Scaling Community Cellular Networks with CCM

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Thanks!

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Omar Ramadan, Matt Ball,
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UP VBTS team,
Globe Konekt team,
...so many others!
“In most countries, even in Africa, mobile operators have already rolled out 2G and 3G network coverage as far as possible within the envelope of a commercially sustainable business model.”

GSMA, “Understanding the Economics of Network Coverage Expansion” (2017)
1.7 billion

People outside mobile broadband coverage
400 million

People outside any mobile coverage
Community Cellular Networks

Built by and for their users
Run cooperatively
Optimized for local needs
Leveraging local resources
Providing local services
Sustainable in rural areas

Rhizomatica (Mexico)
Scale of telcos + Reach of community networks
CommunityCellularManager

github.com/co-cell/ccm
3 years
17 sites
2.8K people
Telco partner
Mobile Core Network

Voice/SMS

Internet
Mobile Core Network

Voice/SMS

Internet

$
1. No **flexibility** across sites
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2. Doesn’t degrade gracefully
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2. Doesn’t **degrade gracefully**
3. Modifying mobile core is **expensive**
Centralize Management
Decentralize Network Services

1. No **flexibility** across sites
2. Doesn’t **degrade gracefully**
3. Modifying mobile core is **expensive**
CCM is 2G only.

40% of devices only support 2G.*
LTE/5G is not [yet] relevant in our context.

Voice/SMS

CCM Controller

Internet

CCM Client

CCM Client

CCM Client
Synchronizing state: Checkin

**Request** *(Client -> Controller)*

```json
{
  'status': {
    'active_users': 24,
    'ran_load': 51,
    ...
  },
  'events': [
    [15, 'IMSI123', 'out_sms', ...],
    [16, 'IMSI345', 'transfer', ...],
  ],
  'modified_subs': [...],
  'ctx': {...}
}
```

**Response** *(Controller -> Client)*

```json
{
  'config': {
    'radio_band': 51,
    ...
  },
  'events': {'seqno': 16}
  'subscribers': [...]}
```
Synchronizing state: Checkin

CCM Client → HTTP POST → CCM Controller

DB → [status': {'active_users': 24, 'ran_load': 51, ...
  'events': ['IMS123', 'out_sms', ...],
  'modified_subs': [...],
},

DB → [status': {'active_users': 24, 'ran_load': 51, ...
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Synchronizing state: Checkin

```json
{
  'config': {
    'radio_band': 51,
    ...
  },
  'events': {'seqno': 16},
  'subscribers': [...]
}
```
Synchronizing state: Checkin

CCM Client

DB

ctx: {
'config': 'b9ba2...',
'events': '12f3b...',
...
}

{ 
'status': {
 'active_users': 24,
 'ran_load': 51,
...
},
'events': [
[17, 'IMSI123', 'out_sms', ...],
[18, 'IMSI345', 'transfer', ...],
],
'modified_subs': [...],
'ctx': {...}
}

CCM Controller

DB

ctx: {
'config': 'b9ba2...',
'events': 'a3414...',
...
}

{ 
'status': {
 'active_users': 24,
 'ran_load': 51,
...
},
'events': [
[17, 'IMSI123', 'out_sms', ...],
[18, 'IMSI345', 'transfer', ...],
],
'modified_subs': [...],
'ctx': {...}
}
Synchronizing state: Checkin

CCM Client

DB

{ 'config': { 'radio_band': 51, ...
'events': {'seqno': 16}
'subscribers': [...] }

ctx: {
'config': 'b9ba2...',
'events': 'a3414...',
...
}

CCM Controller

DB

{ 'config': { 'radio_band': 51, ...
'events': {'seqno': 16}
'subscribers': [...] }

ctx: {
'config': 'b9ba2...',
'events': 'a3414...',
...
}

{ 'events': {'seqno': 18} }

{ 'events': {'seqno': 18} }

{ 'events': {'seqno': 18} }

{ 'events': {'seqno': 18} }
Synchronizing state: Billing

IMSI123:
{
'bts1': {'+': 500, '-': 200}
}

Balance: 300
Synchronizing state: Billing

IMSI123:

{‘bts1’:{‘+’: 500, ‘-’: 250}}

Balance: 250
Synchronizing state: Billing

IMSI123:

{‘bts1’:{‘+’: 500, ‘-’: 250} }

Balance: 250
Synchronizing state: Billing

IMSI123:
{
'bts1':{'+': 500, '-': 250}
}

Balance: 250

IMSI123:
{
'bts1':{'+': 500, '-': 250}
'bts2':{'+': 0, '-': 250}
}

Balance: 0
Synchronizing state: Billing

IMSI123:

```
{ 'bts1': { '+' : 500, '-' : 250 }
 'bts2': { '+' : 0, '-' : 250 }
}
```

Balance: 0
Deployment and Evaluation
UP Sites
Sabang-Limbok
Dikapinisan
Dibut
Diotorin
Bacong-Market
Dianao

Globe Sites
Tanay
Talisay
Binobohan
Ginulagan
Balogo
Casalaan
Banat-i
Mayaposi
Golden Valley
San Mariano
Binucayan
Online (1hr)
Offline (1hr)

Intermittent outages
Consistently online
Extended outage
65% downtime!
<table>
<thead>
<tr>
<th>Cause</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backhaul</td>
<td>VSAT outage due to weather</td>
</tr>
<tr>
<td>Power</td>
<td>Discharged batteries</td>
</tr>
<tr>
<td>Site hardware</td>
<td>Overheating</td>
</tr>
<tr>
<td>Site RF</td>
<td>Damaged RF cables</td>
</tr>
<tr>
<td>Other</td>
<td>Software bug</td>
</tr>
</tbody>
</table>
Outage causes in UP sites

- Backhaul: 42%
- Power: 24%
- HW Failure: 21%
- RF Failure: 12%
- Other: <1%
Outage causes in UP sites

- Backhaul: 42%
- Power: 24%
- HW Failure: 21%
- RF Failure: 12%
- Other: <1%

Addressed by disconnected operation!
+19% local calls + SMS

+16% credit transfers (sales)
< 2.8kB (6 sec call) @ 50th %tile
< 392kB (40 sec call) @ 99th %tile (~90% savings)
Local Services

UP Sites
- “Repair manual” SMS app
- Promotional billing
- SMS outage hotline
What next?
LTE changes everything.
LTE changes everything many things.
Wireless ISP deploying fixed broadband with LTE.
Peru, 2017
Community network deploying LTE.
Indonesia, 2019
Open source LTE

- **Magma** (Facebook)
  github.com/facebookincubator/magma
- **CoLTe** (U. Washington)
  github.com/uw-ictd/colte
- **OpenAir-CN** (OpenAirInterface Alliance)
  github.com/OPENAIRINTERFACE/openair-cn
- **NextEPC**
  github.com/acetcom/nextepc
CommunityCellularManager

1. Provides **autonomy** for community cellular networks
2. Degrades **gracefully** in the face of failures
3. Enables **cooperation** between community cellular networks and telcos
4. Supports the **largest** community cellular network deployment to date
Thanks!

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github.com/co-cell/ccm
Autonomy for the community.

Every site should be able to provide service without reliance on external systems.