Search and Rescue Technology

Satellite Aided Search and Rescue

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Cospas-Sarsat Council

Program

- Program
- Purpose
- Cospas-Sarsat Overview
- Technology Advances
  - User Segment (Beacons)
  - Space and Ground Segment
- Organizational Improvements
  - Membership
  - Data Distribution
  - Management
- Conclusions

Purpose

- Provide background on Cospas-Sarsat

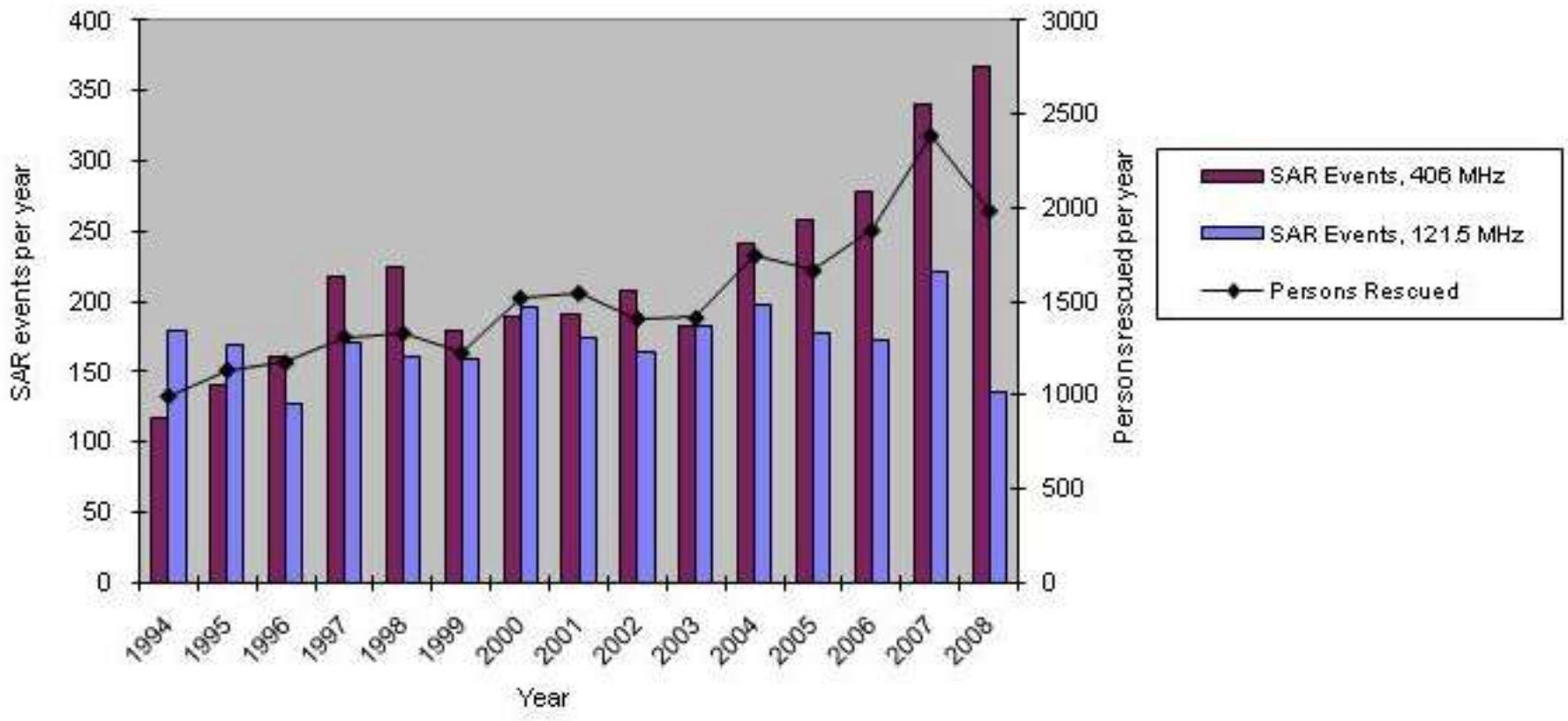
- Discuss efforts by Cospas-Sarsat to improve satellite-aided search and rescue technology AND efforts by Cospas-Sarsat to make the technology more useful and reliable
  - *Introduce the term "orgware"*
    Set of tools, policies and procedures needed to make the best use of technology
  - *Without organizational and operational improvements the technology cannot deliver the services for which it is designed*

