Weightless: A standard designed for machine communications in white space spectrum

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The M2M application requirements

- Very low cost of technology which can be readily integrated into machines (for example included on chipsets within eg smart meters)
- Very low power consumption enabling battery life of years for some types of machines
- Ability to handle large numbers of terminals efficiently
- Ability to handle large numbers of small data packets efficiently
- The need to be able to work effectively with a small and simple antenna at the receiver

Leads to a logic flow of design

- Ubiquitous coverage implies a cellular architecture
  - Which in turn means location registers, billing systems, etc
- Deep indoor coverage with low transmit power and avoiding the need for a large number of cells implies spreading to extend range
- Lower transmit powers at the device imply narrowband uplink to balance the link budget
- White space operation implies TDD
- Unlicensed operation brings an interference risk requiring frequency hopping to mitigate
- All of this implies a structured transmission with the base station imparting information such as the hopping pattern
  - Leading to a frame structure and scheduled transmissions

Which has the following ramifications

- Spreading means the header information takes a long time so the overall frame duration must be long (~2s)
- This does allow all the base station processing to be moved to the core network and for the core network to be implemented in software running in the Cloud
- Long battery life implies a sleep mode with periodic awakening at around 15 minutes and that listening time is minimised by providing all the information needed in the frame header
- Keeping signalling low requires terminal-driven handover
- Tight emission limits require single-carrier modulation to enable rapid roll-off (rather than CDMA or OFDM)
- A large number of terminals requires careful network scheduling

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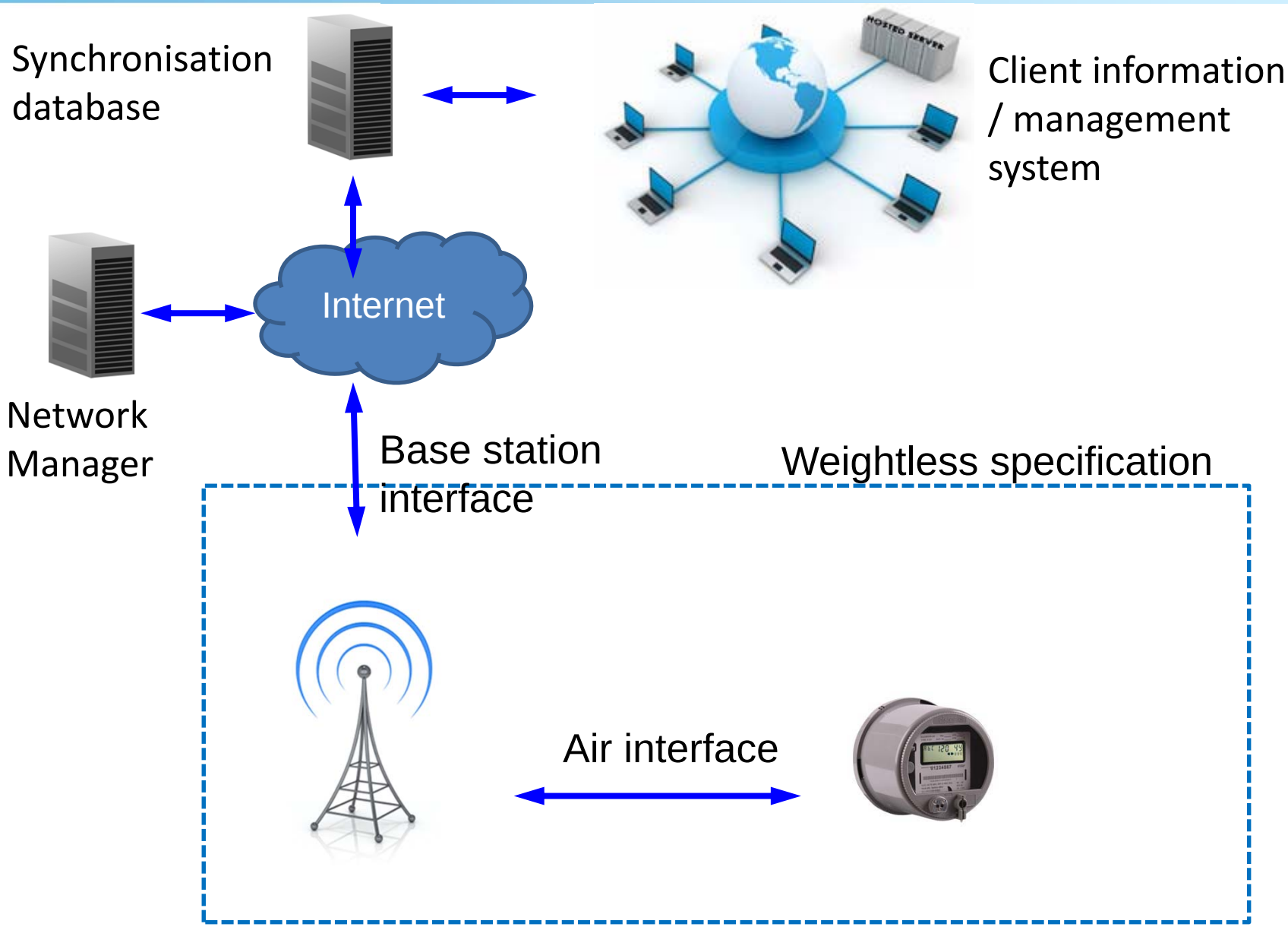
Architectural overview

