

# GreenApps: An Off-Grid Cellular Edge Apps Ecosystem

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# Cellular Edge Services in Kumawu, Ghana

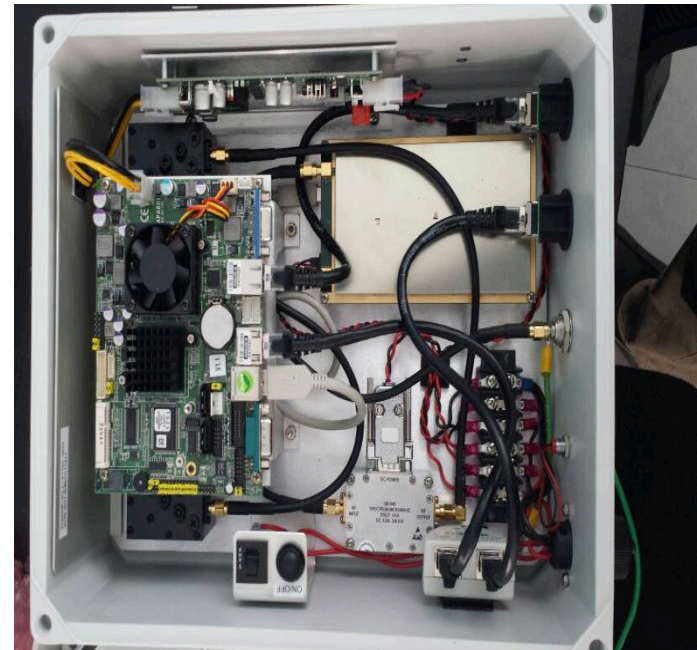