Cospas-Sarsat Overview

- Vision
  - *To take the "search" out of search and rescue*
- Mission
  - The International Cospas-Sarsat Programme provides accurate, timely, and reliable distress alert and location data to help search and rescue authorities assist persons in distress
- Objective
  - Provide distress alert and location information to *"support the objectives of the International Civil Aviation Organization and the International Maritime Organization concerning search and rescue"*

Cospas-Sarsat Overview

More than 26,000 persons rescued with the assistance of Cospas-Sarsat



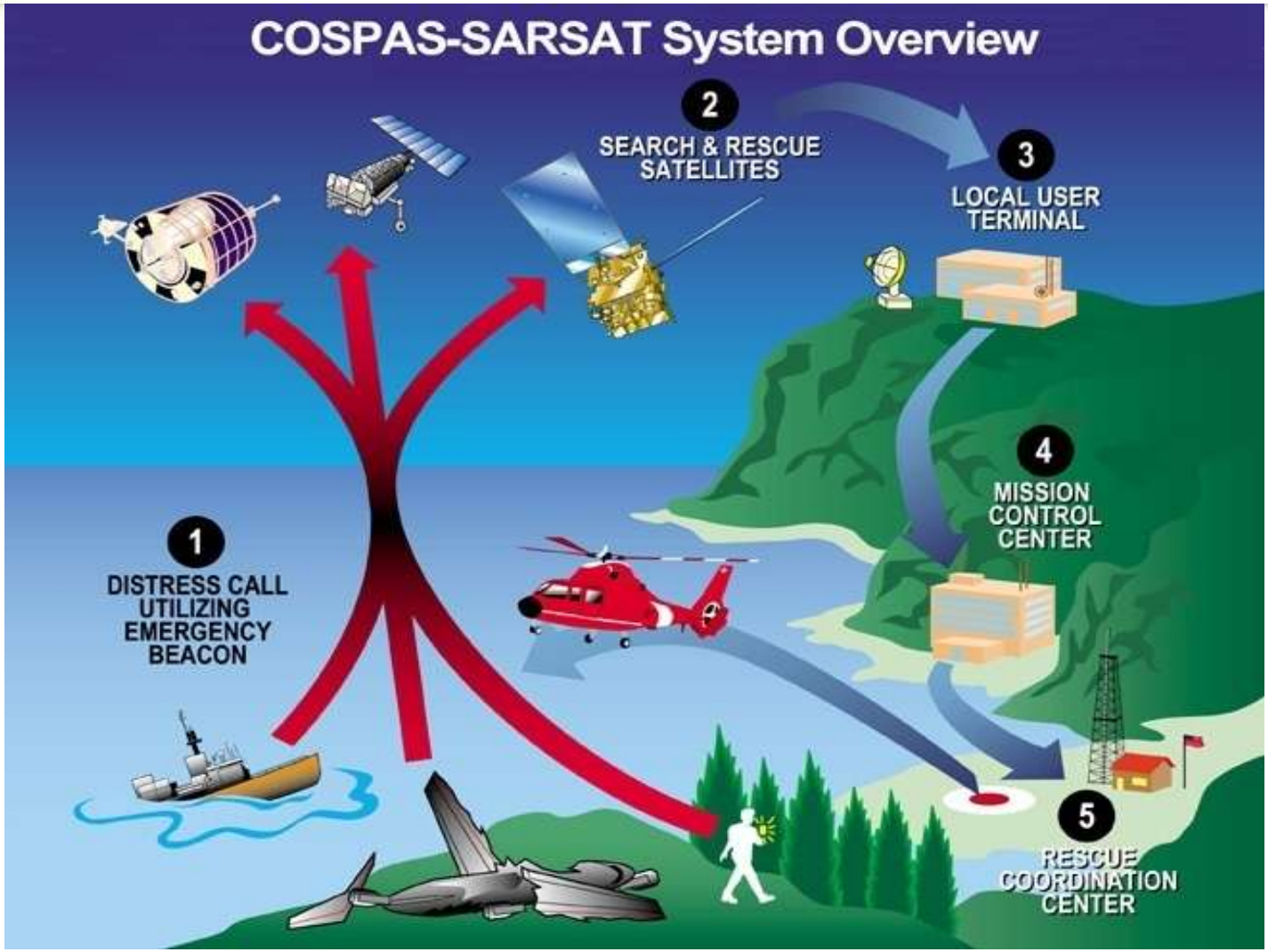
Cospas-Sarsat Overview

S/V WIDE EYES

- Within minutes of detecting emergency beacon(s) on S/V rescue forces were notified

