

Advance smart metering technologies and software for precise end-use Identification

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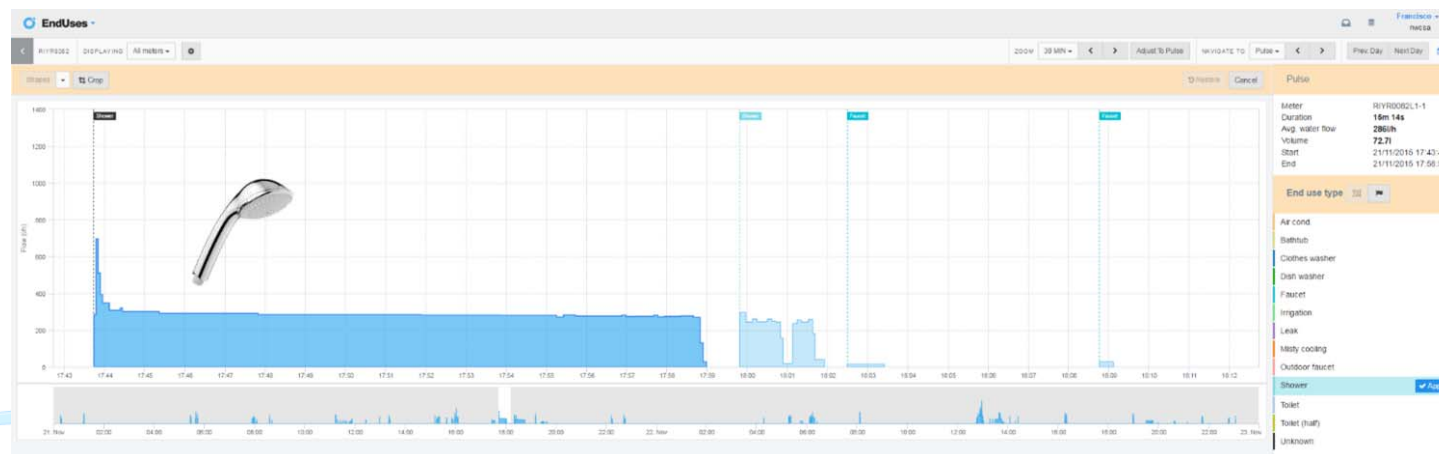
Gestión sostenible del agua urbana

Outline

- Hardware

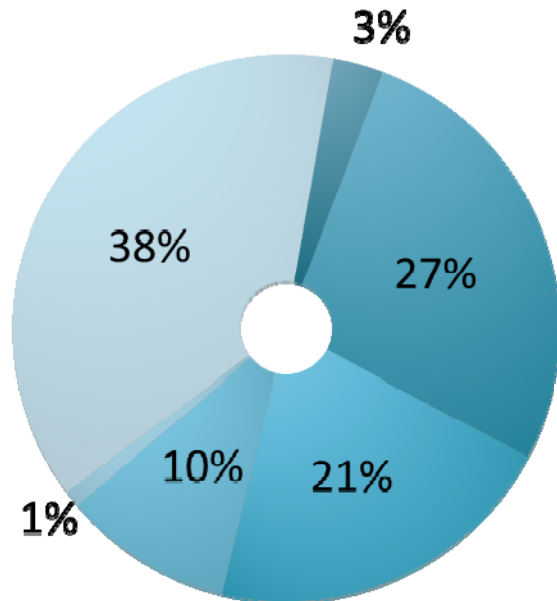


- Software

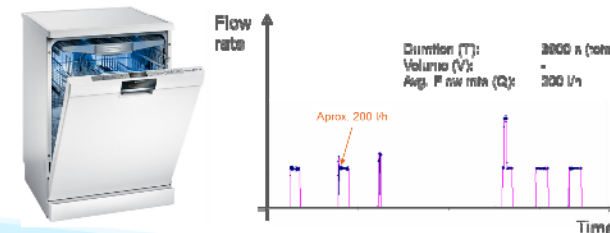
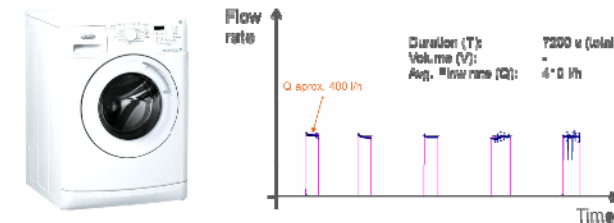
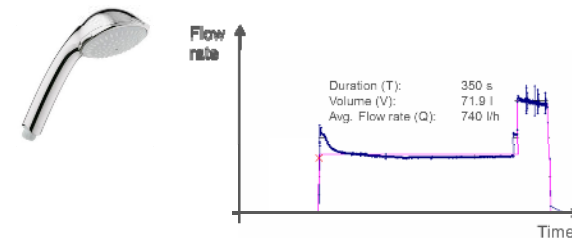
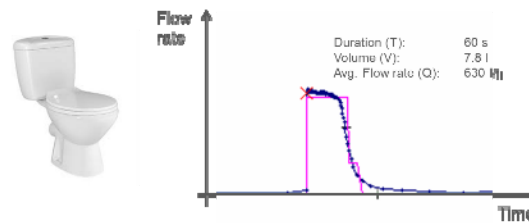


Fundamentals of End-Use analysis

- End-Uses analysis disaggregates water consumption into its basic components



- Leaks
- Showers
- Toilets
- Washers
- Dishwashers
- Faucets



Fundamentals of End-Use analysis

- End-Uses disaggregation:

- ❑ It is mainly intended for residential users
- ❑ It is based on the intrinsic characteristics of the consumption

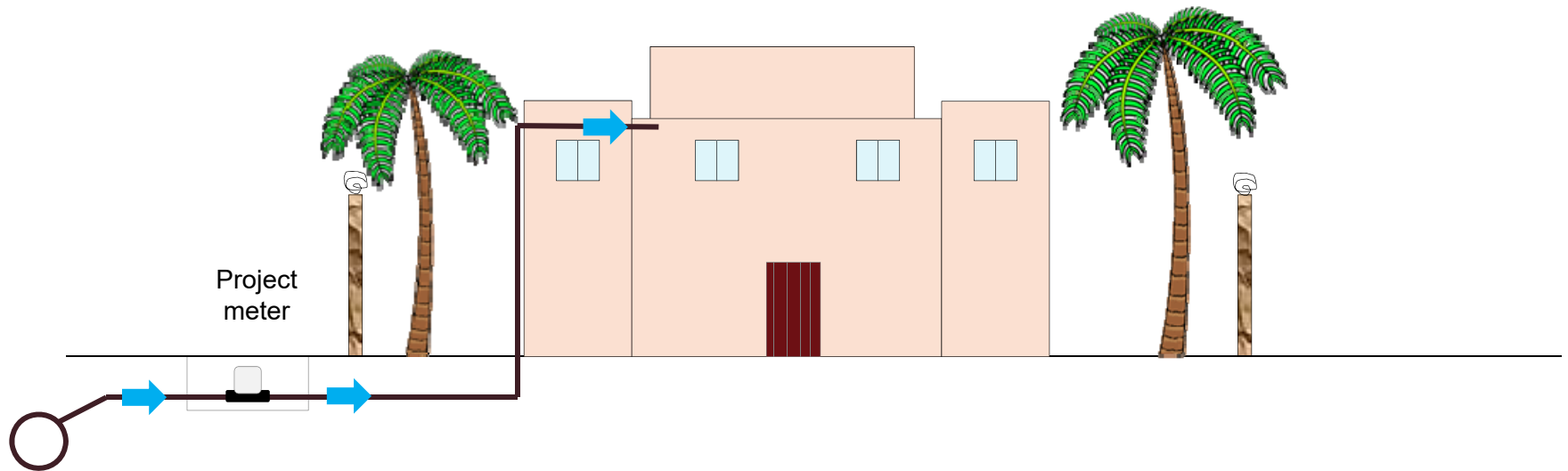


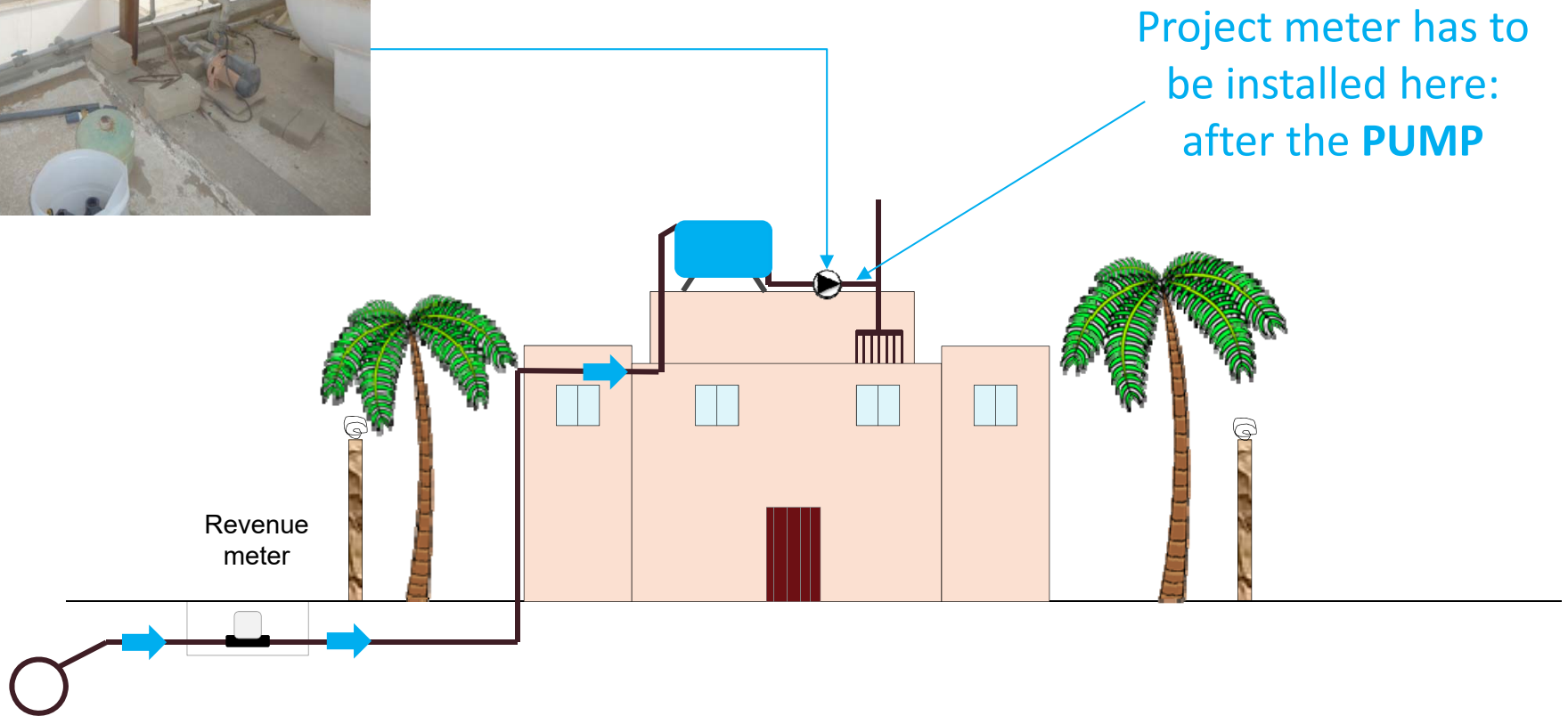
- ❑ Reliability of the results depend on:



Most times limited by budget

End-Use disaggregation is not 100% reliable with current technology





Project meter has to be installed here: after the **PUMP**

Fundamentals of End-Use analysis

- Limited consumption series
 - Limited duration - most times 2 weeks
 - Is this enough to establish changes in behaviour?
 - Is this enough to be reliable?
 - Reduced number of households



Data-quality for End-Use identification



What's this?



