An evaluation of communication means for smart metering in Flanders

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• report for *Flemish Regulation Entity for the Electricity and Gas Market* (VREG)

• outline
  - smart meter requirements
  - communication means
  - cost
  - conclusion
Smart meter: AMR + AMM

- (VREG): E / G meter, with 2-way communication
  - send measurement registers
    - on demand (1/yr) + periodically (monthly)
  - remotely (dis)connect & reduce E/G supply; budget meter
  - multiple measurement registers
  - remote modification of tariffs and tariff periods
  - remote upgrading of firmware for new functionality
  - send on demand PQ diagnosis + automatic fraud alarms

- in line with NTA 8130
  - also other utility functions (heat, water)
  - requires *simultaneous* dimming/disconnecting consumers
# Smart meter requirements

<table>
<thead>
<tr>
<th>transaction type</th>
<th>time critical</th>
<th>response min/typ/max</th>
<th>#times/yr</th>
<th>#data min/typ/max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>command</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>store measurement registers</td>
<td>yes</td>
<td>immediate 5 min</td>
<td>1</td>
<td>0,5 KiB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 h</td>
<td></td>
<td>1 KiB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16 KiB</td>
</tr>
<tr>
<td>send measurement registers</td>
<td>no</td>
<td>immediate 10 min</td>
<td>13 (12+1)</td>
<td>1 KiB</td>
</tr>
<tr>
<td>(periodically + on demand)</td>
<td></td>
<td>2 h</td>
<td></td>
<td>32 KiB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16 MiB</td>
</tr>
<tr>
<td><strong>command</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>reduce load</td>
<td>yes</td>
<td>immediate 5 min</td>
<td>1</td>
<td>0,5 KiB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 h</td>
<td></td>
<td>1 KiB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16 KiB</td>
</tr>
<tr>
<td><strong>adjust</strong></td>
<td>no</td>
<td>immediate 10 min</td>
<td>2</td>
<td>0,5 KiB</td>
</tr>
<tr>
<td>parameters</td>
<td></td>
<td>2 h</td>
<td></td>
<td>1 KiB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16 KiB</td>
</tr>
<tr>
<td><strong>upgrade</strong></td>
<td>no</td>
<td>-</td>
<td>0,2</td>
<td>0,5 KiB</td>
</tr>
<tr>
<td><strong>firmware</strong></td>
<td></td>
<td></td>
<td></td>
<td>1 KiB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>512 KiB</td>
</tr>
<tr>
<td><strong>send</strong></td>
<td>no</td>
<td>immediate 10 min</td>
<td>0,2</td>
<td>0,5 KiB</td>
</tr>
<tr>
<td>alarms</td>
<td></td>
<td>2 h</td>
<td></td>
<td>1 KiB</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16 KiB</td>
</tr>
</tbody>
</table>
Situation in Flanders

- 0.5 MiB / meter / yr for measurement registers
  - min. 15 KiB – max. 250 MiB
- 3.1 million E-meters + 1.6 million G-meters
  - (2.6 + 1.4 million residential)
  - approx 3 million smart meters
- results in 1.28 TB raw data / yr (4 - 654 TB)
  - negligible with respect to internet traffic
Need for hierarchical approach

- need for hierarchical approach

<table>
<thead>
<tr>
<th>Data \ Time</th>
<th>5 s (min.)</th>
<th>10 min (typ.)</th>
<th>2 h (max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 KiB</td>
<td>1.6 kbps</td>
<td>14 bps</td>
<td>1.1 bps</td>
</tr>
<tr>
<td>32 KiB</td>
<td>52 kbps</td>
<td>437 bps</td>
<td>36 bps</td>
</tr>
<tr>
<td>16 MiB</td>
<td>27 Mbps</td>
<td>224 kbps</td>
<td>19 kbps</td>
</tr>
</tbody>
</table>

- small bandwidth sufficient for basic information
  - additional services require broadband

- real-time requirements
  - if no broadcasting, only 1.2 ms is available for addressing all meters in 1 hour
• communication architecture
  ▪ direct connection (PSTN/GSM/GPRS)
    o dial-in via modem or data connection
  ▪ dedicated intermediate comm. infrastructure
    o with concentrators (PLC, RF)
  ▪ existing intermediate comm.
    o ADSL or internet connection
Overview of communication means