- Success due to merging of technology of Cospas-Sarsat system and other factors such as:
  - Carriage of proper equipment (emergency beacon)
  - Proper registration of emergency beacon)
  - Well defined data distribution procedures
  - Commissioned space and ground equipment

Cospas-Sarsat Overview



Cospas-Sarsat Overview

Participating Countries

Cospas-Sarsat Overview

Technology Advances

User Segment (Beacons)

- 1970s – 121.5 MHz emergency beacons
  - Loose specifications
  - Low power
  - No identification
  - Inaccurate (12-20km error) – Regional coverage
- 1980s – 406 MHz emergency beacons
  - Rigid specifications
  - Unique identification
  - Designed for satellite transmission
  - More accurate (2-5km error) – Global coverage
- 1990s – 406 MHz emergency beacons with navigation input
  - Highly accurate (100m error)
  - Smaller size
- 2010s – 406 MHz emergency beacons - new specifications

Technology Advances

User Segment (Beacons)

Relative Search Areas and Times

121.5 MHz

12 Hours

406 MHz

2 Hours

406 MHz w/ GNSS

Minutes

Technology Advances

Space and Ground Segment

- 1980s – Low-Earth Orbiting System (LEOSAR)
  - Able to detect low powered beacons
  - Provided polar coverage
  - Inherent delay in detecting and locating emergency beacons
  - Doppler technology led to ambiguity in location on first pass
- 1990s – Geostationary Earth Orbiting System (GEOSAR)
  - Near real-time detection
  - No independent location capability
  - No polar coverage
  - Susceptible to terrain blockage
- 2010s – Medium-Altitude Earth Orbiting System (MEOSAR)
  - Near real-time detection and location
  - No ambiguity in location
  - Global coverage (with corresponding ground segment)
  - Robust space segment

Organizational Improvements

Organizational and Mission Goals

"80 percent of every dollar – [is] needed to support, manage and organize the other 20 percent spent on technology"

- Dr. Costis Toregas

Hardware

- Satellites
- Ground Stations
- Beacons
- Communication (Physical)

Software

- Data
- Applications
- Communications (Virtual)

Organization (Orgware)

- Policies
- Procedures
- Performance/Quality
- Training
- Tools

Organizational Improvements

Membership

- Initially Cospas-Sarsat Participants were likely to be Space and Ground Segment Providers
  - Focus on demonstrating capability
  - Operating under an Agreement between Agencies