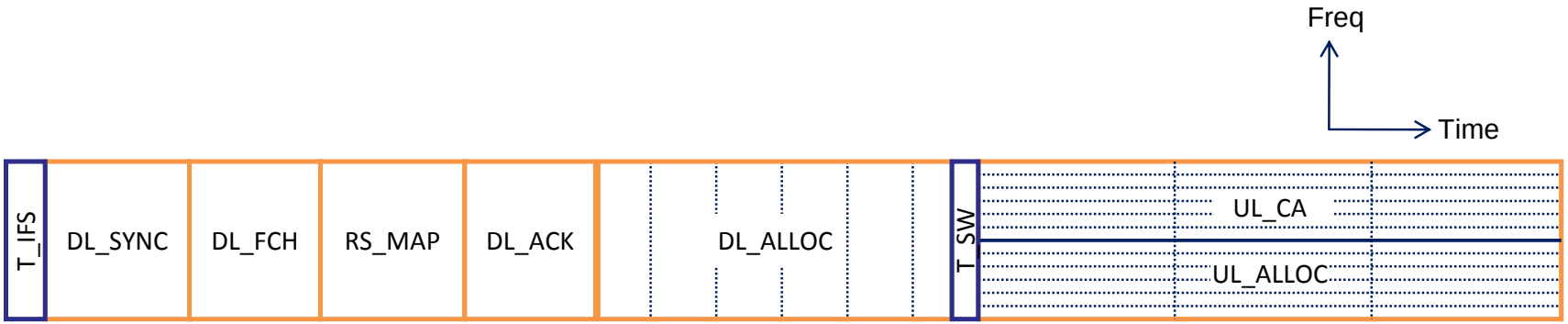


Physical Level

- Single carrier downlink with TDMA (time-slots) used for multiplexing users
- Uplink is divided into 24 sub-channels, each of which can be used by a simultaneous user
  - This allows improved capacity given the much lower Tx power (and antenna gain) for M2M devices
- SC-FDE used for higher data rates
- Rake equalisation where spreading factors are >16

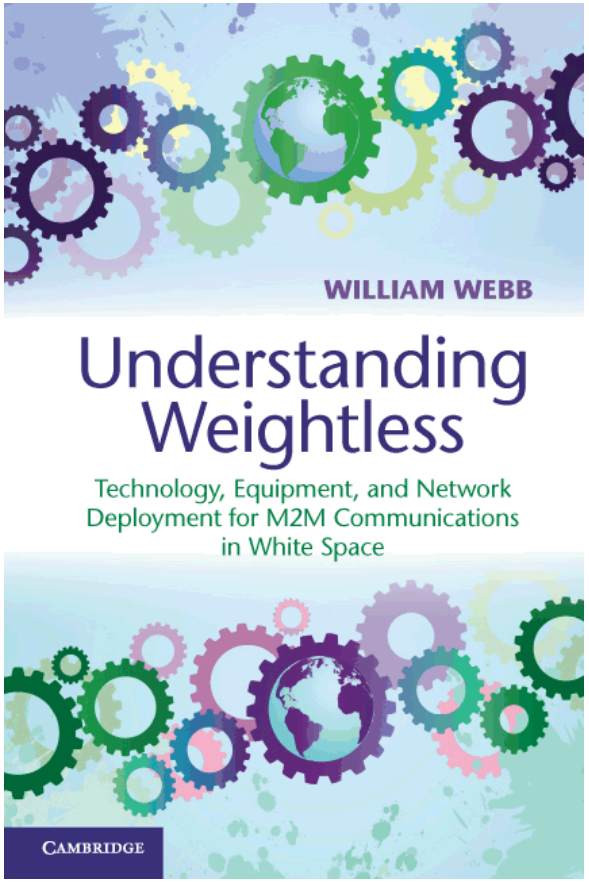
Multiple Access Level

- Frame structure repeats at 2s intervals
- Flexible downlink – uplink boundary
- Broadcast channel every 15 minutes
- Device can entirely synchronise on 1 frame
- Contended access carefully controlled and with variable message size



Finding out more

- “Understanding Weightless” available from Amazon provides an excellent introduction
- Join the Weightless SIG to get the full specification (www.weightless.org)



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