# Cellular Edge Services near Pearl Lagoon, Nicaragua

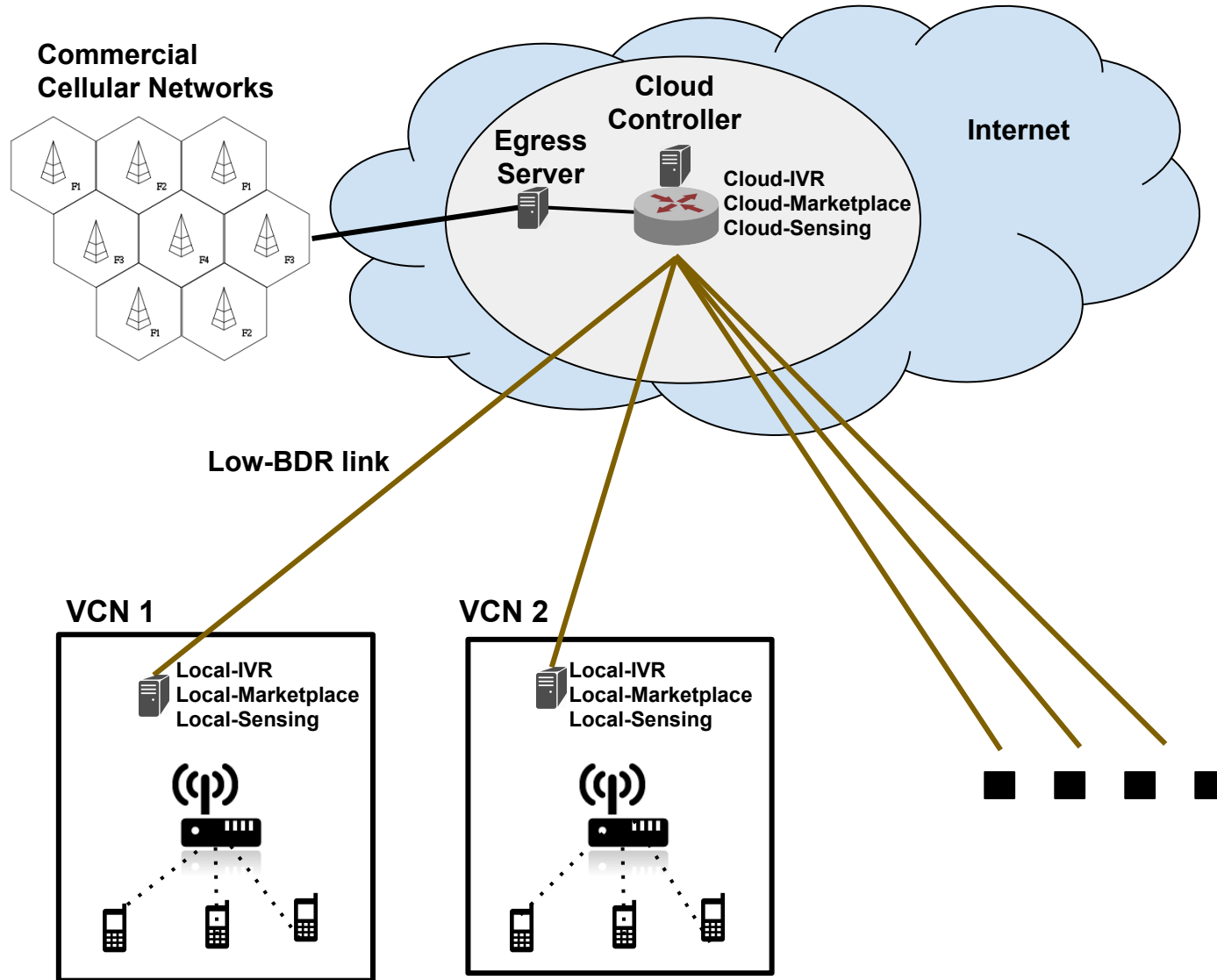


# Small Cells

1. Provides basic cellular network functionalities
2. Comparable range
3. Power requirement order of magnitude lower  $\sim 300$  Watts



