ARA Wireless Living Lab and CHI@Edge

ARA Team

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Rural Broadband Challenge

- Rural US as home to agriculture, manufacturing, renewable energy industries etc
 - Agriculture & food sectors: \$750+ billion contribution to annual GDP
- Rural broadband is a foundation for rural economy (e.g., precision agriculture) and quality of life
- Yet 39% of rural US lacks broadband access, and most ag farms are not connected at all





ARA: Wireless Living Lab for Smart and Connected Rural Communities



- ARA: southern constellation of stars in astronomy; <u>agriculture and rural Communities</u>.
- The image of Ara (upper-right corner of the image above) shows the way rural wireless is expected to look like, that is, with disk-like wireless access networks connected by long-distance wireless backhauls.
- The light in the sky from the Ara stars also signifies the vision of "ARA as the light for rural wireless and broadband".

Redefine Rural broadband

- Technology
 - Missing elements beyond fiber, WiFi 6, 5G, LEO satcom
 - □ Factor of 10+ reduction in CapEx
 - Making rural broadband as affordable as urban broadband!
- Use case
 - From rural communities to rural industries (farms, factories etc)

ARA Deployment in Central Iowa



Long-Distance, High-Throughput Communications

- **AraHaul**: multi-modal, long-distance, high-throughput systems
 - Terrestrial communications

 Optical (AraOptical) 	160Gbps	15km+
 mmWave (Aviat WTM 4800) 	20Gbps	15km+
 Microwave (Aviat WTM 4200) 	2.5Gbps	20km+
 Multi-band (Aviat WTM 4811) 	2.5-20Gbps	15km+
LEO satellite communications	100Mbps	across planet

- Capabilities enabled
 - Spatial, temporal, and spectral channel diversity for robust high-capacity
 - *RaptorQ rateless coding* for *real-time* bandwidth aggregation

• **AraRAN**: high-throughput COTS & SDR systems

- Low-UHF mMIMO (Skylark) 100Mbps+ 10km+
- mmWave (NI, InterDigital, Ericsson) 100Mbps+ 150m+
- sub-7GHz (NI, Ericsson) 50Mbps+ 1km+
- Capabilities enabled
 - bandwidth aggregation, channel aggregation & bonding
 - mMIMO
 - Waveforms beyond OFDM
 - Dynamic spectrum sharing

Applications Research



high-throughput phenotyping



agriculture automation



precision livestock farming



AR-based ag education (Blippar, 2020)

AraSoft: from Equipment to Wireless Living Lab



Wireless Networks = **Computers (& Networks)** + RF Equipment



CHI@Edge as AraSoft Baseline



Example AraSoft Extensions of CHI@Edge

- Wireless resource modeling and management
 - Resource spec: radio type, frequency, transmission power, resource block, channel/weather condition etc
 - **Blazar:** spectrum & radio reservation etc
- Wireless guard
 - Reactive RF sensing + proactive RF configuration safety check
 - Fail-stop/emergency-stop mechanisms
 - Stop experiment/container/radio

Field-to-Cloud Continuum: From AraSoft to ARA-Chameleon Federation!