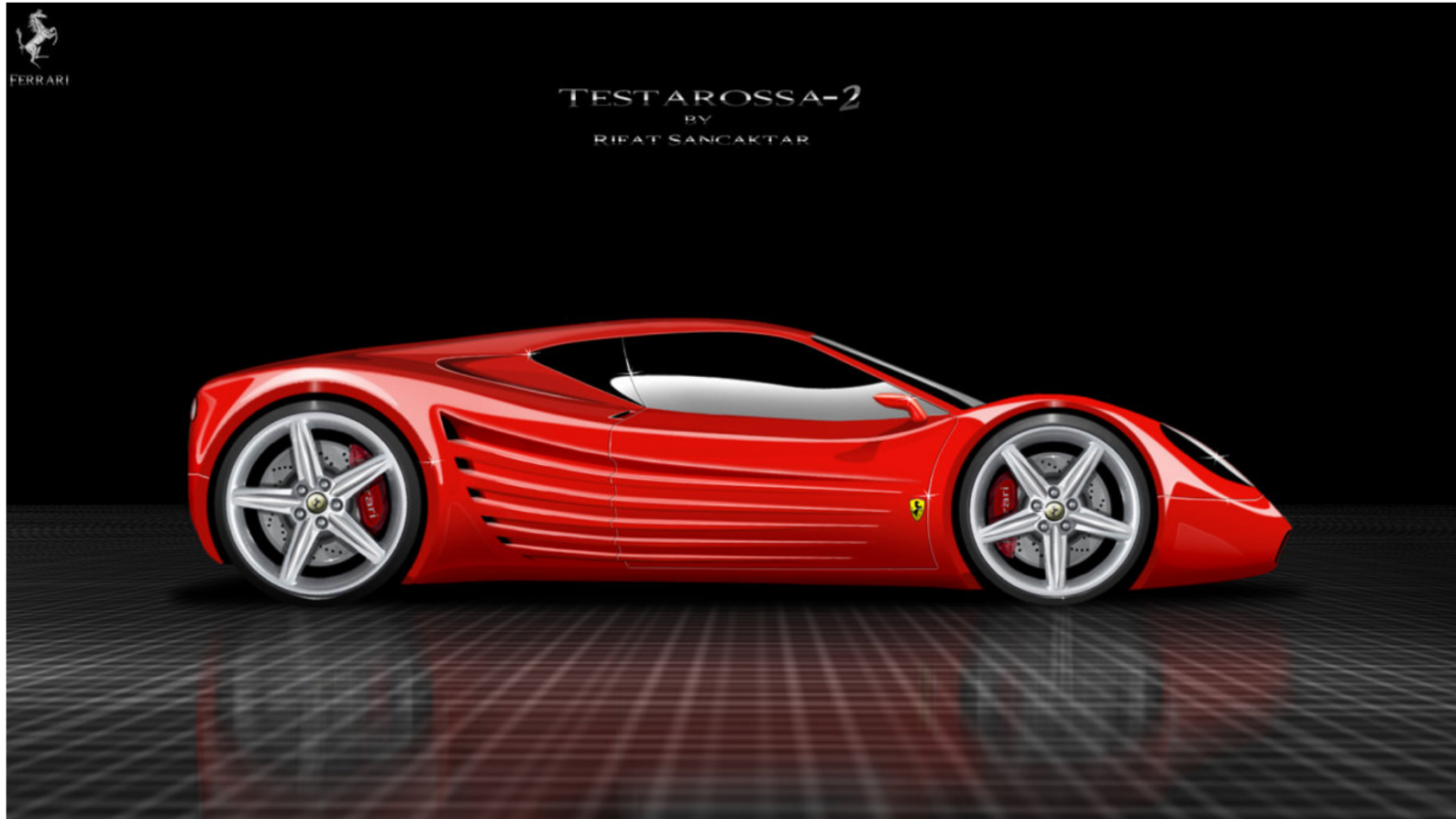
What's this?

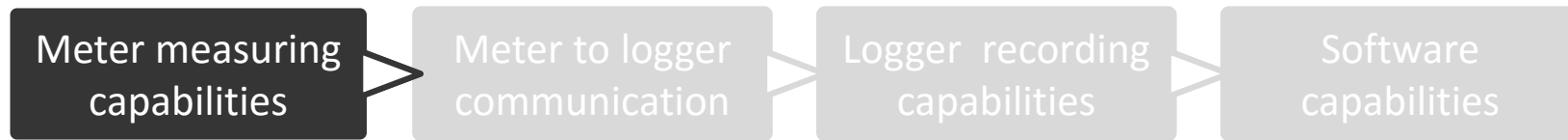


What's this?



What's this?





- Metrology of the meter

- ❑ Low flows (be careful with using utility meters!)
- ❑ High flows
- ❑ Frequency response (how fast the meter responds to changes in flow)

- Working principle of the meter

- ❑ Mechanical: Velocity – Positive displacement



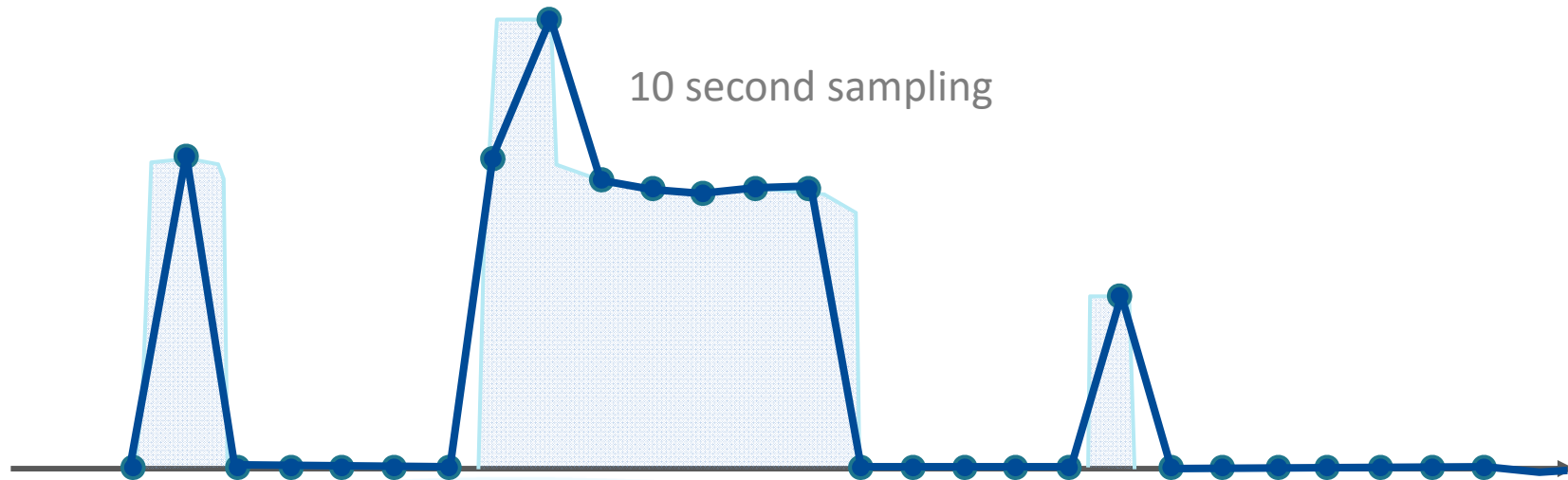
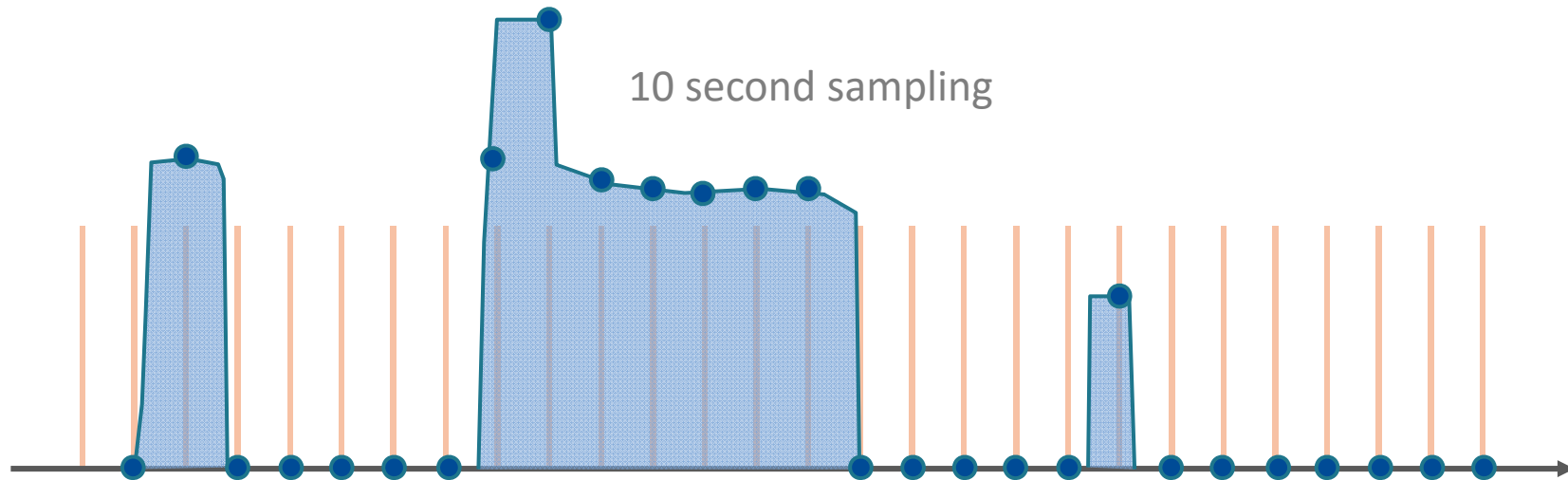
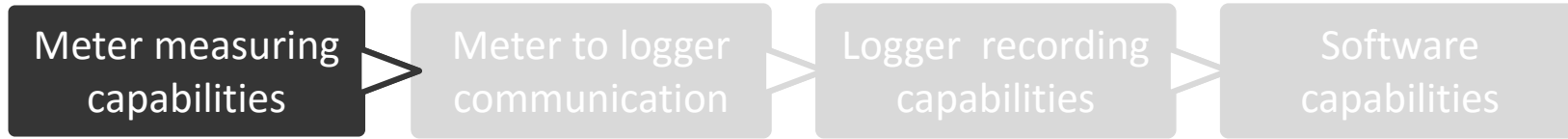
Continuous flow measurement

