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Digital Communication for Open DC Grids

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Arguments against digital comms in the Developing World

- With no comms, debugging only needs a multimeter
  - With comms, a very patient help desk! (logic analyser is unrealistic)
- Digital protocols keep changing
  - The cleverer they are, the harder it is to ensure backwards compatibility (which is an absolute requirement!)
- To a person with no education, a smart system is unpredictable and impossible to understand
- An *Open* grid must permit anyone to connect anything, if there is sufficient power
  - A protocol to disable an unsafe system ***will*** be subverted!
- *I'm not saying stay dumb, but these issues must be understood and addressed*

Early smart grid questions

- What are we trying to achieve?
  - Grid electrical stability (µS – mS)?
  - Rapid fault isolation (mS)?
  - Implementation of an energy management strategy?
    - Energy reservation for fixed-cycle and despatchable loads (secs-hours)?
  - Commercial objectives?
    - Metering, billing, access restrictions, PAYG? (secs)
  - Demand-side Power management? (secs)
    - How to explain to an uneducated user?
  - Remote management?
    - Monitoring, reporting (read-only)?
    - Control (read/write)?? –> User distrust
- We are likely to need different physical layer solutions for different functions

Physical Layer choices

- Wiring simplicity
  - Easier to control manufacturing environment than electrician in the field
- In-band or out-of-band?
  - If OOB, wired or wireless? (is this a binary choice?)
- Compatibility with all existing systems with which it might have to co-exist
- Controlling the boundaries between control domains
- Bandwidth, latency, error correction required
- Requirement for operation during power failure, short-circuit, black start
- Radio interference (causing, immunity to)
- Energy efficiency (low-power with high noise-immunity)

My recommendations

- Signalling only between power sources and storage
  - Optionally for energy management to despatchable/ schedulable loads and rented PAYG, but dumb loads are fine
- Behaviour of the system must be extremely easy for uneducated people to understand (no manual!)
  - The absolute minimum of intelligence necessary to ensure a reliable system
    - If something turns off using comms – for any reason at all – it must be extremely easy for an uneducated user to understand why, and what the penalty will be if they defeat it

Conclusion

- Choices we make around signalling are critical to the usability and openness of the system
  - We must not implement *any* signalling function "just because we can"
- Remember that uneducated people find smart systems very challenging
  - They distrust systems that behave in ways they don't understand
  - In Kenya, people in rural areas would rather buy a dumb poorly assembled system from a local guy they trust, than a really clever system from an international agency