

The DARPA Advanced RF Mapping Program (RadioMap)

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**Presentation to
ISART 2012: Exploring Approaches for Real-Time Federal Spectrum Sharing
25 July 2012**





Program Overview

Needs

- Increasing complexity and density of RF spectrum usage
- High cost of a dedicated sensor network for real-time awareness of RF spectrum use

Technology trends

- Increasing deployment of software-defined radio technology
- Increasing tuning range of deployed radios
- Increasing computational and storage capacity in mobile devices

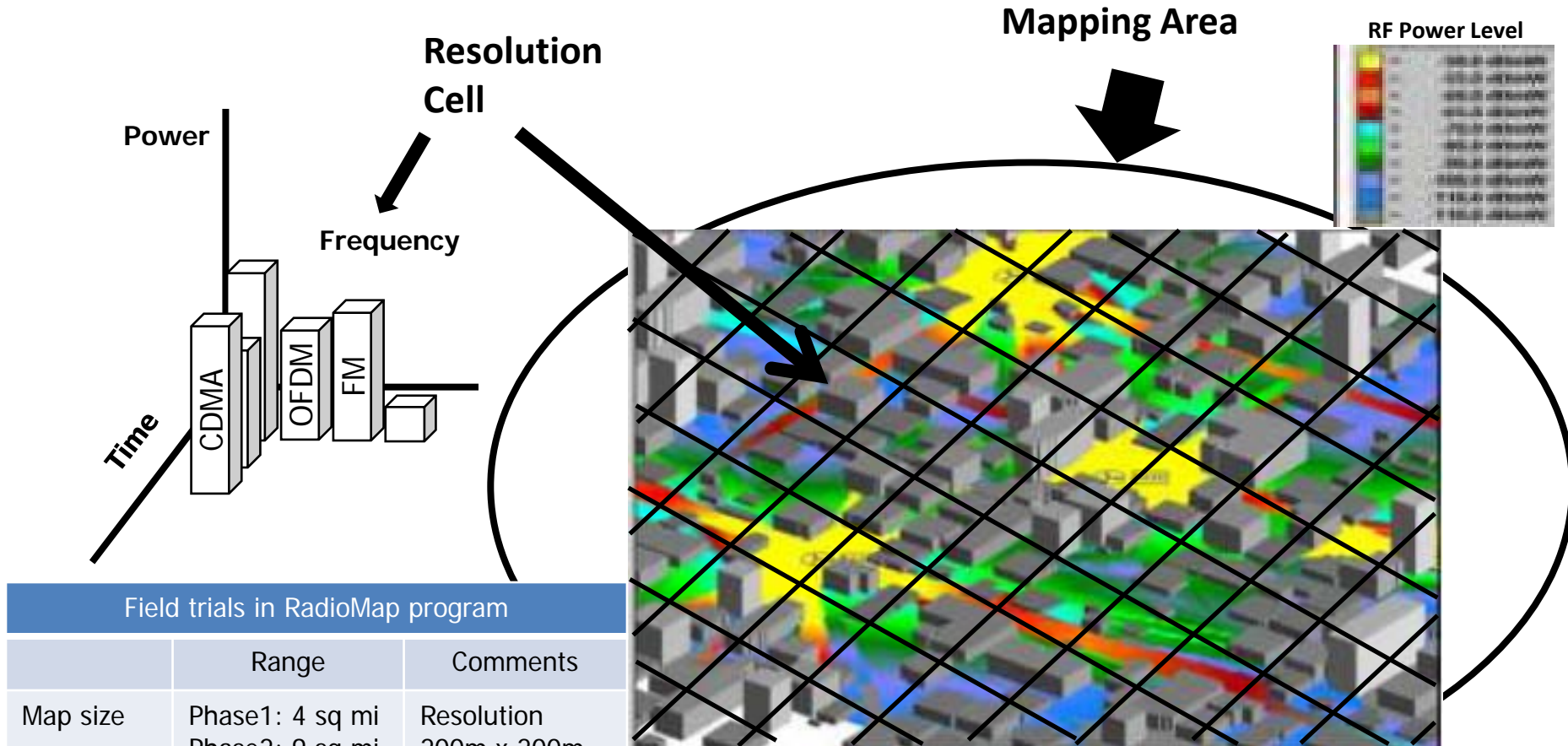
This program

- Use RF devices to perform additional tasks without harm to their primary function
 - Pathfinder task: RF situational awareness ("Radio Mapping")
 - Follow-ons: EW, ISR, Navigation
- Deliver Radio Mapping capability to 3 communities
 - Spectrum managers and dynamic spectrum access systems
real-time usage maps for better spectral efficiency
 - Small-unit tactical leaders
organic RF situation awareness
 - Electronic warfare officers
mapping and cueing to support EW systems



Radio Map: A map of what signals a receiver hears

Signal type and power level vs location, time, frequency



Field trials in RadioMap program		
	Range	Comments
Map size	Phase1: 4 sq mi Phase2: 9 sq mi	Resolution 200m x 200m
Sensors	Phase1: 25 Phase2: 75	Heterogeneous in Phase 2
Frequency	470-928 MHz	
Time	Continuous	Averaged over 10 sec intervals

