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DATA SHEET

DS-002A.2
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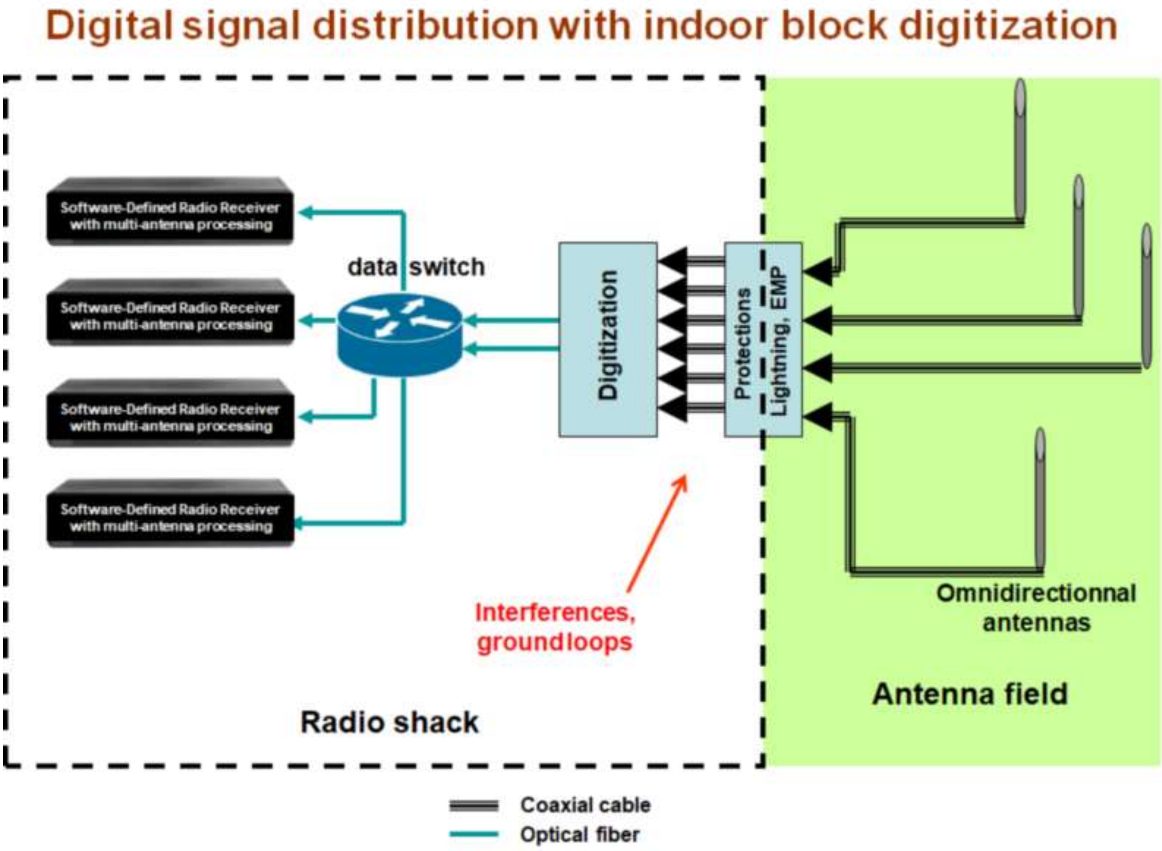
DHASA
Digital HF Antenna System for Phased Arrays

Receive antenna arrays allows significant SNR rising through beamforming and/or spatial/polarization diversity, and are required in the HF domain for long range high data rate modulations like WBHF, HFXL, ...

Conventional (ie first generation) digital HF receive antenna arrays use locally-synchronized digitizing receivers in the radio shack, connected to active HF antennas through long coaxial cables. The data from the digitizing receivers is then distributed to software-defined radio (SDR) receivers with multi-antenna processing.