- ❑ Non-Mechanical: Ultrasonic – Electromagnetic



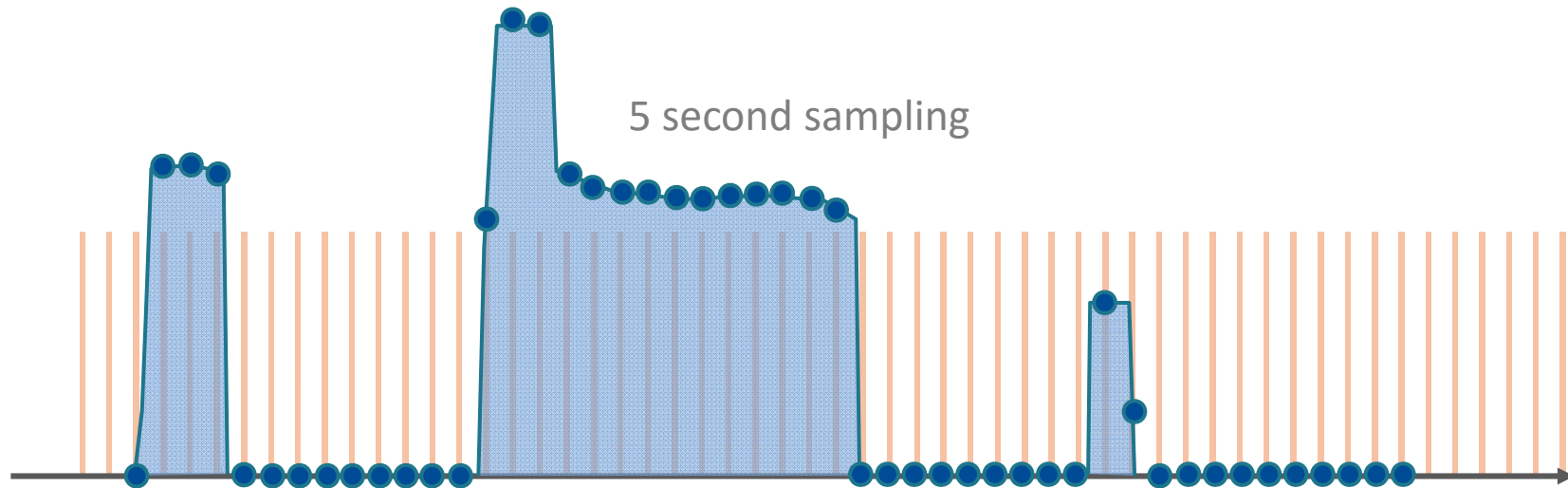
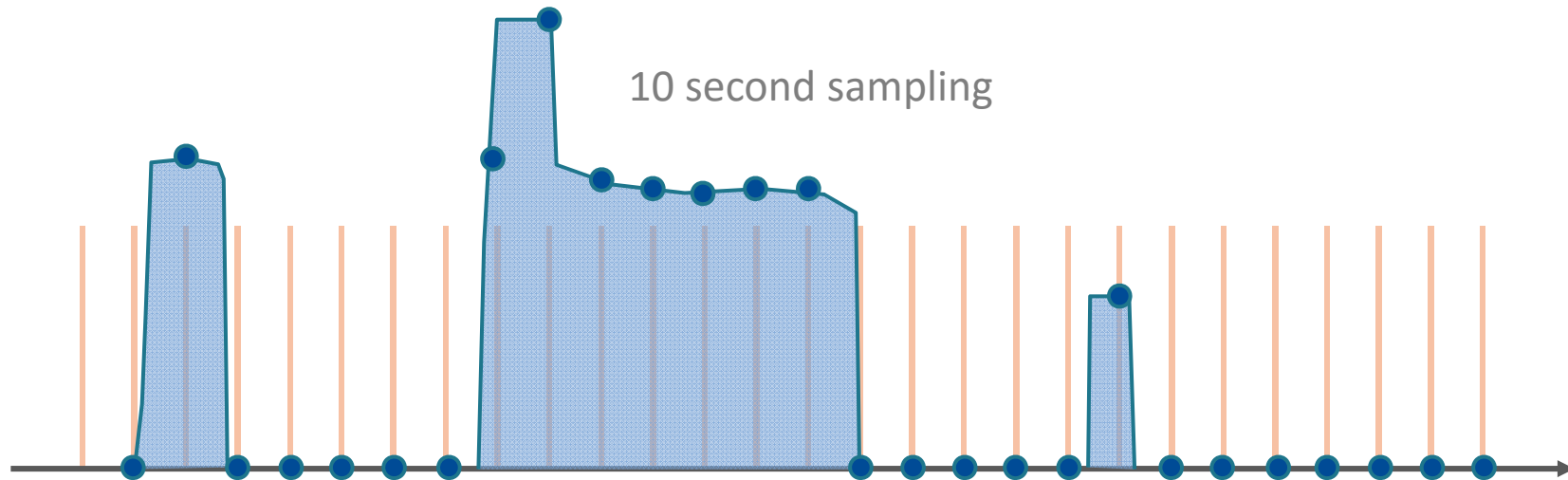
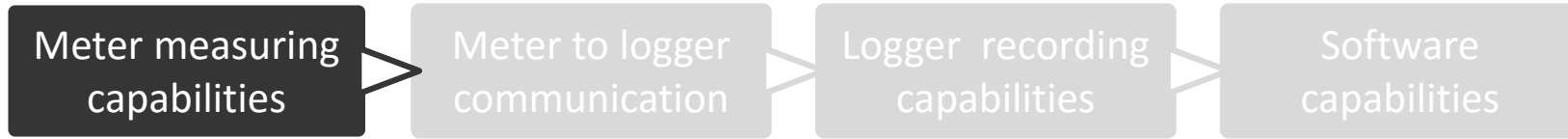
Flow signal is sampled to save battery

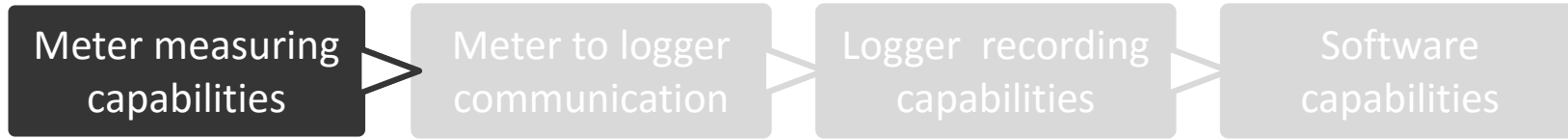




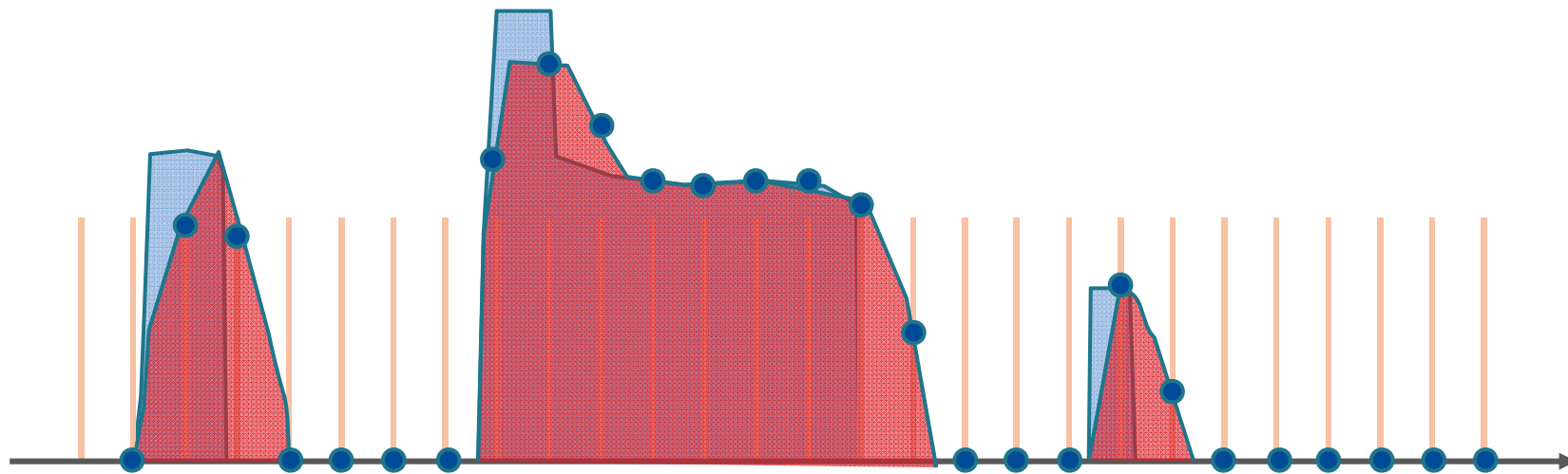
This is signal sampling!