# Virtual Cellular Networks





# Solar power – Good for 5kms

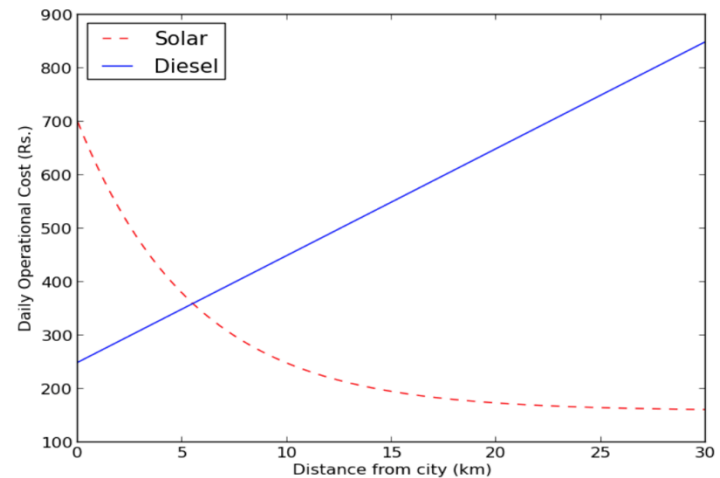
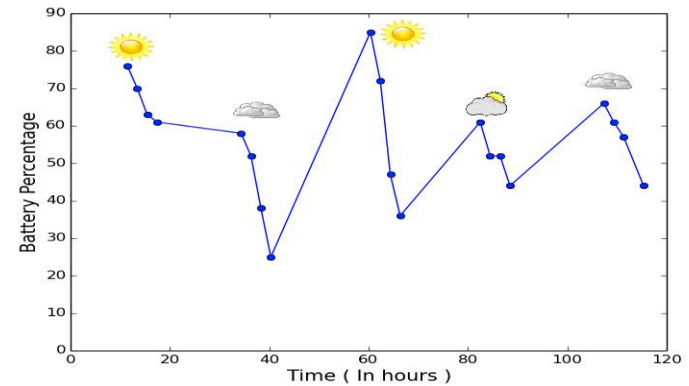
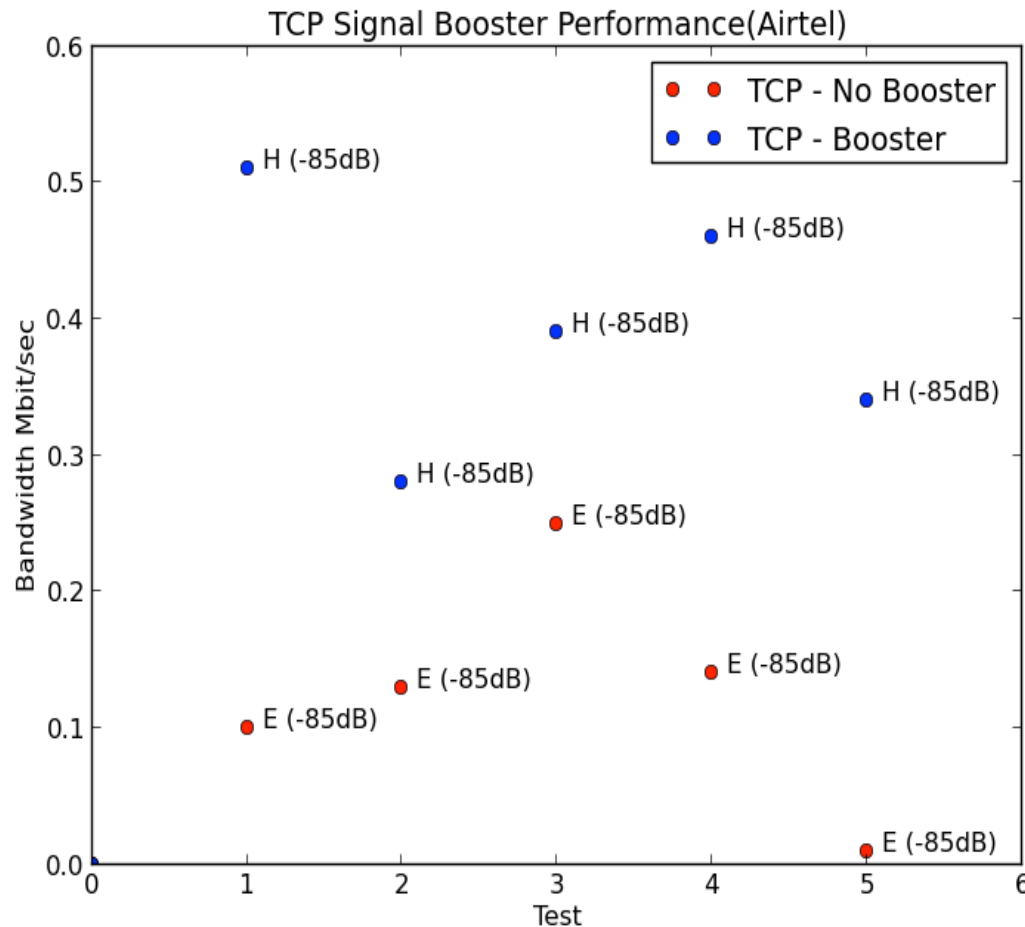