• categories studied
  - power line communication
  - comm. over telephone / cable infrastructure
  - wireless communication

• discussion
  - technical aspects
    - description, protocols
  - suitability for smart metering
    - bandwidth, responsiveness, reliability, accessibility, …
  - situation in Flanders
Power line communication

- Usage: between smart meters and concentrators
- + no extra cabling required
- - smallband, short distances to concentrators (< some km)
- - reliability less than other communication means, but still OK
- - not available when certain power problems occur
Communication over telephone and cable infrastructure

- smallband communication over analog / digital phone lines
  - + very reliable
  - - smallband
  - - requires connection to phone equipment & call centres
  - - slow communication setup
  - - smallband, no multicasting
- broadband connection over phone line or TV cable (dedicated / shared)
  - + broadband
  - - requires connection to phone or cable equipment & access points
  - - short distances (<3 km)
  - + multicasting on TV cable
Wireless communication

• 2nd or 3rd generation mobile telephony and data
  - circuit-based: GSM, HSCSD
  - packet-switched: GPRS, EDGE, UMTS, ...
  - smallband (2G)
  + broadband (3G), - not yet widely available
  - not so good coverage in cellars

• non-licensed RF (ISM band)
  - requires antenna infrastructure (hierarchical)
  - typically smallband
Wireless communication (ctd.)

- licensed RF (PMR, trunked radio)
  - + very reliable, broadcasting, fast, good coverage
  - - smallband
- others (WiMax, …)
Cost analysis

costs per meter

yearly costs per meter
initial costs per meter
Costs over 15 year time horizon

**total costs per meter over time horizon**

- PLC
- Small band telephone
- Dedicated broadband connection
- Existing broadband connection
- GSM
- GPRS
- UMTS, PMR, WMX
- RF

Costs range from 0 € to 900,00 €.
## Conclusion

<table>
<thead>
<tr>
<th></th>
<th>PLC</th>
<th>cable</th>
<th>wireless</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>internet</td>
<td>telephone</td>
</tr>
<tr>
<td><strong>reachability</strong></td>
<td>100%</td>
<td>S: 95% / B: 60%</td>
<td>98%</td>
</tr>
<tr>
<td><strong>costs</strong></td>
<td>medium</td>
<td>S: very high B: medium</td>
<td>medium to high</td>
</tr>
<tr>
<td><strong>operation</strong></td>
<td>own</td>
<td>S: telecom-provider B: ISP</td>
<td>telephone operator</td>
</tr>
<tr>
<td><strong>access</strong></td>
<td>via comm. provider</td>
<td>directly</td>
<td>directly</td>
</tr>
<tr>
<td><strong>suitability</strong> (bandwidth, BW)</td>
<td>functions with low BW</td>
<td>functions with high BW</td>
<td>functions with medium BW</td>
</tr>
<tr>
<td><strong>suitability</strong> (real-time, RT)</td>
<td>functions with RT req’s</td>
<td>functions with (S) / without (B) RT req’s</td>
<td>functions without RT req’s</td>
</tr>
<tr>
<td><strong>flexibility</strong></td>
<td>medium</td>
<td>high</td>
<td>medium / high</td>
</tr>
<tr>
<td><strong>reliability</strong></td>
<td>high</td>
<td>medium / high</td>
<td>very high</td>
</tr>
</tbody>
</table>
Conclusion: technical & non-technical aspects

- all communication means fulfil minimal req’s
- technical
  - much data → broadband
    - broadband internet-based solutions or 3G mobile
  - real-time → broadcasting
    - PLC or wireless solutions (RF, PMR, UMTS, …)
- non-technical aspects
  - costs
    - PLC/RF and existing internet solutions
  - (in)dependence
    - telecom infrastructure by third parties
• smart utility interface + measuring instruments
  - (E, G, heat, water, …)
• future-proof: broadband + real-time required
  - creative contracts with critical/non-critical apps
  - PQ-based services
  - decentralised control of DER