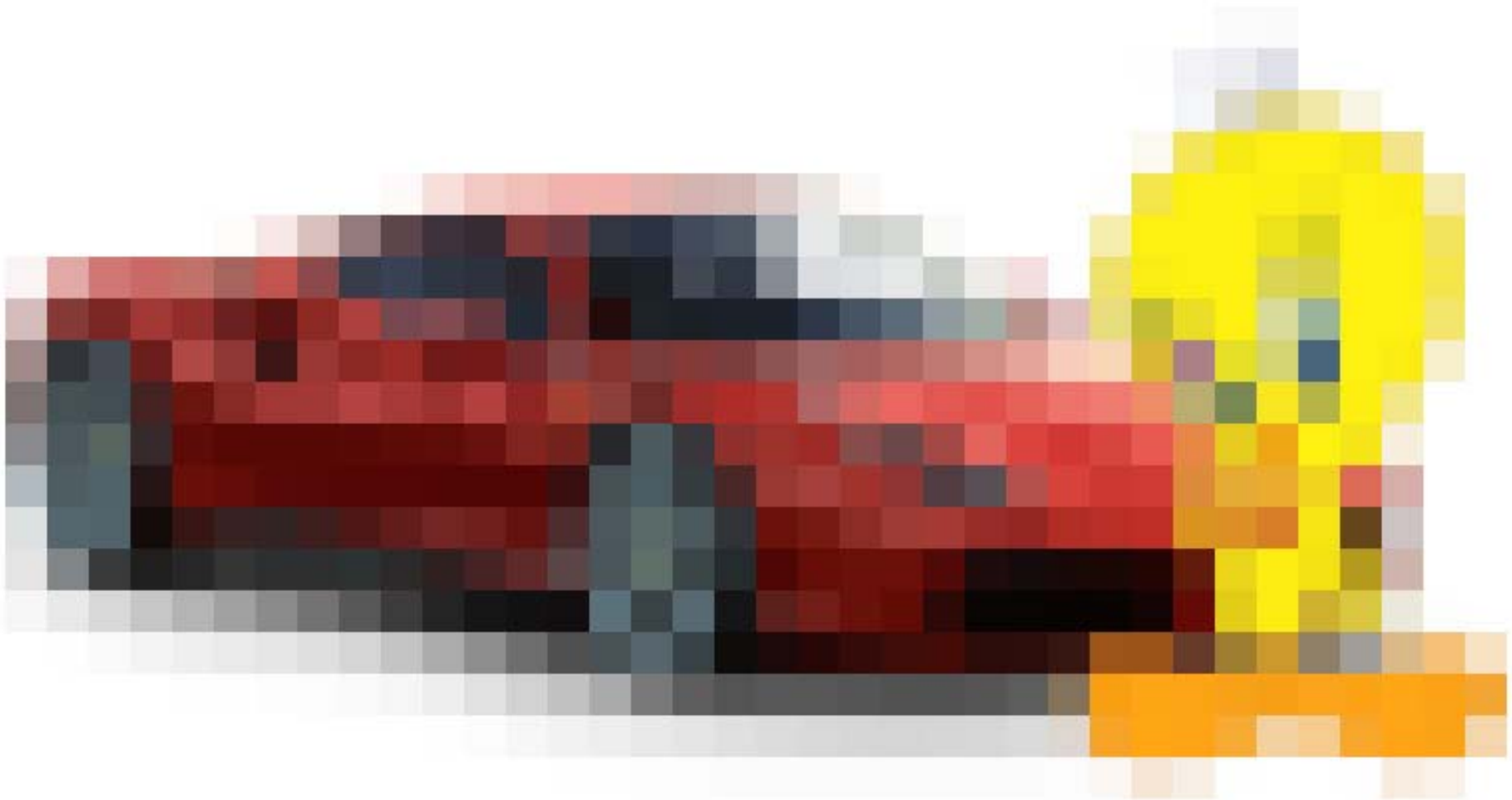




Low frequency response of a meter

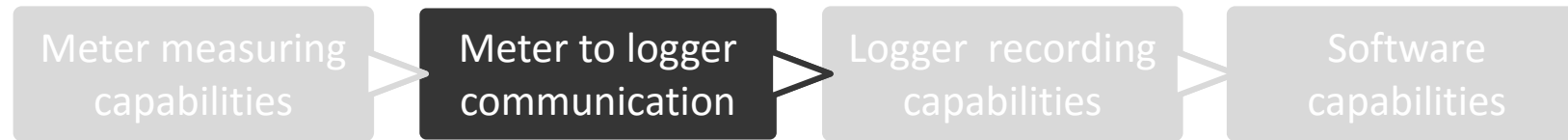


What about overlapping?

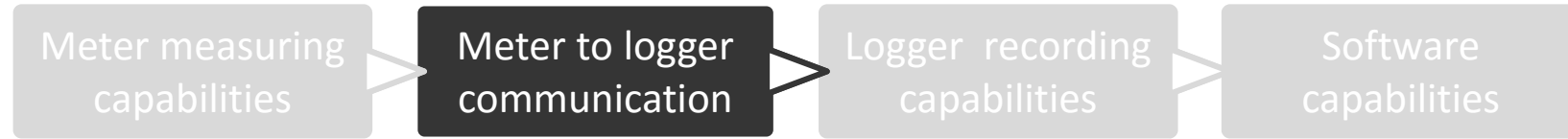


What about overlapping?





- How consumption data can be extracted from the meters?
- By type
 - Pulse output
 - Mechanical (Reed switch)
 - Non-mechanical (Hall effect)
 - Communication protocol
 - M-BUS
 - Other protocols
 - Analogue output
 - 0-5 V, 0-100 mV, 4-20 mA
- By medium of communication
 - Wired
 - Wireless

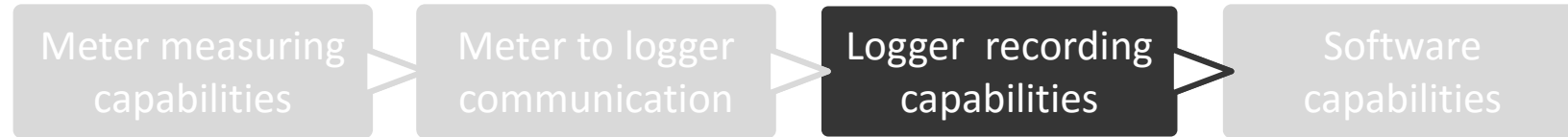


Advantages

Disadvantages

	Advantages	Disadvantages
Pulse output	<ul style="list-style-type: none"> Low cost Volume reading resolution Availability & flexibility 	<ul style="list-style-type: none"> Reliability Limited amount information Inverse flow
Protocol comm.	<ul style="list-style-type: none"> Absolute readings Additional information 	<ul style="list-style-type: none"> Slow communications Poor volume reading resolution Battery consumption