Figure 3: SSC cost vs. diesel

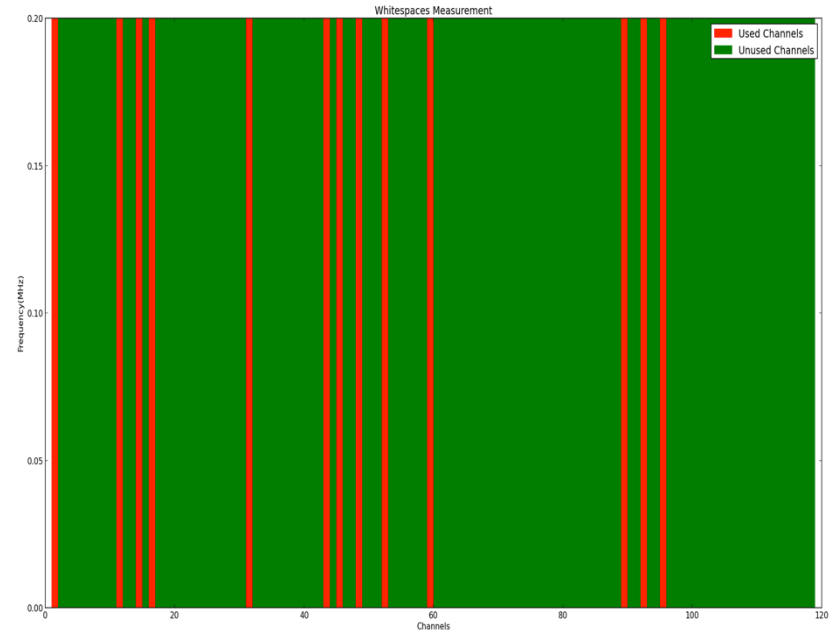
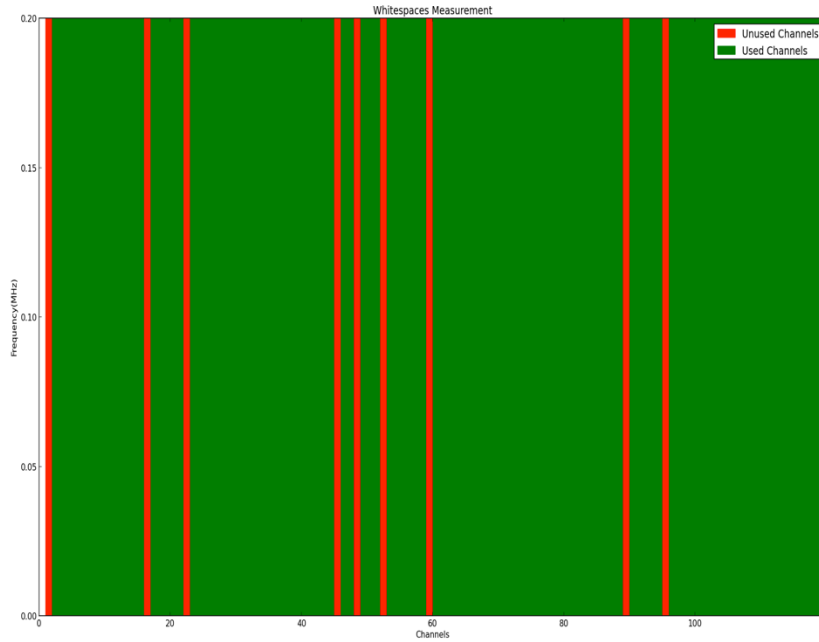
# Signal Boosted Backhauls – Kumawu, Ghana



TCP bandwidth increases by up to 5 times while using a booster.