Adapted from Reference: "Radio Frequency Pollution Mapping", Agbinya, Chaczko, Aboura, Center for Built Infrastructure Research, University of Technology Sydney, Australia

Radio mapping is not geolocation of emitters or interception of content



RF Mapping technical challenges

Mapping in urban areas

- High multipath, fading, shadowing

Dense RF signal environment

- Potentially 1000s of emitters per square kilometer

Limited receiver resources – cannot observe all locations and frequencies all the time

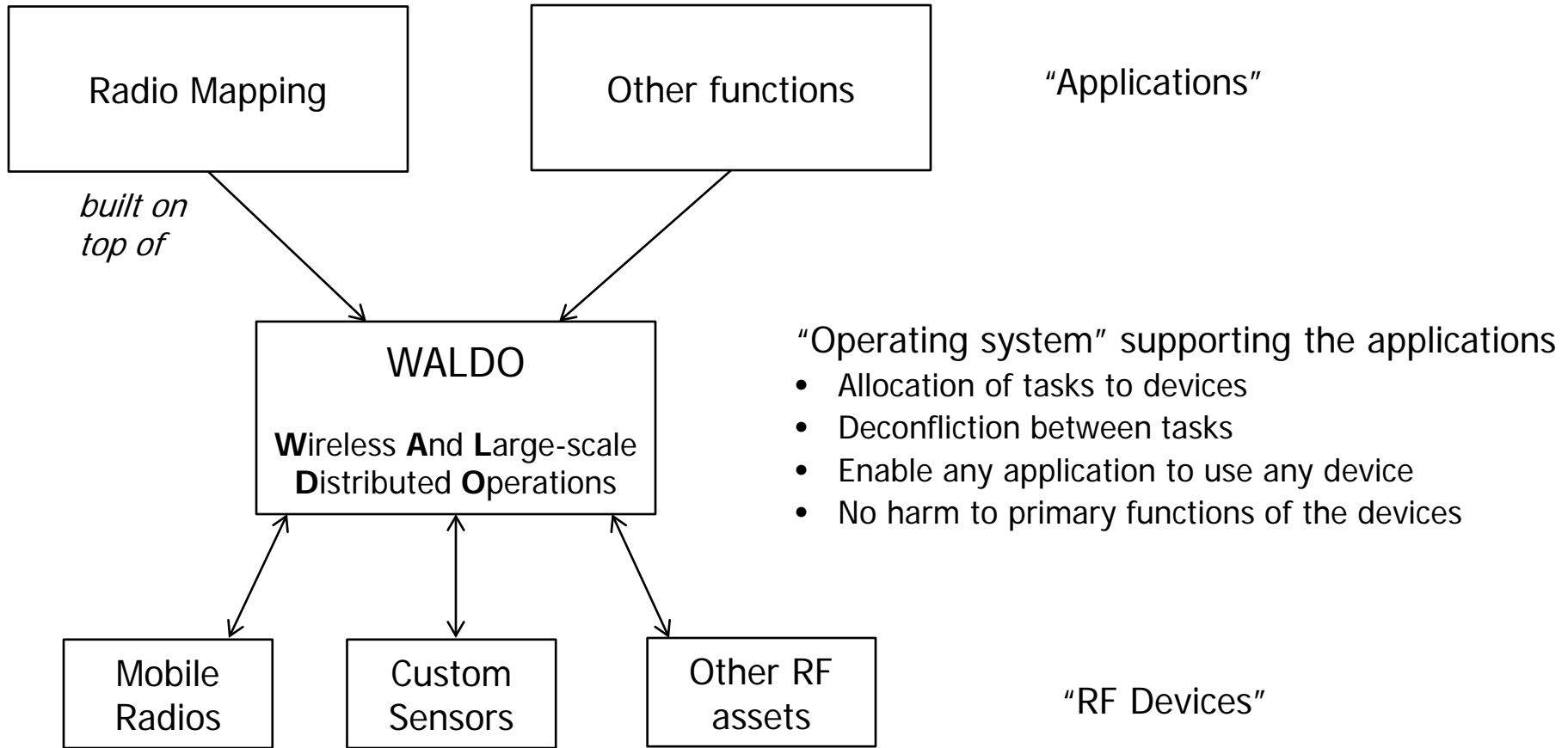
- Must sample and interpolate/extrapolate in both space and time
- Exploit information such as:
 - Models of emitters and networks
 - Maps of the urban environment and terrain
 - Propagation models
 - Spectrum license databases