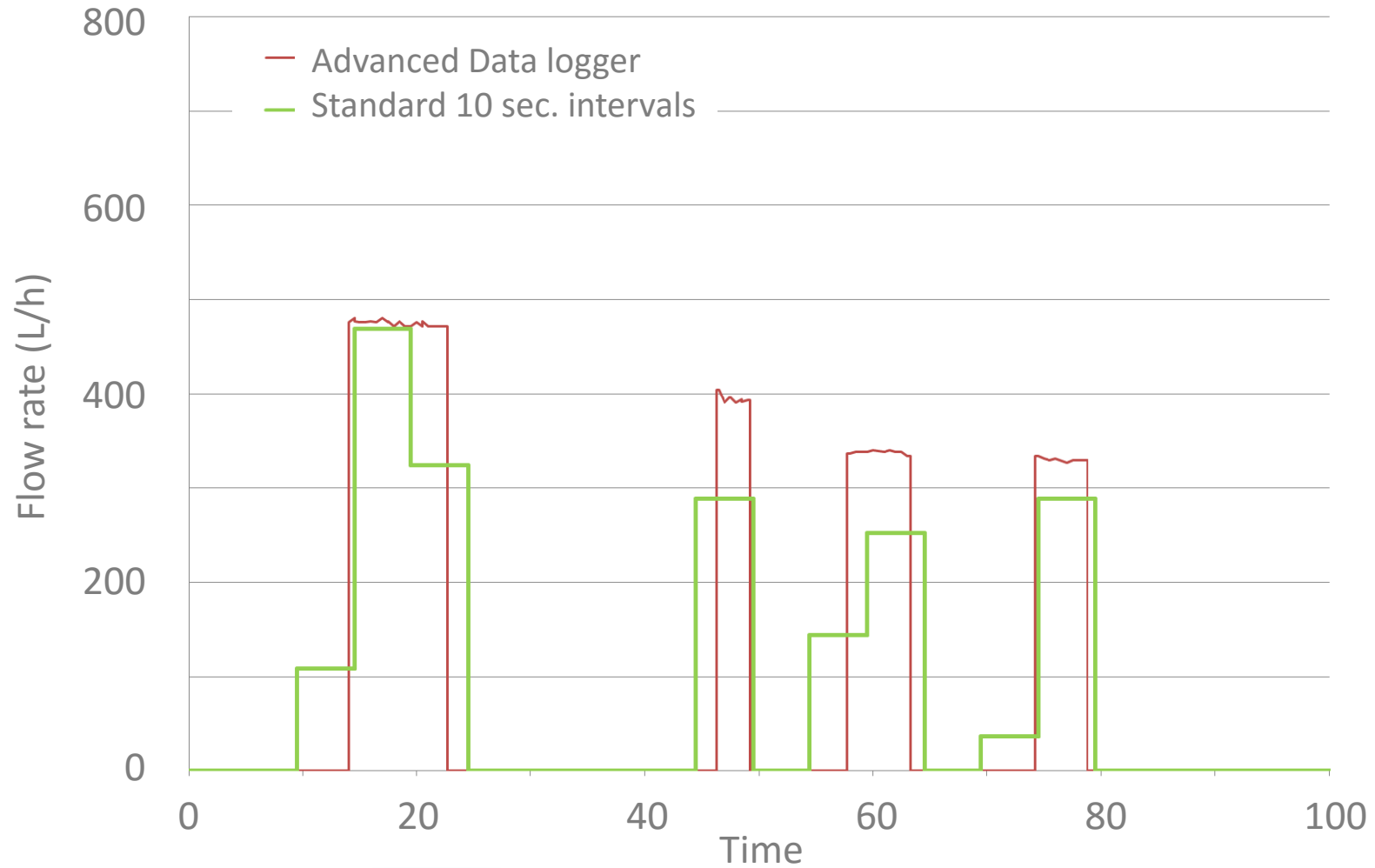




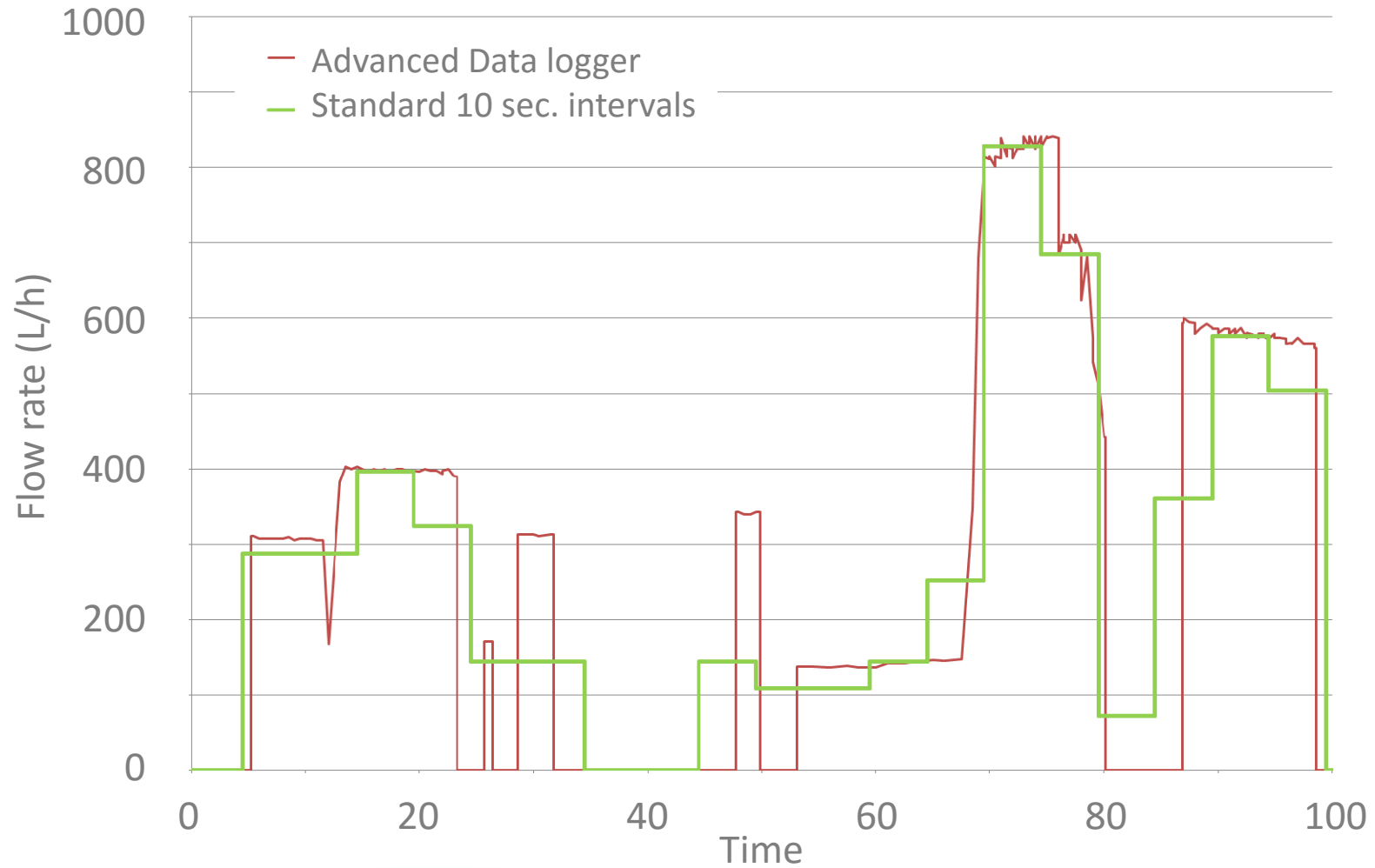
- Memory capacity
- How consumption data is stored in the logger
 - ❑ At fix intervals of time
 - ❑ Recording the time of occurrence of the pulses



Flow traces distortion caused by data acquisition equipment

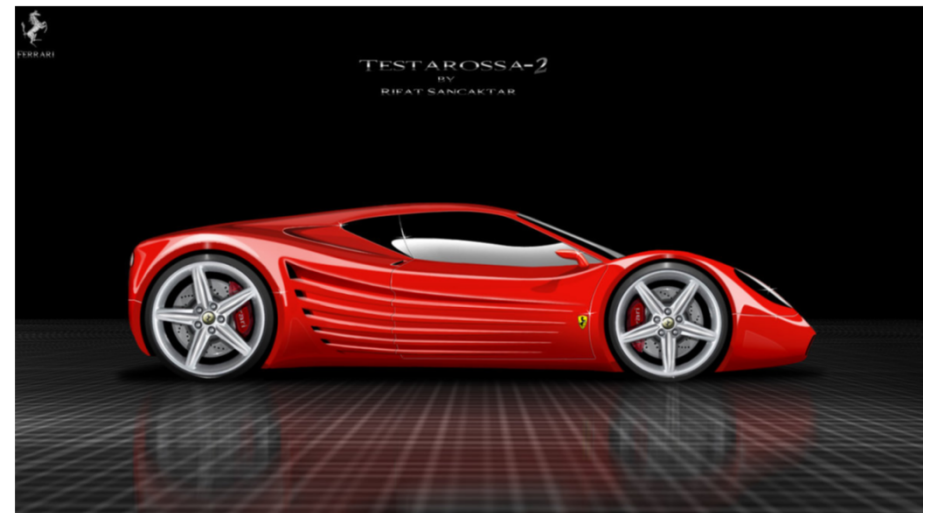


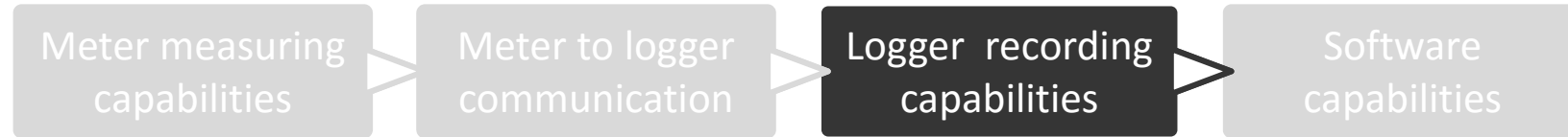
Flow traces distortion caused by data acquisition equipment



How far do we want to go?

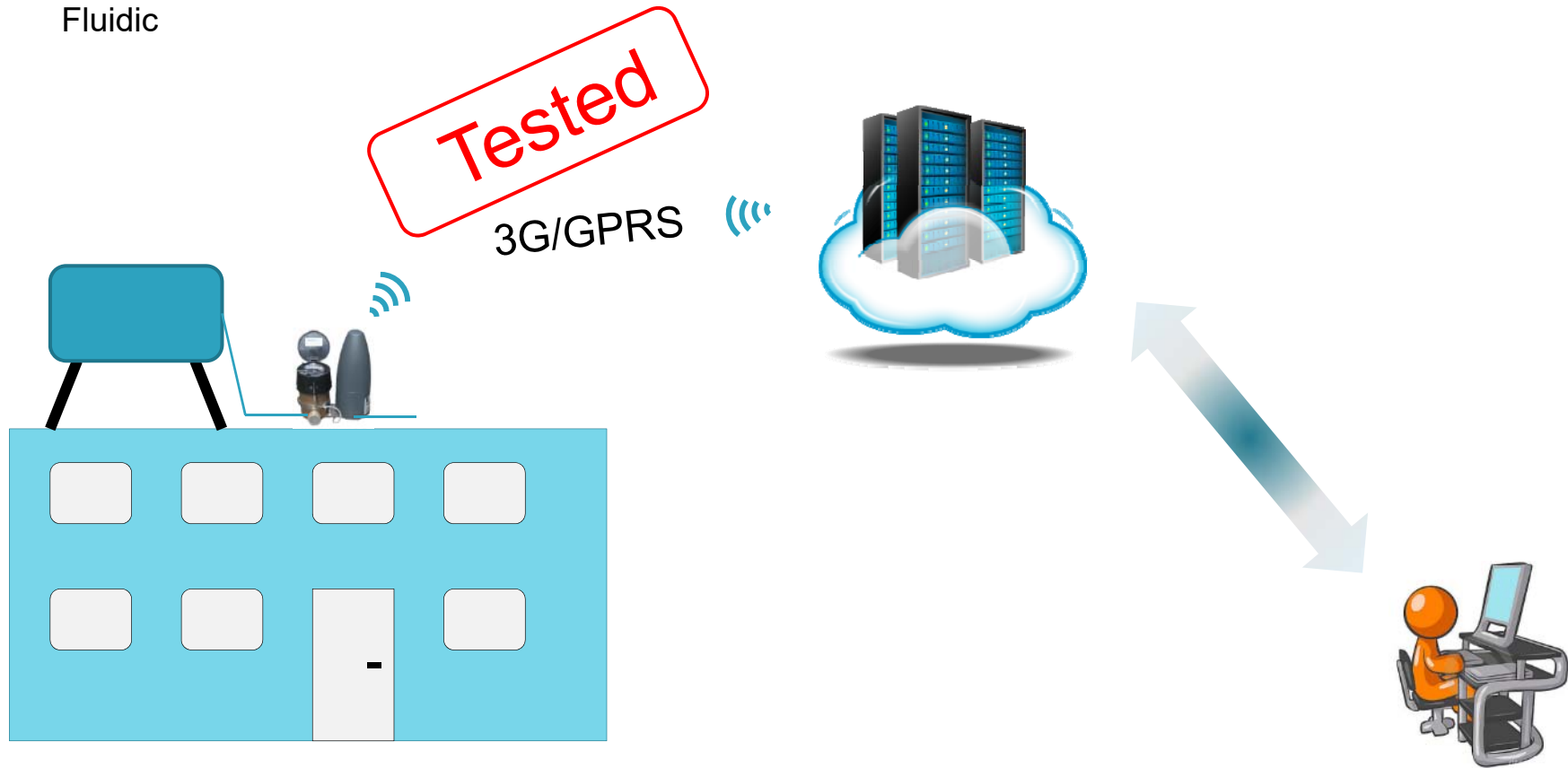
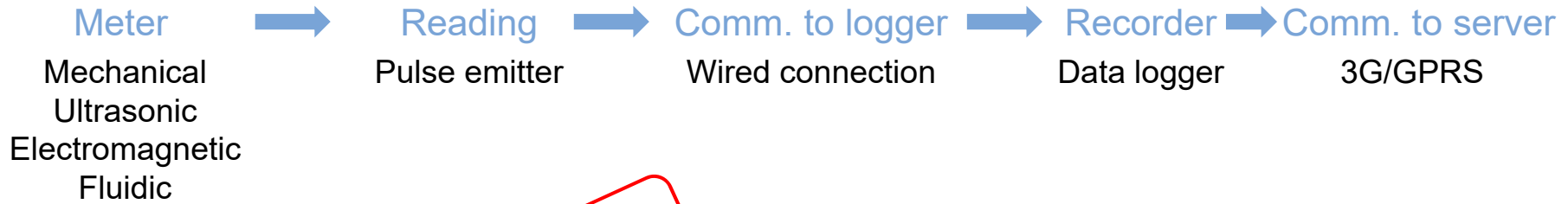
- Decide the objectives to define how accurately we need to measure water consumption.