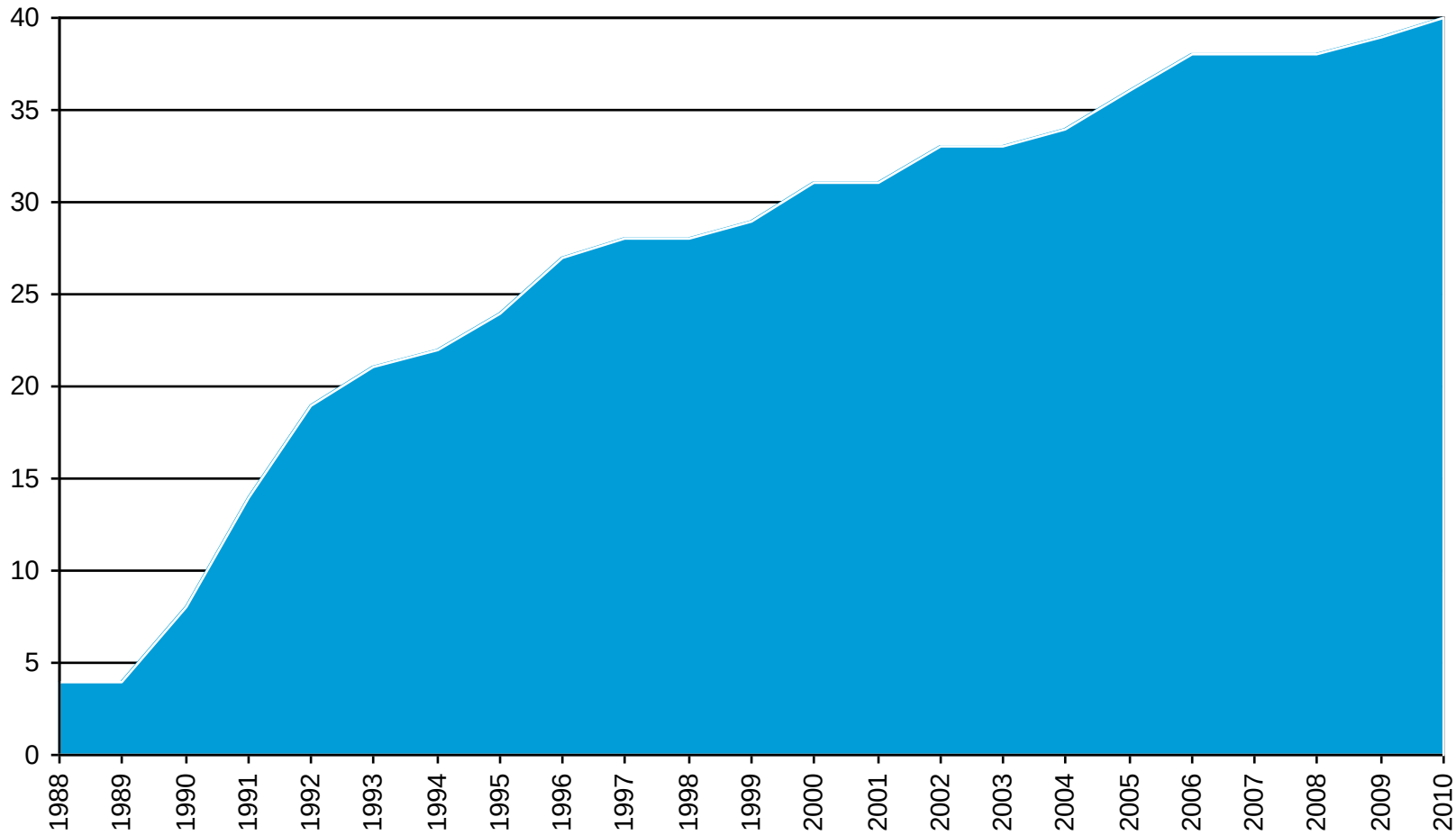
- 1988 – International Cospas-Sarsat Programme Agreement (ICSPA) signed (Canada, France, U.S.S.R, United States)
  - Treaty level Agreement
  - Ensures long-term provision of services
  - Allows for permanent Secretariat
  - Allows for other States and Organizations to join
  - Automatically extended

- Increase in number of States associated with program provides credibility and expose to technology
  - Supporting statutes and regulations ensure use of emergency beacons

Organizational Improvements

Membership

Number of Participating States



Organizational Improvements

Data Distribution

- Cospas-Sarsat data distribution procedures initially designed to meet regional and national needs

- Global nature of program and system required re-evaluation of data distribution procedures – New procedures developed in 1990s
  - Basic principles of data distribution established
  - Improved validation of alerts in the ground segment
  - Standard procedures among States
    - Minimizes processing of redundant data while ensuring appropriate SAR services are informed
    - Facilitates backup and contingency operations
    - Expectation of SAR services similar

- New procedures will be required for MEOSAR
  - Will take advantage of MEOSAR capabilities

Organizational Improvements

Data Distribution

System Capabilities	Resulting Characteristics	Data Distribution Procedures
Polar Satellites - Location Determined by Doppler Shift - Store and Forward System Providing Global Coverage - Inherent Delay in Detecting Emergency Beacons Geostationary Satellites - Immediate Detection of Emergency Beacon - No Polar Coverage - Each Satellite Provides Hemispherical Coverage	Alerts without Location Information	Alerts Passed to State Associated with Beacon
	Errors in Location Information	Updates Passed until Location Confirmed
	Ambiguity in Location Information (on first pass)	Alerts Passed to All States Associated with Positions
		Ambiguity Resolution Passed to All States Associated with Positions
	All Ground Segment Operators have Access to Data	Filter Redundant Data
		Facilitates Backup Arrangements