Many or most sensors are not controlled by the RF mapping algorithm

- Sensors may be mobile
- Sensors may be intermittent



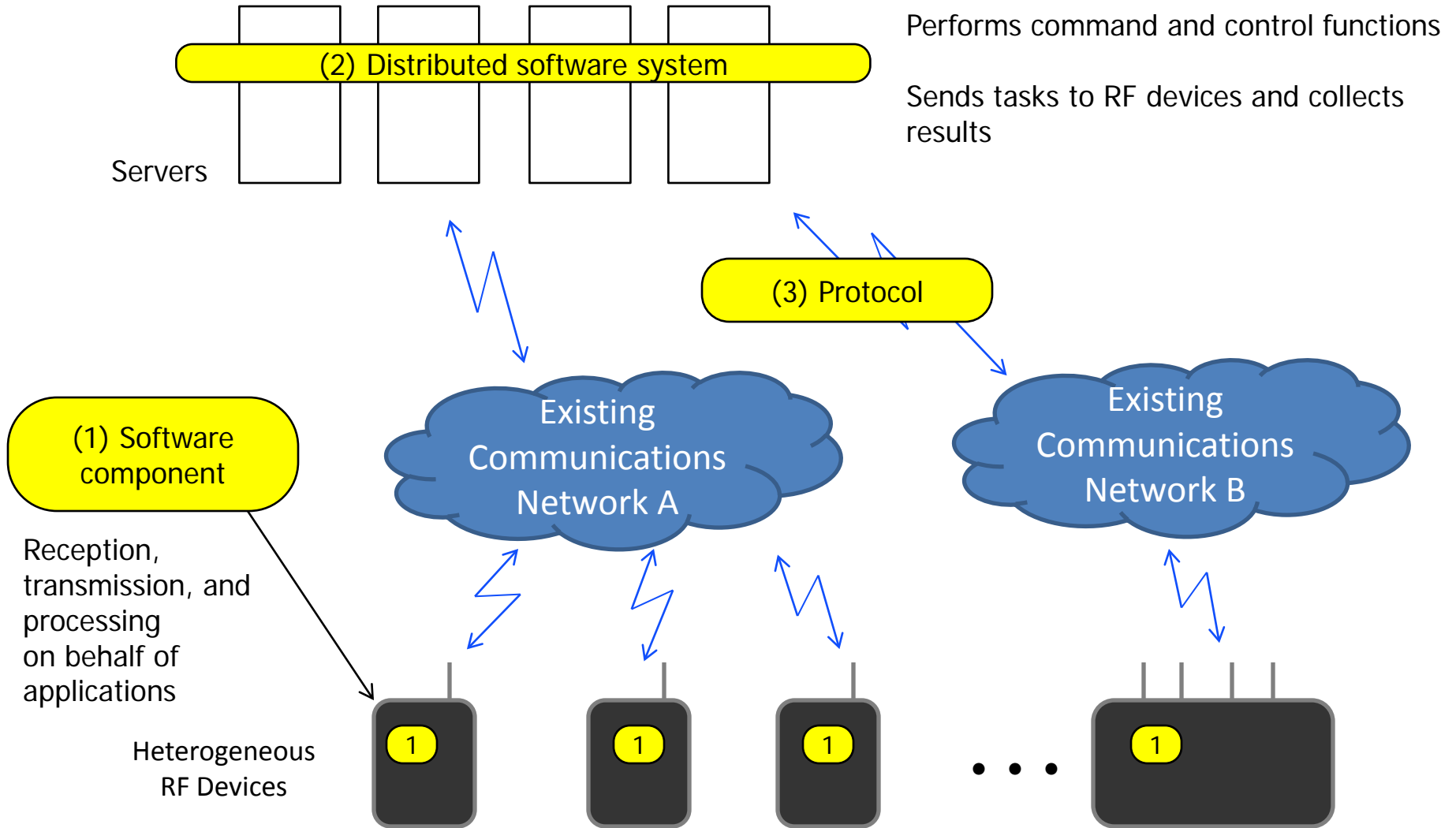
Implementation strategy



WALDO solves the common problems faced by any application that exploits RF devices deployed for other missions



WALDO system components





WALDO technical challenges

System feature	Example challenges
Any application can use any device	Don't change RF device software for each application. Flexible use of special-purpose processors (GPU, FPGA).
Robust operation	Don't crash the RF devices. Survive application misbehavior.
Secure operation	Don't create a new vector for adversaries to hack into the RF devices.
Efficient operation	Minimize consumption of device and network resources to carry out requested jobs.
Support multiple simultaneous applications	Automatic deconfliction based on resource use.
Scalable to 1000 or more RF devices	Automatic allocation of sensors at large scales.
When network quality of service is low	Tolerate high jitter and high packet loss.
When information about the RF devices and the environment is uncertain	Efficient operation despite poor device location information and rapid changes in device status.



Status and notional schedule

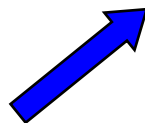
Startup

- BAA released February 2012
- Proposal evaluation completed
- Awards expected summer 2012



Phase 1 (12 months)

- Implement Radio Mapping prototype
 - Final field trial summer 2013
- Design WALDO system
 - Lab studies of sharing tactical radios between communications and RF mapping
- Analysis of other applications



Phase 2 (12 months)

- Improve radio mapping prototype
- Heterogeneous sensors, mobility
- Final field trial summer 2014
- Solicit for system design and system lead



Phase 3 (24 months)

- Develop transitionable RadioMap capability
- Develop WALDO system
- Demonstrate 2 additional applications
- Port to fielded radios