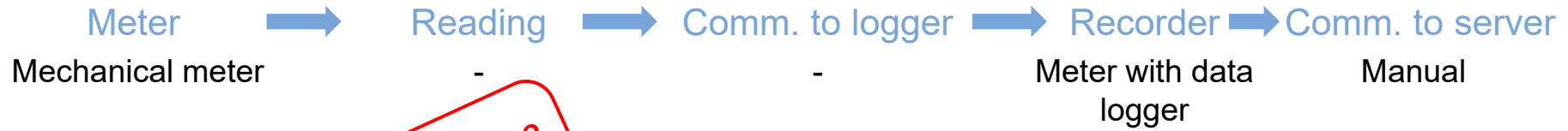


- Memory capacity
- How consumption data is stored in the logger
 - ❑ At fix intervals of time
 - ❑ Recording the time of occurrence of the pulses
- Battery duration ← Thinking on the long term
 - ❑ Lithium batteries
 - ❑ Rechargeable batteries + solar panel
- 3G/GPRS communication
 - ❑ More data –higher transmission costs and battery consumption
- Remote configuration capabilities
 - ❑ 2-Way communication required

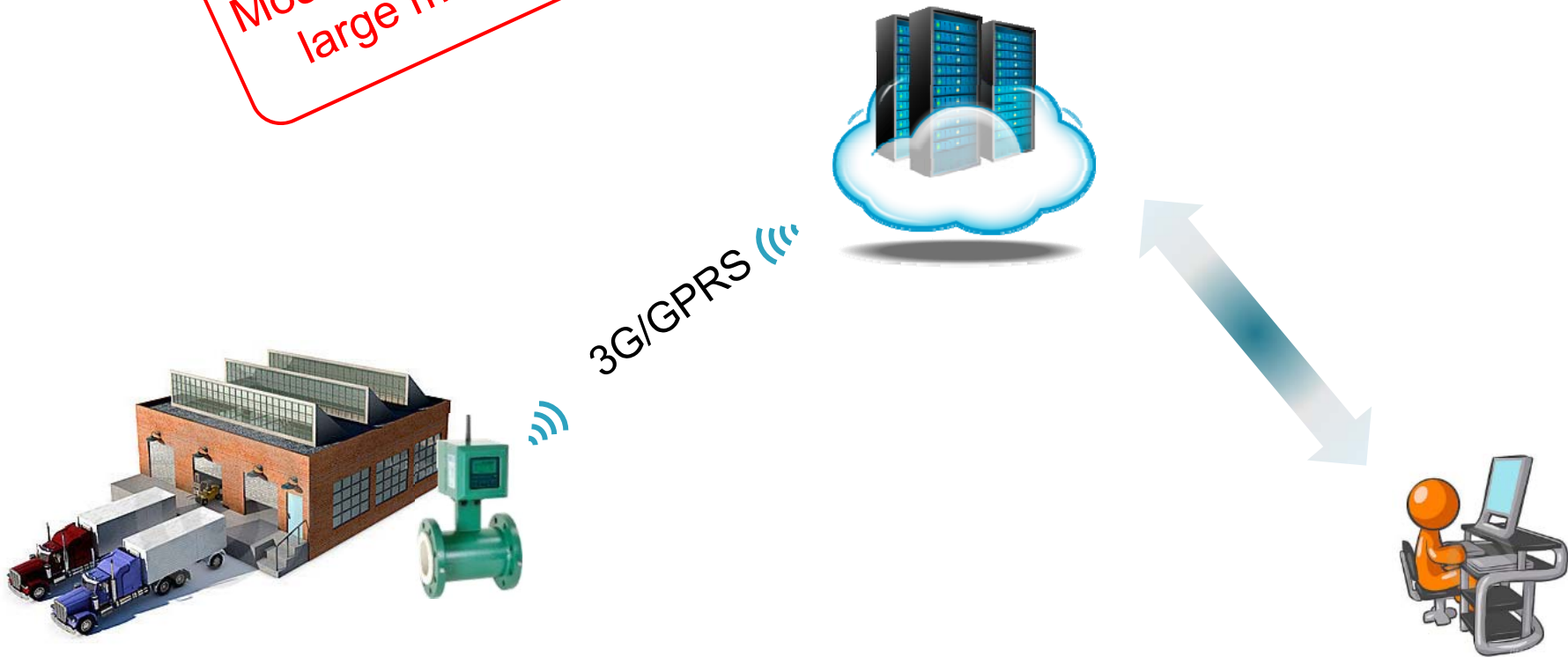
Option 1



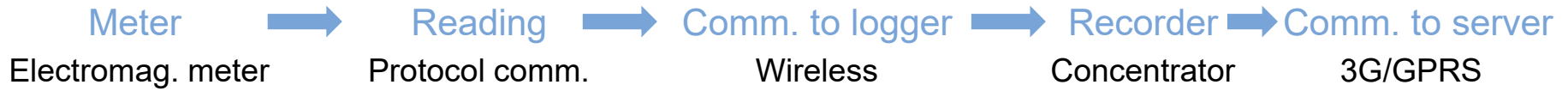
Option 2



Mostly medium & large meters



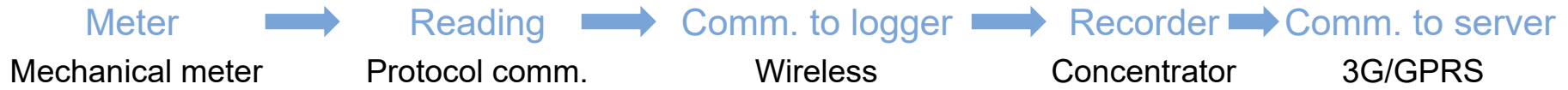
Option 3



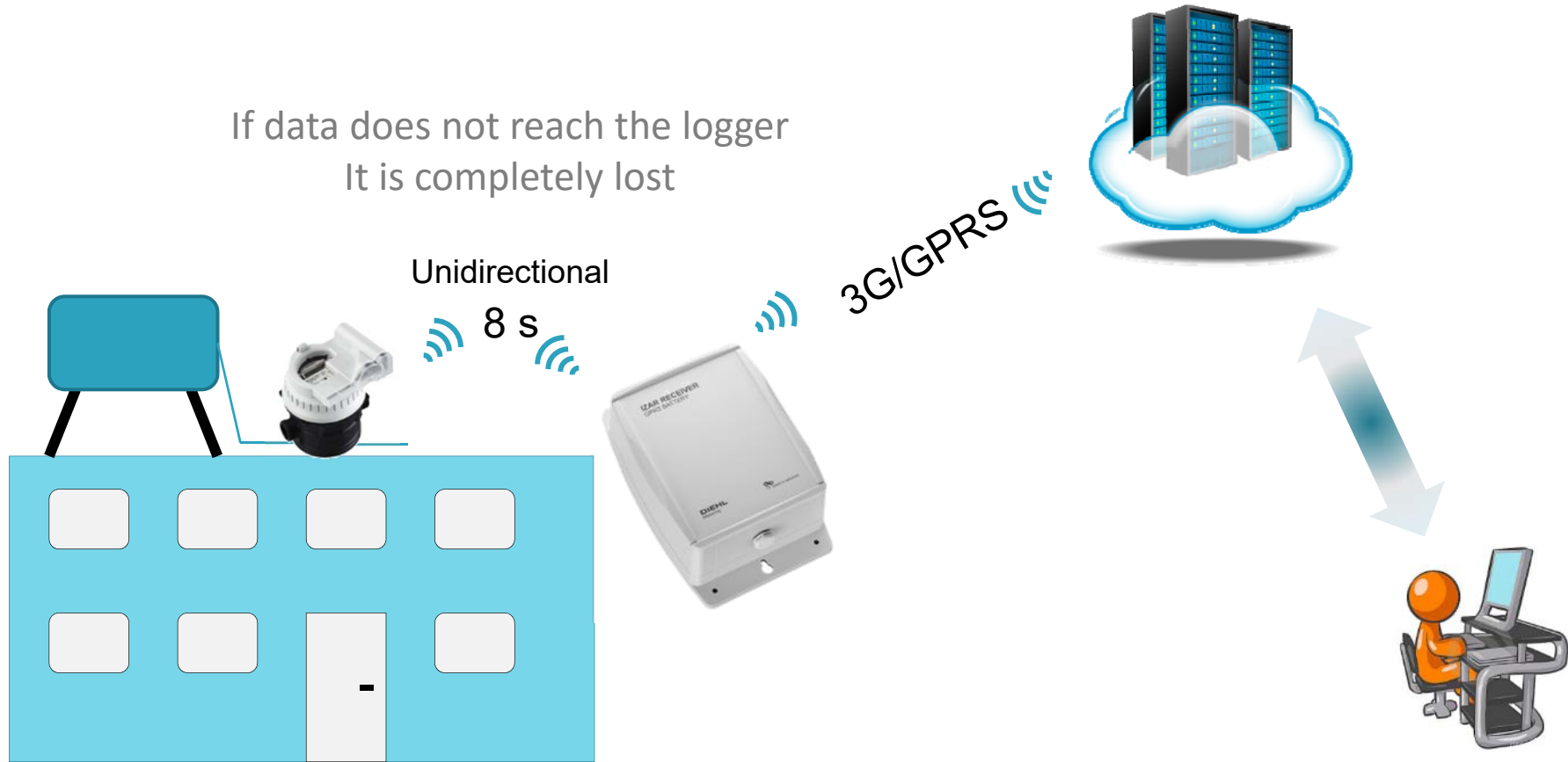
If data does not reach the logger
It is completely lost