Organizational Improvements

Data Distribution

System Capabilities	Resulting Characteristics	Data Distribution Procedures
Mid-Earth Orbiting Satellites - Location Determined by Time and Frequency Differences of Arrival - “Bent-pipe” system limiting global coverage (from a Space Segment perspective) - Limited Delay in detecting and locating Emergency Beacons	Possible alerts with no Location information	Alerts Passed to State Associated with Beacon
	Near real-time alerts with Location Information	Alerts Passed to appropriate Search and Rescue Region
	Limited errors in Location Information	Updates Passed until Location Confirmed
	No Ambiguity in Location Information	No need for Ambiguity Resolution Notifications
	Not all Ground Segment Operators have Access to Data	Filter Redundant Data
		Requirement for robust ground network

Organizational Improvements

Management (Strategic Plan)

- In order to provide direction for the Programme, Cospas-Sarsat published its first Strategic Plan in 2008
  - Identifies key stakeholders, users and customers
  - Addresses user needs and needs and expectations of SAR authorities - Performance requirements from ICAO/IMO
  - Identifies priorities for the program as well as challenges and opportunities

- Five goals the Programme
  - *Continuous and effective System operation*
  - *Comprehensive management structure to support System evolution and ensure Programme continuity* – Implement a Quality Management System
  - *Worldwide support for the Programme*
  - *Participants, users and customers use and operate the System to its full potential*
  - *A robust industrial base to support System operations*

Organizational Improvements

Management (Quality Management)

- Quality Manual adopted by Cospas-Sarsat in 2008
  - Ensures the organization focuses on search and rescue requirements and applies internationally recognized quality management principles

- Scope of Cospas-Sarsat quality management system broad – focus on system operations and not on auditing States or the Secretariat function
  - Includes design, commissioning, operation and monitoring of ground segment including communications and reference beacons
  - Relevant aspects of emergency beacons and type approval as well as spectrum management
  - Commissioning and monitoring of the space segment

- Framework includes monitoring, measurement, assessment, analysis, reporting and accountability

Organizational Improvements

Management (Quality Management)

- Near real-time monitoring of space and ground segments
  - Availability of ground segment components
  - Location accuracy of Doppler solutions
- Periodic tests of communication links including those between Mission Control Centers and SAR Points of Contacts
  - SPOC test highlights issues with delivering data to responders
  - 164 tests with SPOCs between October 2008 and April 2010
    - 11 (6.7%) never acknowledged receipt of test communication
    - 38 (23.2%) acknowledged receipt less than 50% of the time
  - Cospas-Sarsat developing on-line data collection to facilitate reporting
- Working with IMO to address issue

Organizational Improvements

Management (Training)

- New training Handbook
  - *Handbook on Distress Alert Messages for Rescue Coordination Centres (RCCs), Search and Rescue Points of Contact (SPOCs) and IMO Ship Security Competent Authorities* – C/S G.007
- Provides an overview of the system
  - Space and ground segment
  - Beacons
- Designed to help improve understanding of types and contents of distress message
- Goal is to make the system more effective

Organizational Improvements

Management (Registration Database)

- Cospas-Sarsat maintains an International Registration Database for 406 MHz emergency beacons
  - Designed for States who do not maintain beacon registries accessible on a 24x7 basis
  - Assists States in meeting their ICAO and IMO obligations
- Since its inception more than 18,000 406 MHz emergency beacons have been registered
  - Provided by 102 different Administrations
- Search and rescue personnel access the database an average of 250 times a month
- Cospas-Sarsat to update International Registration Database based on its success to date