There is still significant variability

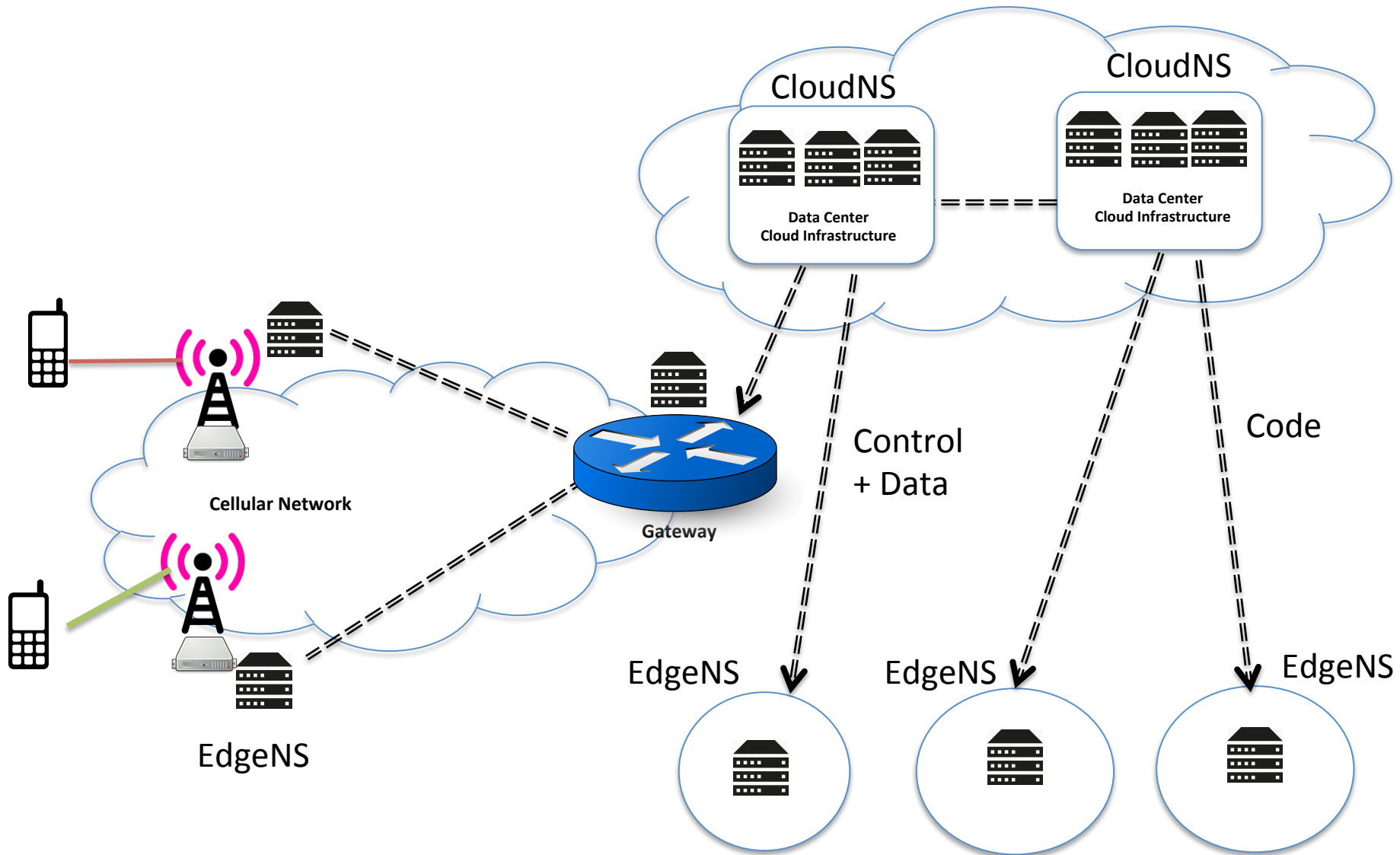
# Participatory Whitespaces



There is a constant need for scanning.



# Distributed Network Services Model



# Distributed Network Services

- Cloud NS – Cloud Controller Network Service
  - Controls several EdgeNS
  - Operates over same App-state space as EdgeNS
  - Can install App-Code on the fly in EdgeNS
- Edge NS – Edge Network Service Instance
  - Middlebox in the data path to the client
  - Loose synchronization of state with CloudNS
  - Runs App-Code in isolated VM environments
  - Can run several Apps at the Edge

# Identity Primitives and Management

- Network Identities (network layer - easy!)
- Device Identities
  - EdgeNS maintains ownership of device identities
  - Liveness vs Consistency tradeoff
    - EdgeNS gives us ownership in the face of failures
  - Ownership controlled by CloudNS
    - Mobility
- Application Identities
  - Assign identities to each State
  - Specify CAP tradeoffs as a function of state
  - CAP tradeoffs determine synchronization primitives