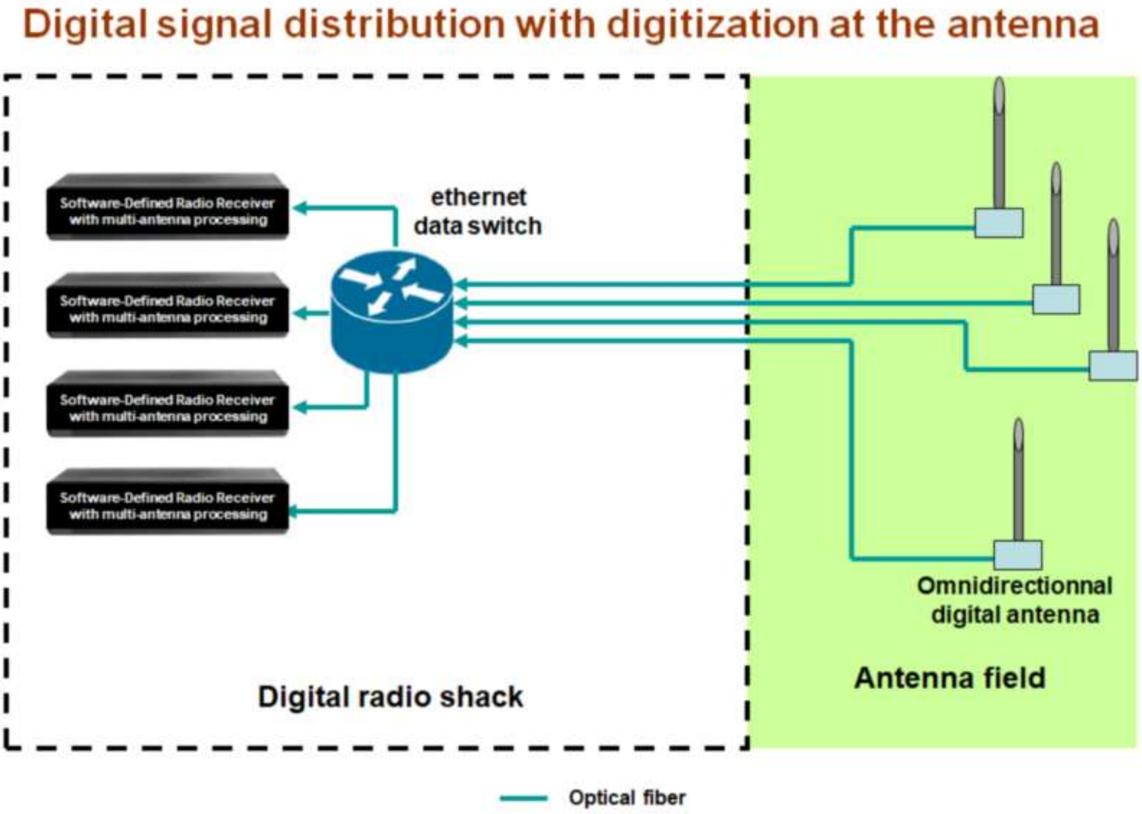


Such configuration has several drawbacks with limit performance, array baseline extension and array-to-shack distance:

- coaxial cables losses
- coaxial cables coupling to antennas
- coaxial cables cost, weight (for non-fixed arrays)
- coaxial cables lengths have to be precisely known (centimeter range), but still temperature-dependant
- antenna calibration drift

- at shack level: interferences, ground loops, coaxial lightning protections required
- ...