Conclusions

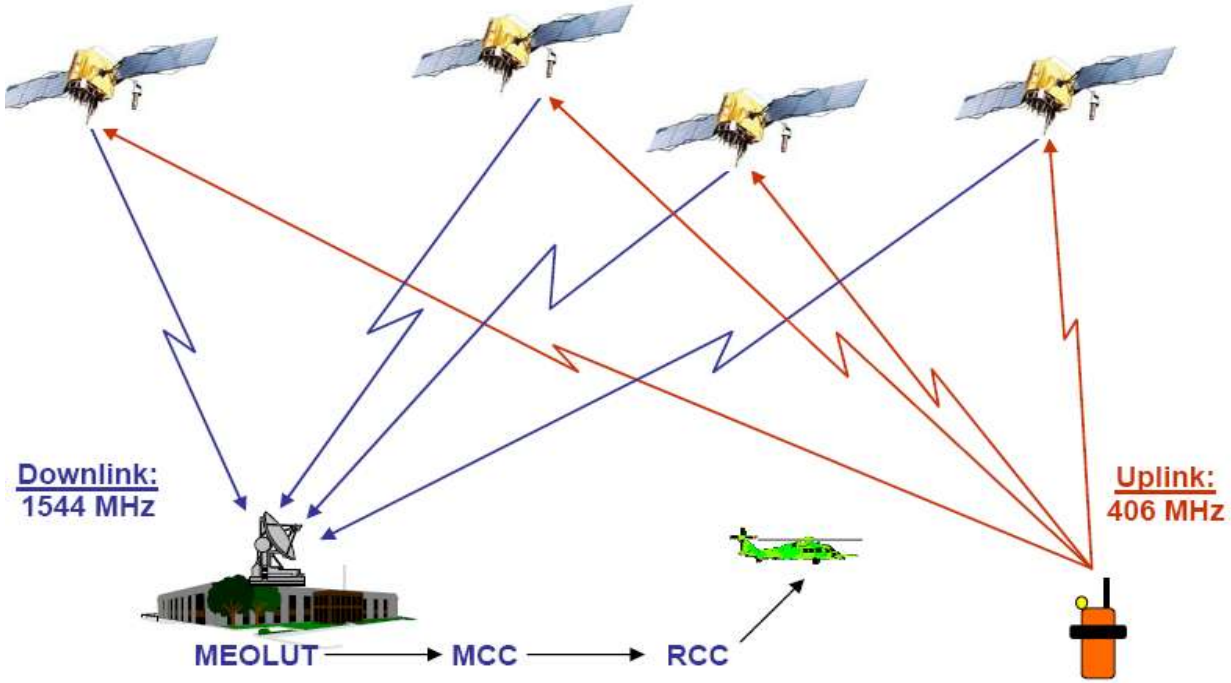
- Technology promises to help take the “search” out of search and rescue
- Technology does not overcome insufficiently trained and committed human responders
- Organizational improvements to improve service delivery are essential to realize full benefit of technology
- Cospas-Sarsat has taken significant steps to improve not only the technology but to improve its service delivery