# Intermittent File System Primitives

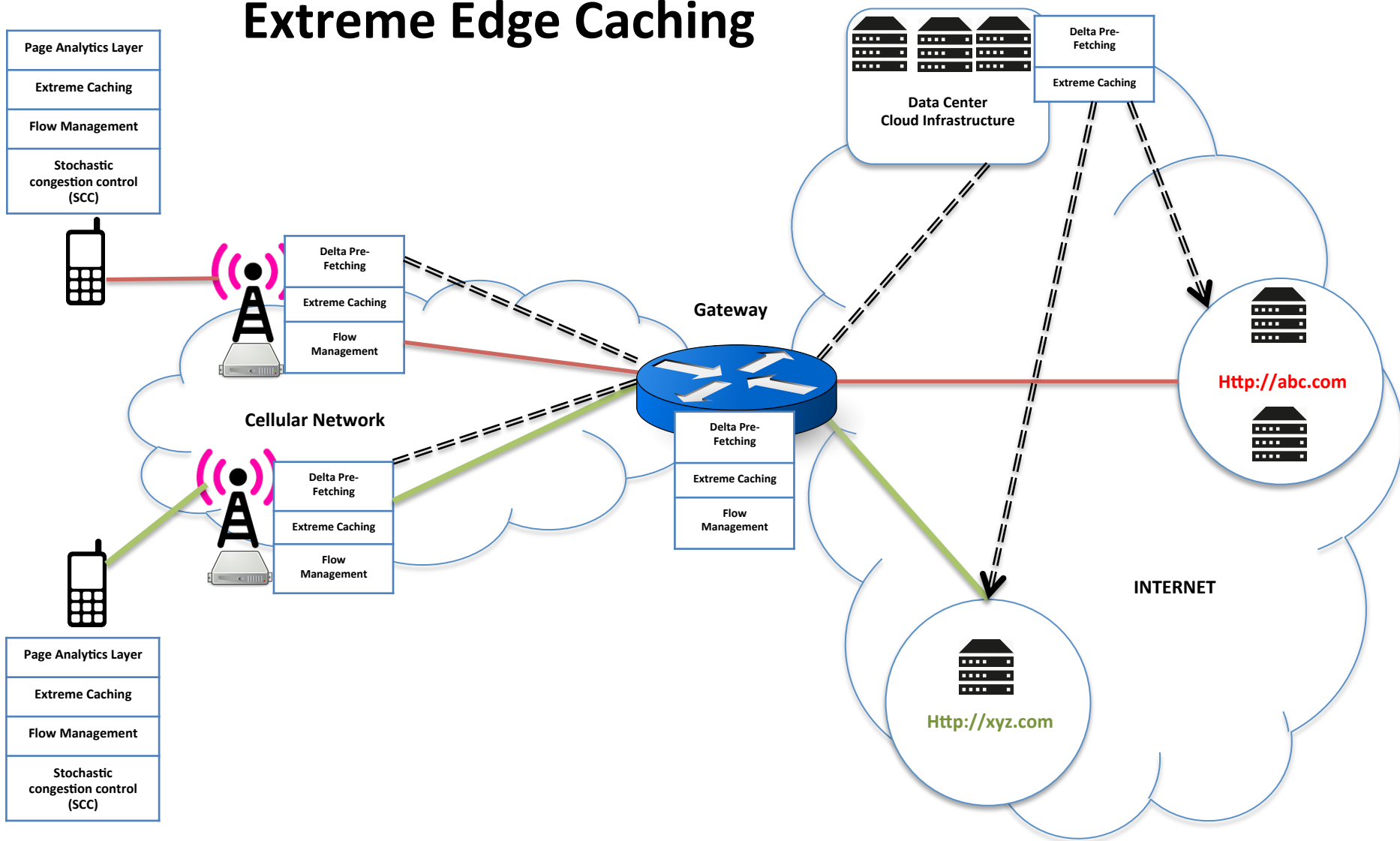
Application independent primitives.

- POST - Helps applications send data to the cloud in a lazy manner
- GET - Helps applications fetch data from the cloud instantly
- SEARCH - Helps applications search data in the cloud instantly

# Extreme Edge Applications

- Marketplace – Distributed Buy/Sell Bidding
- Mapping – Distributed GPS mapping
- Intermittency-Aware Distributed Voicemail
- Intermittency-Aware Distributed Messaging

# Extreme Edge Caching





# Fishline in Nicaragua