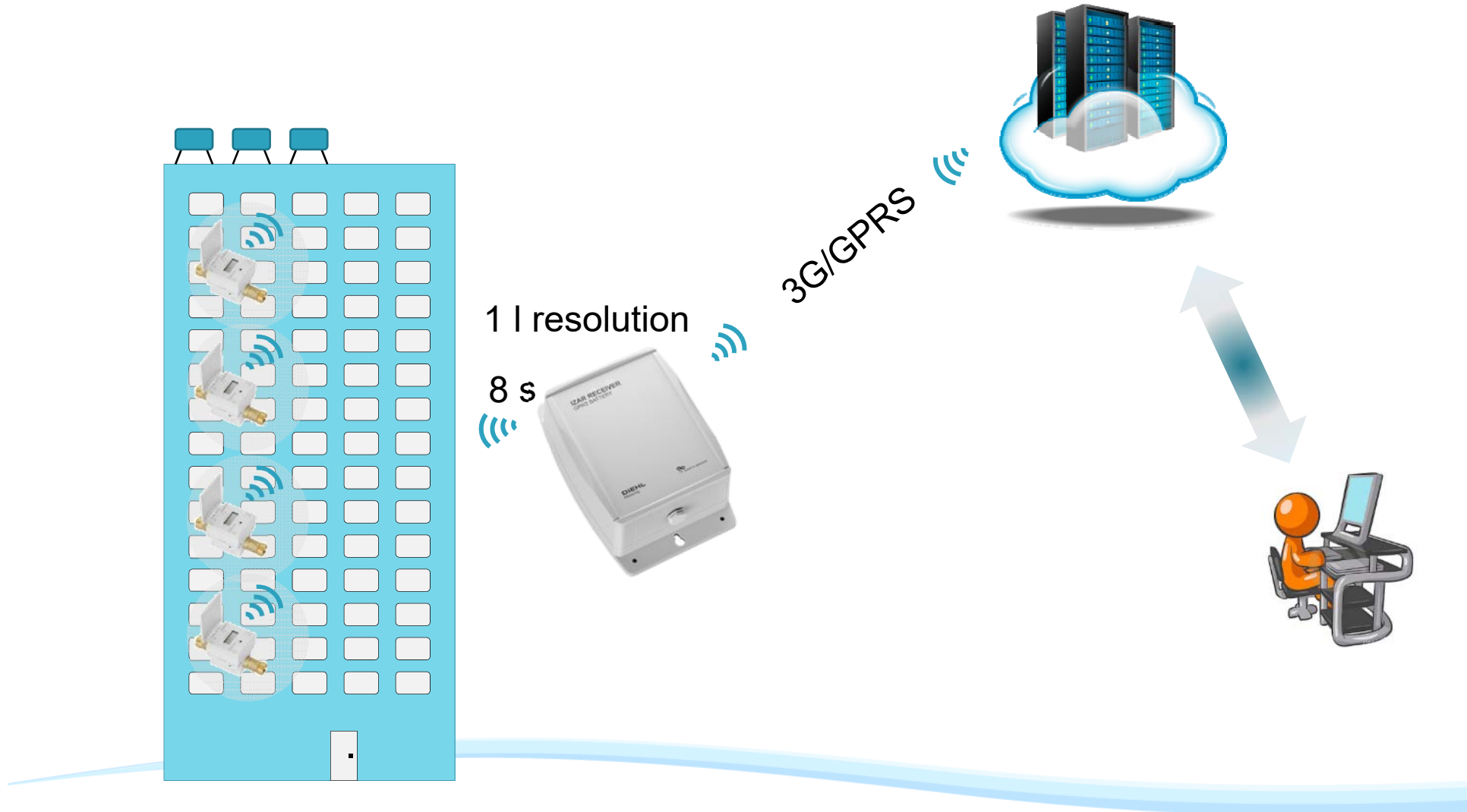
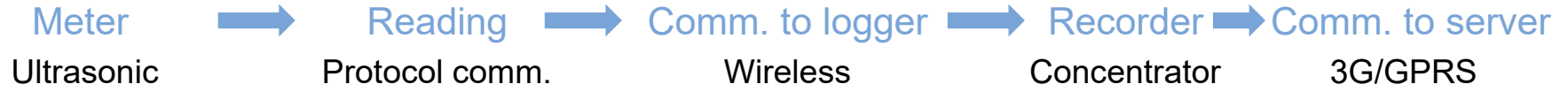
Option 4



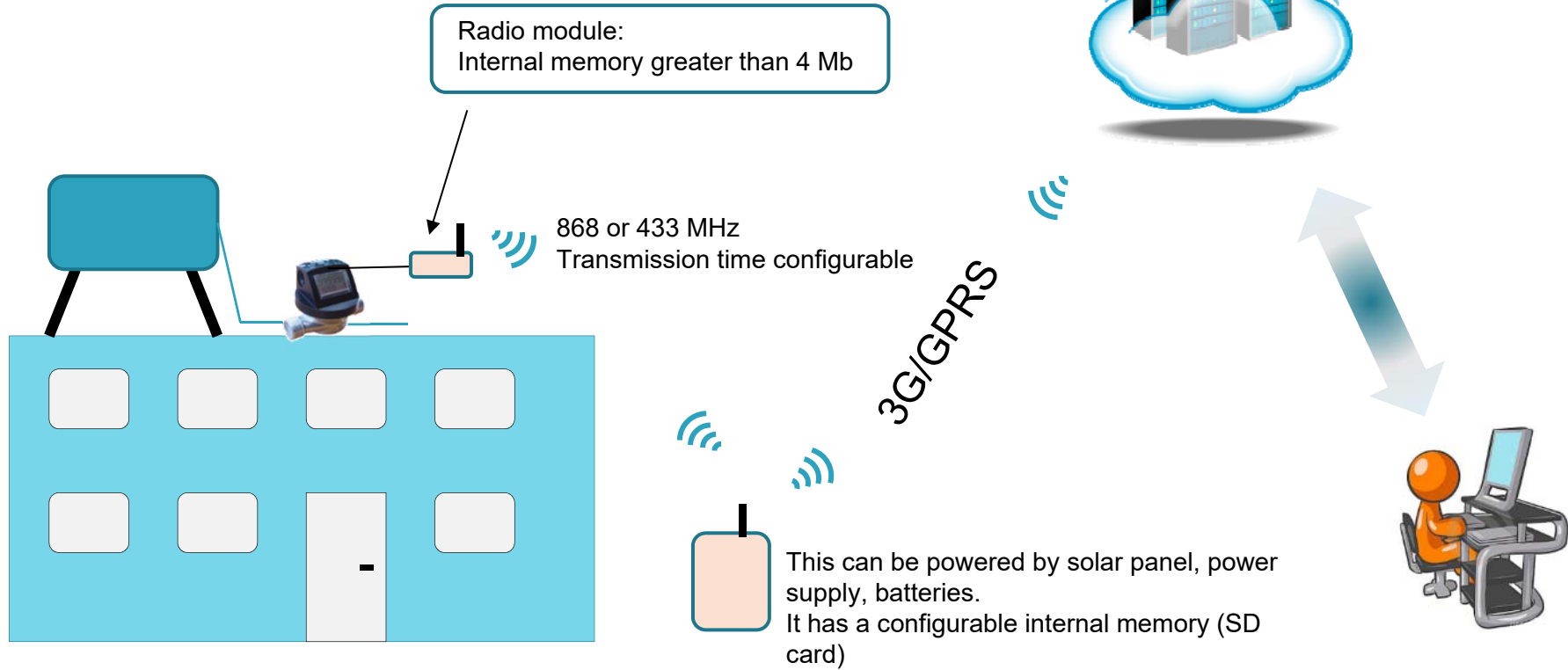
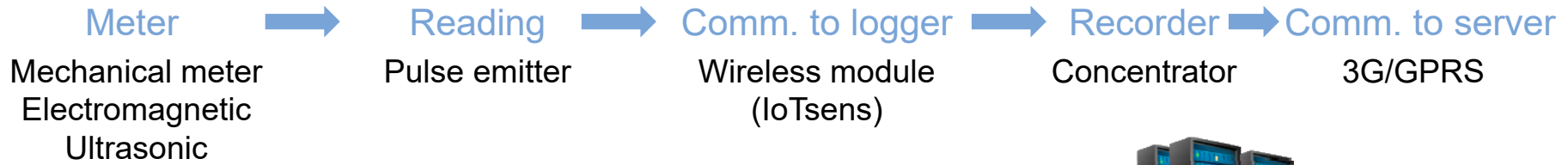
If data does not reach the logger
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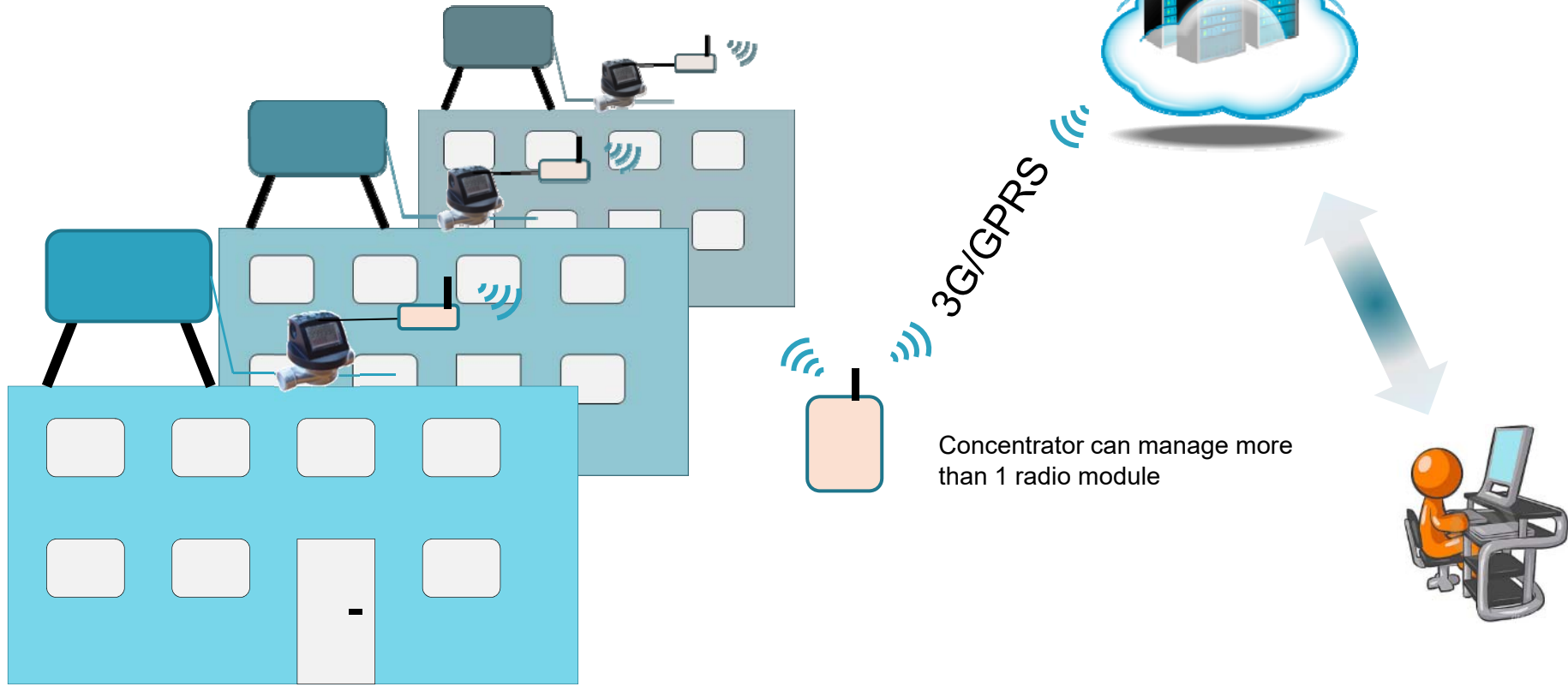
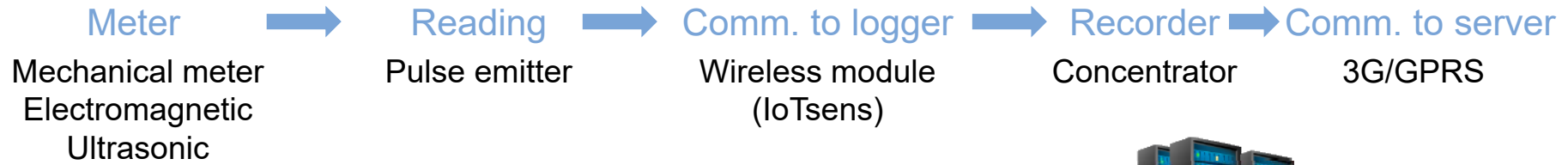
Option 4