Backup


INTERNATIONAL SATELLITE SYSTEM
COSPAS
SARSAT
SEARCH AND RESCUE

MEOSAR

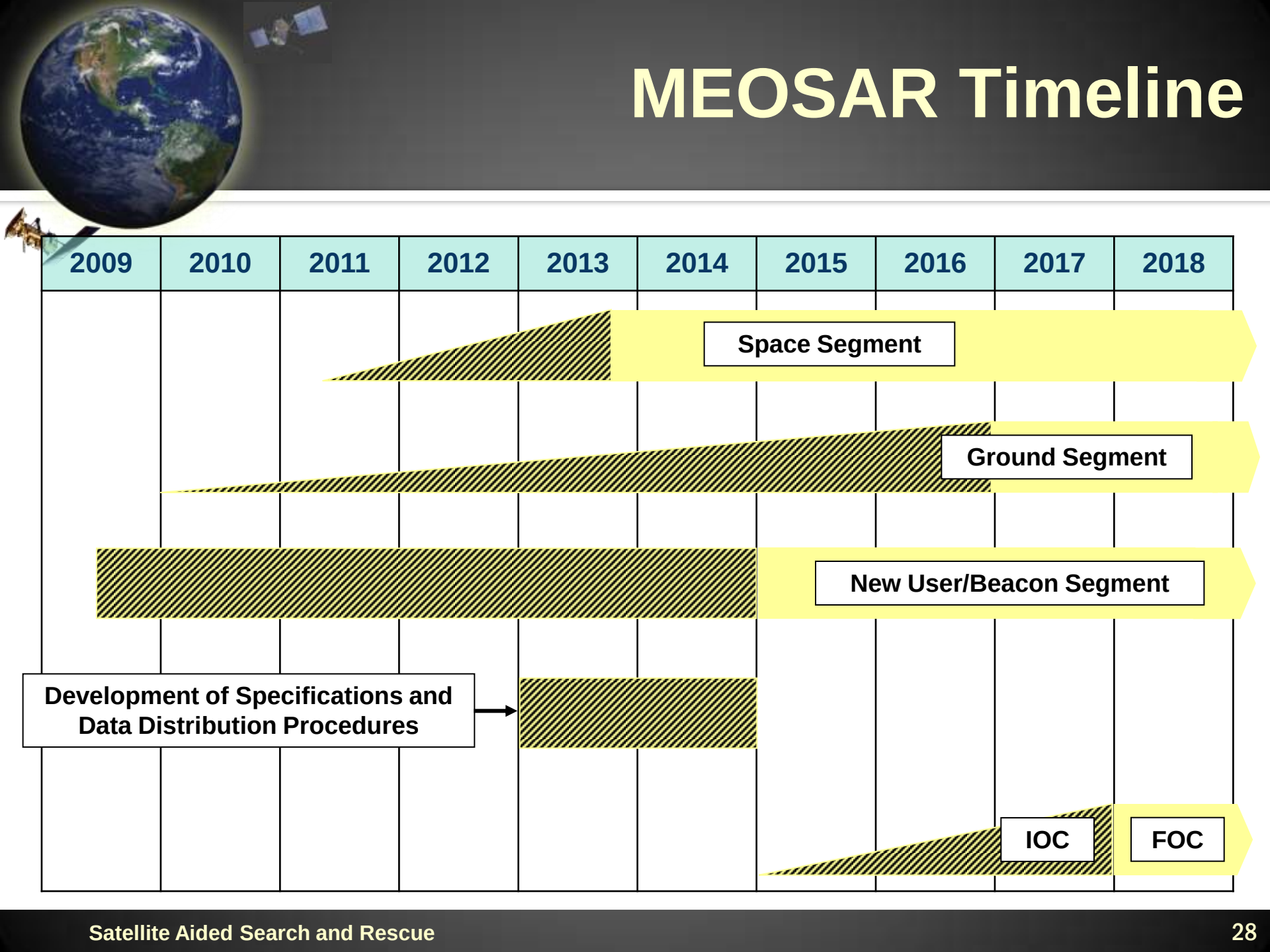
Concept of Operation



MEOSAR

- Continuous Earth coverage – no waiting for satellites to come into view
  - Major improvement over current system (three-minute to eight-hour delay depending on latitude and terrain)
- Minimizes signal blockage by terrain features
- Location can be derived from single burst
  - Can locate beacon in danger of being destroyed (e.g., fire, sinking ship)
- Improved system reliability
  - Failure of one or two system elements will not dramatically affect system performance
- Improved location accuracy
  - Average accuracy anticipated to decrease from 3.1 to 1.7 kilometers
- Lower life-cycle costs

MEOSAR Timeline



Orgware

Policy

- International Cospas-Sarsat Programme Agreement
  - High level association from each member State – ensures individual programs have appropriate visibility, management attention and resources
- Supporting statutes and regulations in member States for carriage and certification of emergency beacons
  - Ensures that no matter where you buy or use an emergency beacon, it will meet a certain level of performance and be able to be processed by the SAR system

Orgware

Procedures

- Data distribution concept evolved to common procedures for exchange of data
  - Minimizes process of redundant data
  - Keep appropriate SAR services informed
  - Allows for easy backup and contingency operations
  - Expectations of SAR services similar
- Minimum performance specifications and design guidelines
  - Ensure interoperability
  - Ensures minimum level of performance
  - Assist in integration of technology

Orgware

Procedures

- Commissioning of equipment
  - Ensure interoperability
  - Ensures minimum level of performance
- Beacon specification and type approval
  - Ensures interoperability between space and ground segments
  - Ensures consistent processing and performance
  - Ensures users can have similar expectations

Orgware

Performance/Quality

- Performance management
  - Ensures technology is meeting its intended goals
- Monitoring and reporting
  - Maintains interoperability
  - Identifies proper (e.g., most important) system elemetns to monitor