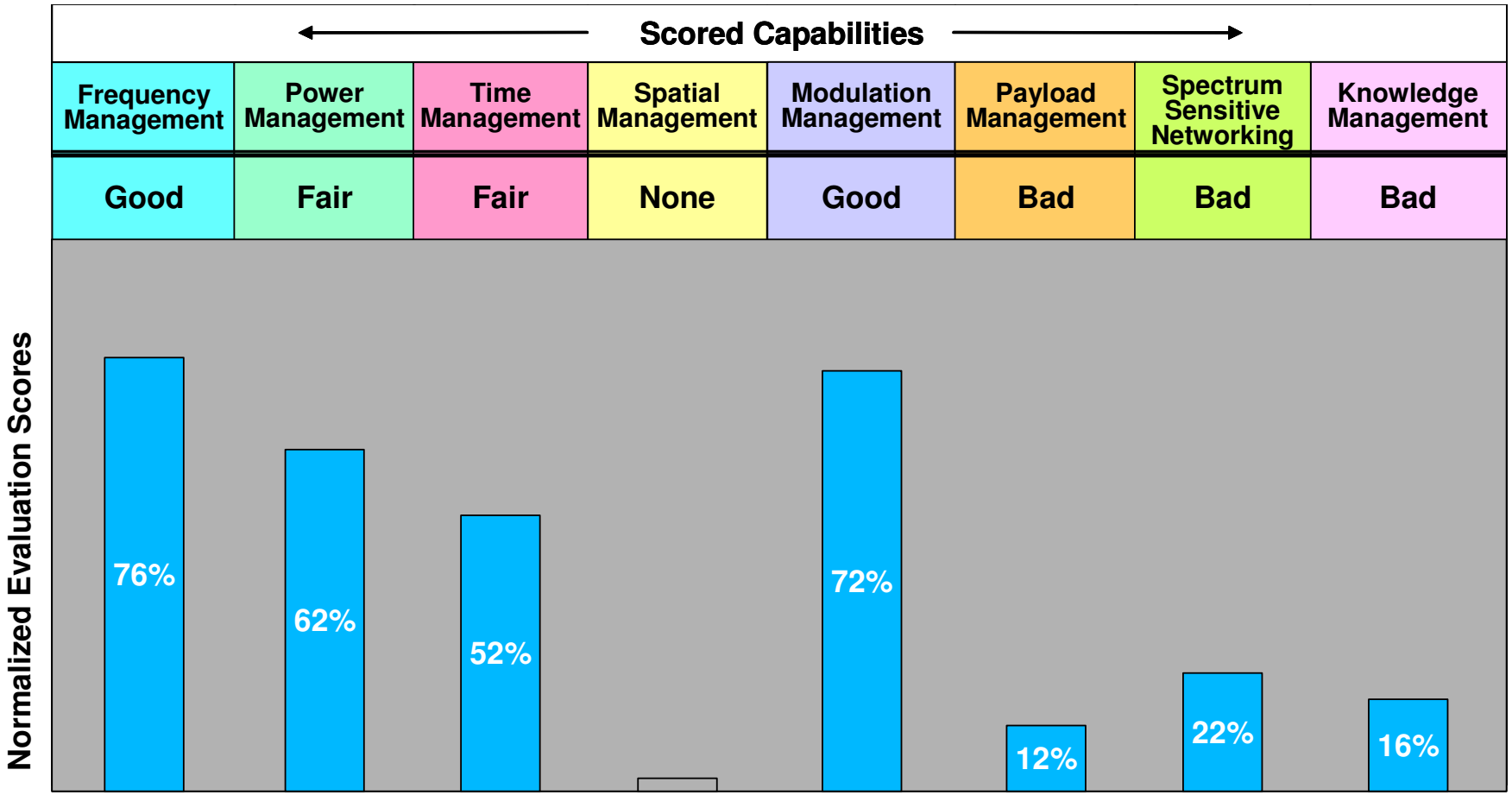
Objectives

- **To provide a spectrum efficiency and effectiveness trade-off analysis methodology for program managers.**
- **To provide a means of improving spectrum access for military systems and to avoid the acquisition of systems that cannot be accommodated within the spectrum regulatory structure.**
- **To apply this methodology at the earliest possible point in new program would promote the development of spectrum efficient and mission effective systems.**

Frequency Management	Power Management	Time Management	Spatial Management	Modulation Management	Payload Management	Spectrum Sensitive Networking	Knowledge Management
Frequency Tuning Range	TX Power Control	Interval Control	Directional Spectrum Reuse	Modulation Flexibility	BW Aware Presentation	Network Configuration	Situational Information Gathering
Frequency Selection	RX Dynamic Range	Response Time	Multipath Transmission (MIMO)	Non-Contiguous Bandwidth Use	Digital Hardening	Data Link Optimization	Information Sharing
Variable Bandwidth	Unintentional Emission	Scheduling	Duplexing Flexibility	Overlay-Underlay	Administrative Overhead	Network Routing	Stored Information Collection
Frequency Diversity	Interference Reduction	Latency	BM Field Diversity			Transport Control	Information Integration
	Energy Conservation & Supply	Time Diversity				Directional Routing	
						QoS Management	



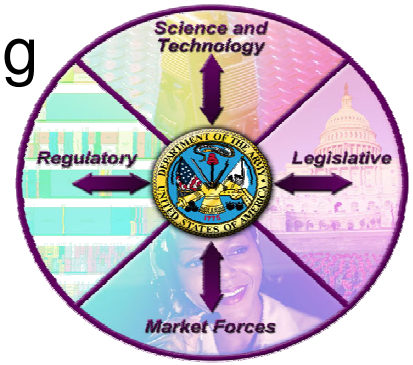
Spectrum Efficiency Scorecard



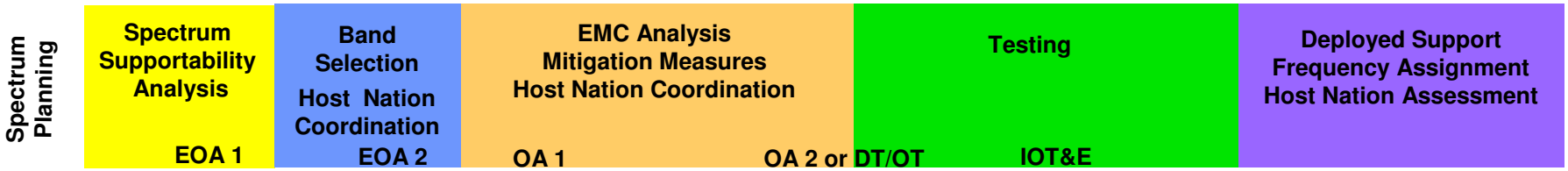
Key Points

- Warfighter equipment must work in the operational electromagnetic environment worldwide

- Challenges are increasing to fielding worldwide deployable equipment



- Early spectrum supportability assessments are crucial



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