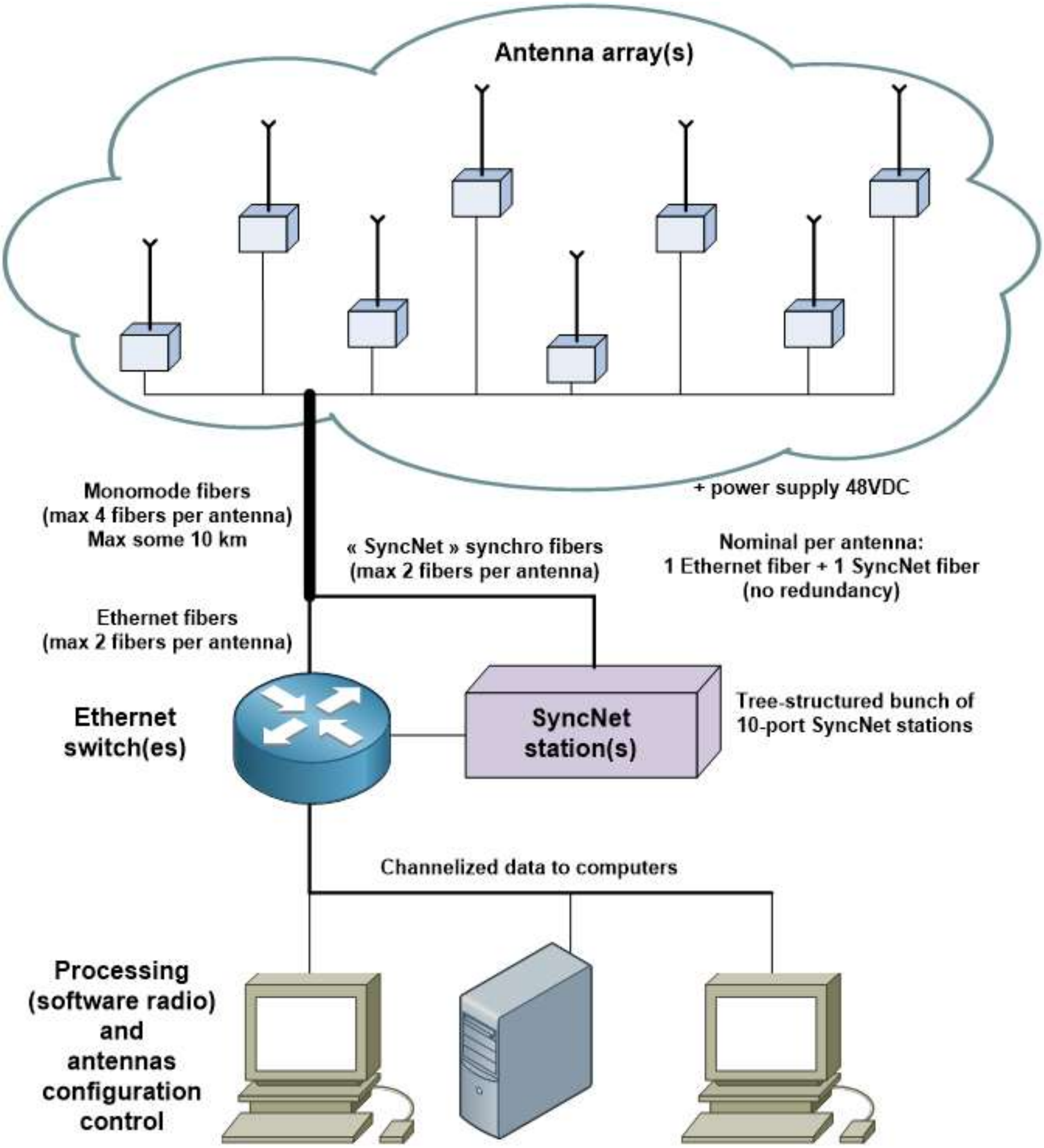
With digitization at the antenna level, the coaxial cables can be suppressed and replaced with optical fibers. Of course, power supply is still needed, but its cables have no such constraints than coaxial ones.



Moreover, with now a computer at the antenna level, this configuration offers new possibilities:

- antenna digital equalization through auto-calibration
- aerial part's impedance measurement through calibration apparatus, enabling ground plane compensation or defect detection
- precise localization (relative/absolute) and orientation through standard GPS modules
- unlimited shack - array distance
- ...

The main problem of this configuration is the long-range synchronization of the antennas' digitizers. FEE uses its SyncNet synchronization system as the array's backbone:



FEE Digital HF Antenna System for Arrays

Through the use of FEE's "SyncNet" picosecond synchronization system, antenna auto-calibration and relative positioning systems, long baseline HF receive pahsed arrays (several km) can then be implemented. This allows spatial diversity exploitation, along with polarization diversity when vertical and horizontal antennas are mixed in the array.

To ease digitized data exploitation, a channelization is done at the antenna level. Associated with an ethernet multicast distribution, each SDR receiver can ask only for channels of interest. This is done through standard IGMP protocol between them and the main ethernet switch. Standard channel in FEE products is 8 kHz wide (both spacing and -3 dB bandwidth), with 10 kHz sampling frequency. Time-stamped complex channel data are provided as standard (IEEE754) 32-bit floating point numbers, and are volt-referenced at the equalized input.

A specific FEE's protocol (ADCP, Antenna Discovery and Control Protocol) relying on UDP/IP is used for configuration, discovery (self-building) and management of the array. A processing unit is needed to manage the array and insures coherent configuration, relative localization calculation,... It's called "master client" of the array.

