Concepts and Characteristics of CASA Radar System
CASA (Collaborative Adaptive Sensing of the Atmosphere)

SHORT-WAVELENGTH TECHNOLOGY AND THE POTENTIAL FOR DISTRIBUTED NETWORKS OF SMALL RADAR SYSTEMS

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Dense networks of small radars—unlike today's large installations—can defeat Earth curvature blockage, thus providing more low-altitude data and meeting the diverse needs of end users.

BAMS 2009
Why CASA?
Current US Weather Surveillance Network

Characteristics:
- $10M [US] per radar
- Doppler, Dual-pol

Network does not:
- View below 2-3 km owing to radar spacing
- Provide high resolution (1 minute, low-altitude, hundreds of meter) measurements for local needs.
CASA – Concept

- Close spacing
  - 30 km vs. 230+ km
- Short-wavelength
  - X-band vs. S-band
- Low-power
  - 10’s Watts
- Low cost
  - $200k US
- Low infrastructure
Fig. 7. Map of the CASA IPI test bed in southwestern Oklahoma showing the radar sites and 40-km range rings. Also shown are the NEXRAD radars at (bottom left) Frederick (KFDR) and (top right) Twin Lakes (KTLX). The rings around the NEXRAD radars are at 40 and 60 km, respectively.
CASA Mechanical Scan Radar Systems

Components

- Antenna
- Radome
- Tower (8m)
- Data Acq.
- Transceiver
- El Positioner
- Az Positioner
- Platform, frames
- Computers, storage
- HVAC

~%200 K; 25K/yr maintenance
1. Radars: Scan atmosphere and send data to repository (initially centralized, later distributed)

2. Weather Detection algorithms run on data

3. Detections and other data are "posted" in Feature Repository

4. Tasks are generated based on detections and User Rules

5. Optimal Radar Scans are configured to complete as many tasks as possible while maximizing data utility to users
CASA IP-1 Network

WSR-88D (Frederick KFDR)

May 8-9, 2007
Multi-Doppler Analysis
Ground Clutter and Attenuation Corrections
Student Test Bed

Off-the-Grid Radar
First node being tested at UMass

OTG-Solar powered and wireless communication

Siting based on Disaster Vulnerability Model
Modified off-the-shelf marine radars

OTG
Solar powered and wireless communication
CASA DFW
Urban Demonstration Network

Brenda Philips, V. Chandrasekar, Fred Carr, Molly Thoerner, Tim McClung, Curtis Marshall, Apoorva Bajaj
Goals

1. Operate DFW Test Bed as “living lab” for high resolution, urban, end-to-end warning systems.

2. Demonstrate quantifiable value of CASA systems
   - Sensors, products, processes, users, impacts
   - Atmospheric sciences, radar met, integrated warning systems, networking, hazardous decision-making, social science, economics.
   - Network-of-networks

3. Develop replicable public/private/local model for regional sensor acquisition, deployment and ops

4. Sustain CASA’s interdisciplinary, multi-institutional collaboration beyond year 10.
Partners

• CASA Institutions: UMass, CSU, OU
  – High resolution warning/forecast systems, flooding and severe weather
  – Research
  – Models for regional deployment of sensor networks

• North Central Texas Council of Governments (NCTCOG)
  – Regional deployment, public safety, economic advantages

• NWS Office of Science and Technology
  – Network-of-networks
  – Shared cost models
DFW RADAR DEPLOYMENT

NETWORK ROLLOUT

First phase in blue
Second phase in green
NCTCOG region in red

UNT, Denton
Discovery Park campus

UTA, Arlington
Carlisle Hall (Installed)

Town of Addison
General Services bldg.

City of Fort Worth,
Water tower
Region/market responsible for cost of radar build out to 16 -20 nodes to blanket region.
Phased-Array Antenna Panels

University of Massachusetts prototype demonstrating ~$10k (US) per LRU

<table>
<thead>
<tr>
<th>Table 5. Key specifications for phased-array panels for the dense network application.</th>
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<tr>
<td>Peak transmit power per panel</td>
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<tr>
<td>Panel size</td>
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<td>Average beamwidth</td>
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<td>Polarization</td>
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<td>Number of panels per site</td>
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<td>Azimuth scan range</td>
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<td>Elevation scan range</td>
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**Umass Amherst Phase-tilt Antenna Array Prototype Tests**

Dual Polarization Performance:
- Co-pol mis-match <5% to 45° (based on LRU NF measurements)
- -20 dB Xpol to 45° (calculated)

E-Scanned Antenna Technologies

First RF Corp

- Phase steer – azimuth
- Mech tilt – elevation
- 1.5 meter x 1 meter
- 70 W peak, 30% duty

Raytheon

- 2D phase-phase array
- 1 meter x 1 meter
- ~ 100 W peak, 30% duty
Manufactured Product FRF – 166
Towards a “Flat Screen TV” Phased Array

Rear face
Radiating face (front)

Notional dimensions:
1.2 m length
0.8 m height
0.1 m (10 cm!) depth
Summary

• Adaptive and collaborative observing strategy with low-cost radar network demonstrated
• Utility of CASA observing systems for providing high temporal and spatial resolution of high-impact weather events established
• Low-cost phased array X-band radars successfully developed and produced
• Transition from feasibility to reality of CASA radar system underway
• New applications, developments, and opportunities for CASA system?
Albrecht’s view of clouds in MCC that initiated 29 June 2012 derecho