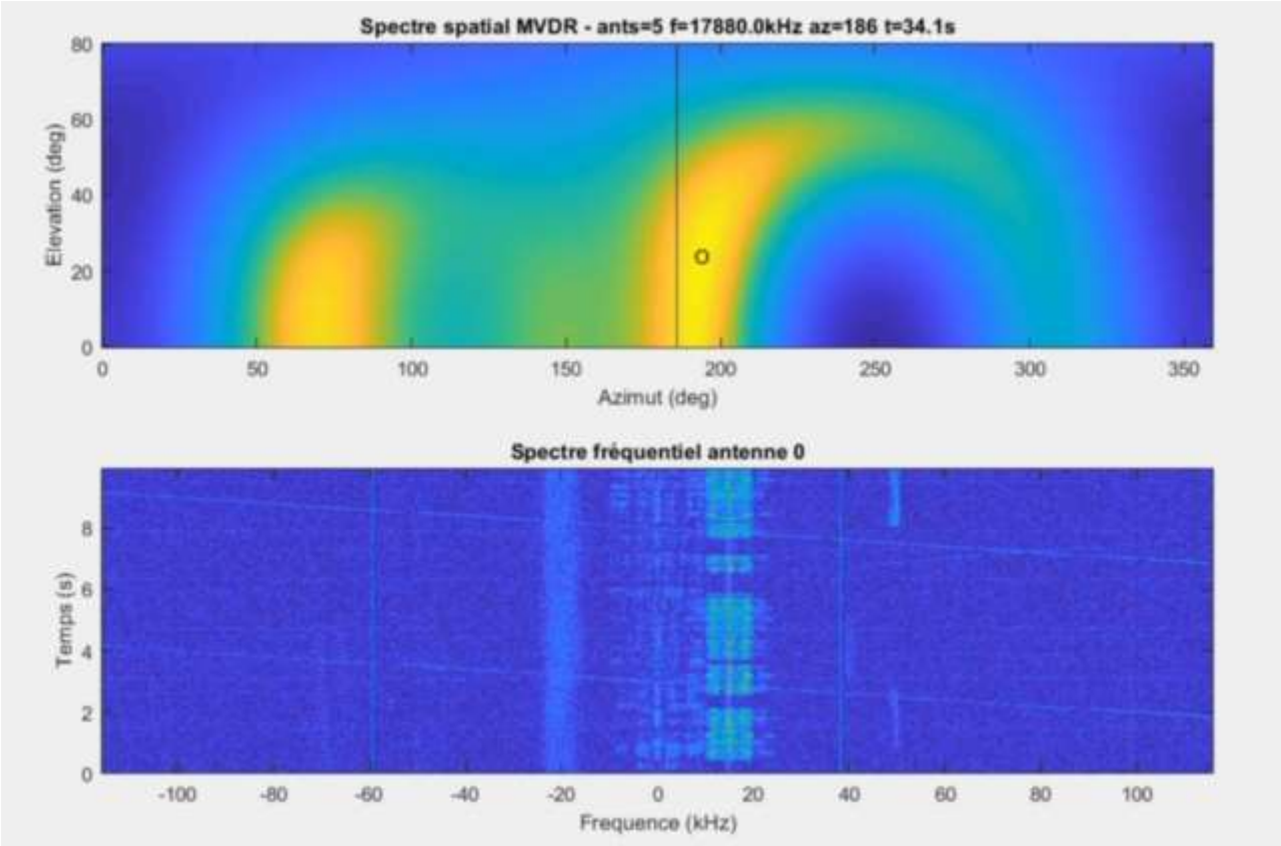
"Slave clients" are the SDR receivers, which rely on master client to get current configuration/status of the array (no direct talk to antennas). As a special multicast address is dedicated to array's status information broadcasting by the master client, it has only little traffic to manage from the slaves (initial configuration).

The channelized data itself is not handled by the master client, and since ethernet multicasting is used to distribute channelized data, the number of SDR "slave" receivers is not limited. With full-band channelization, the SDR receivers are autonomous and can listen for any frequency or bandwidth. Higher bandwidth signal reconstruction from elementary channels can be done by an efficient FFT-based preprocessing stage.

The volt-to-SDR receiver latency is depending on the ethernet data packets parameters choosen by the user (one packet = c channels x s time samples). For a given data packet size, short latencies imply more channels in it, and higher bandwidth required per multicast address. The ADCP protocol enables redundancy if required (2 physical ethernet networks, and up to 2 master clients).

Mainly for monitoring purposes, the FEE digital antennas use an additional multicast address to periodically transmit mean and peak power values for each channel, allowing real-time full HF spectrum visualization (up to 50 fps) at low data rate and minimal computing cost on user side.

Below is a qualitative example of processing from a small 5-antenna protype array (9m diameter): low bandwidth MVDR (Capon) spectrum at 17.880 MHz (2 same-carrier AM stations), and 200 kHz wide frequency spectrum (showing others stations and 2 sounder sweeps).



Example of data processing with a small array of 5 digital monopole antennas DHAMO

Main DHASA products are for now:

- Digital receive monopole HF antenna DHAMO
- Digital receive dual horizontal dipole HF antenna DHADI
- Digital HF receiver SYDRE
- 12-port 48V Power Distribution Station DHAPO
- SyncNet distribution station SYDON for antennas synchronisation in arrays