Option 5



Option 5



Concentrator can manage more than 1 radio module

Applications

Option 5

- Residential customers with more than one meter

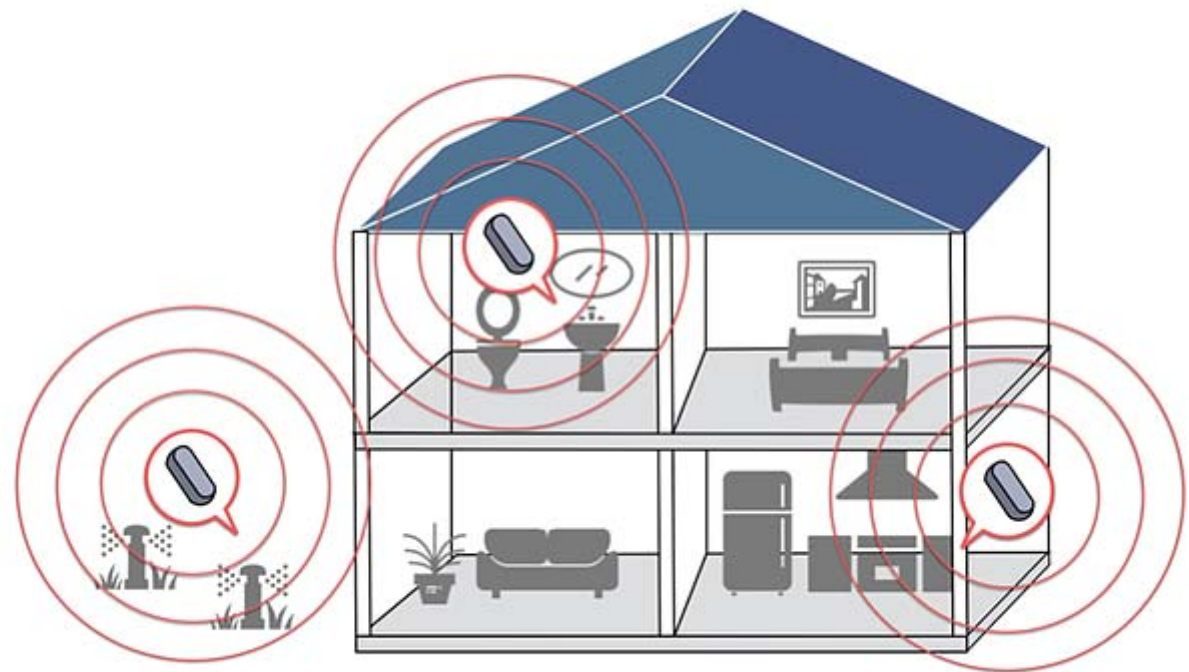


Applications

Option 5

- Residential buildings meters installed in apartments
- Residential areas
- Studies on hot-cold End-Uses of water
- Studies for various utilities at once (water + electricity + gas)
- Analysis of non-residential users
 - ❑ Flow switches + wireless transmitters
 - ❑ Meters at strategic locations
 - ❑ Loggers

Additional hardware available



<http://www.oasys.io/>

Conclusions on hardware technologies

- Non-mechanical meters commercially available today are not suitable for End-Use studies
- Protocol communications cannot be used
 - ❑ Slow
 - ❑ Reading volume resolution
 - ❑ Battery consumption
- Logger's data storing capacity allows for high freq. readings
- Low cost solutions are becoming available for long term monitoring

Not designed for
such frequent
readings!!

Data-quality for End-Use identification



Need for a new software tool

Moving from a PILOT to an EXTENDED study

Pilot study

- Limited number of users
- Limited duration of monitoring period
- Manual data downloading
- Manual processing
- High unitary cost

Extended study

- Large number of users
- Unlimited duration of monitoring period
- Automatic data transmission
- Automatic processing
- Low unitary cost

Need for a new software tool

New requirements

Improved data base structure

Compatibility with commercial AMR systems

Enlarged and adaptative storage capacity

Automatic processing of flow traces

Automatic reporting



Multi-user on-line platform

The screenshot displays a web application interface for monitoring water meters. The browser address bar shows the URL: `nwcsa.buntbrain.com/app.html#/end-uses/monitoring-campaign/campaiguuid`. The application header includes the logo 'EndUses' and the user name 'Francisco nwcsa'. The main content area is titled 'Riyadh Campaign / All meters (222)' and is ordered by 'Customer ID'. A search bar is present above the data table. The table lists various meters, including customer meters (CAS0001-03, Customer Test) and individual meters (M000, M001). Each row shows the meter ID, its status (e.g., 'IN PROGRESS', 'NOT EDITED'), and a target completion time (e.g., '1/30 days'). Progress bars are visible for some meters.

Customer	Meter ID	Status	Target	Progress
CAS0001 2 meters in customer	Meter: CAS0001L1-0	IN PROGRESS	1/30 days	██████████
	Meter: CAS0001L1-1	NOT EDITED	0/30 days	██████████
CAS0002 2 meters in customer	Meter: CAS0002L1-0	NOT EDITED	0/30 days	██████████
	Meter: CAS0002L1-1	NOT EDITED	0/30 days	██████████
CAS0003 2 meters in customer	Meter: CAS0003L1-0	NOT EDITED	0/30 days	██████████
	Meter: CAS0003L1-1	NOT EDITED	0/30 days	██████████
Customer Test 2 meters in customer	Meter: M000	IN PROGRESS	0/30 days	██████████
	Meter: M001	IN PROGRESS	1/30 days	██████████
Customer Test 2 2 meters in customer	Meter: M000	NOT EDITED	0/30 days	██████████
	Meter: M001	NOT EDITED	0/30 days	██████████
Customer Test 3 2 meters in customer	Meter: M000	NOT EDITED	1/30 days	██████████
	Meter: M001	NOT EDITED	0/30 days	██████████
Customer Test 4 2 meters in customer	Meter: CAS0001-0	NOT EDITED	1/30 days	██████████
	Meter: CAS0001-1	NOT EDITED	0/30 days	██████████

Automatic reporting

Riyadh Campaign / DAMR0002

Change status | View survey data | Export | Edit pulses

Meter: DAMR0002L1-0 TO REVIEW Target: 15/30 days
 Meter: DAMR0002L1-1 NOT EDITED Target: 0/30 days

Customer overview during campaign

TOTAL DAILY AVG CONSUMPTION: 226l
 DAILY CONSUMPTION: [Line chart showing consumption over time]

End Uses distribution for all meters in customer

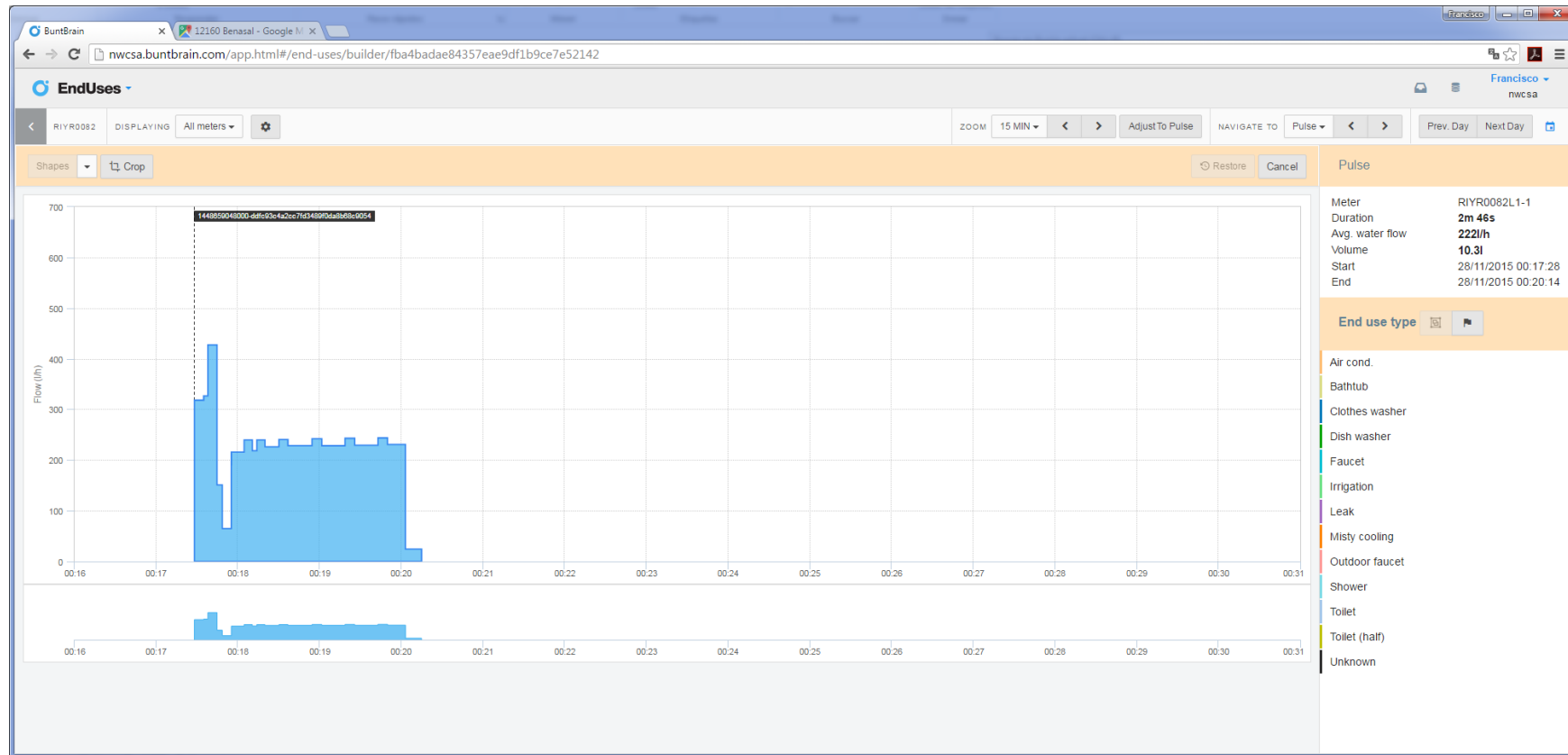
END USE	DAILY CONSUMPTION	
Air cond.	0%	0 l/day
Bathtub	0%	0 l/day
Clothes washer	0%	0 l/day
Dish washer	0%	0 l/day
Faucet	32.2%	103.9 l/day
Irrigation	0%	0 l/day
Leak	0.5%	1.5 l/day
Misty cooling	0%	0 l/day
Outdoor faucet	33.4%	107.7 l/day
Shower	17.7%	57.2 l/day
Toilet	16.2%	52.2 l/day
Toilet (half)	0%	0 l/day
Unknown	0%	0.1 l/day

End Uses distribution by meter

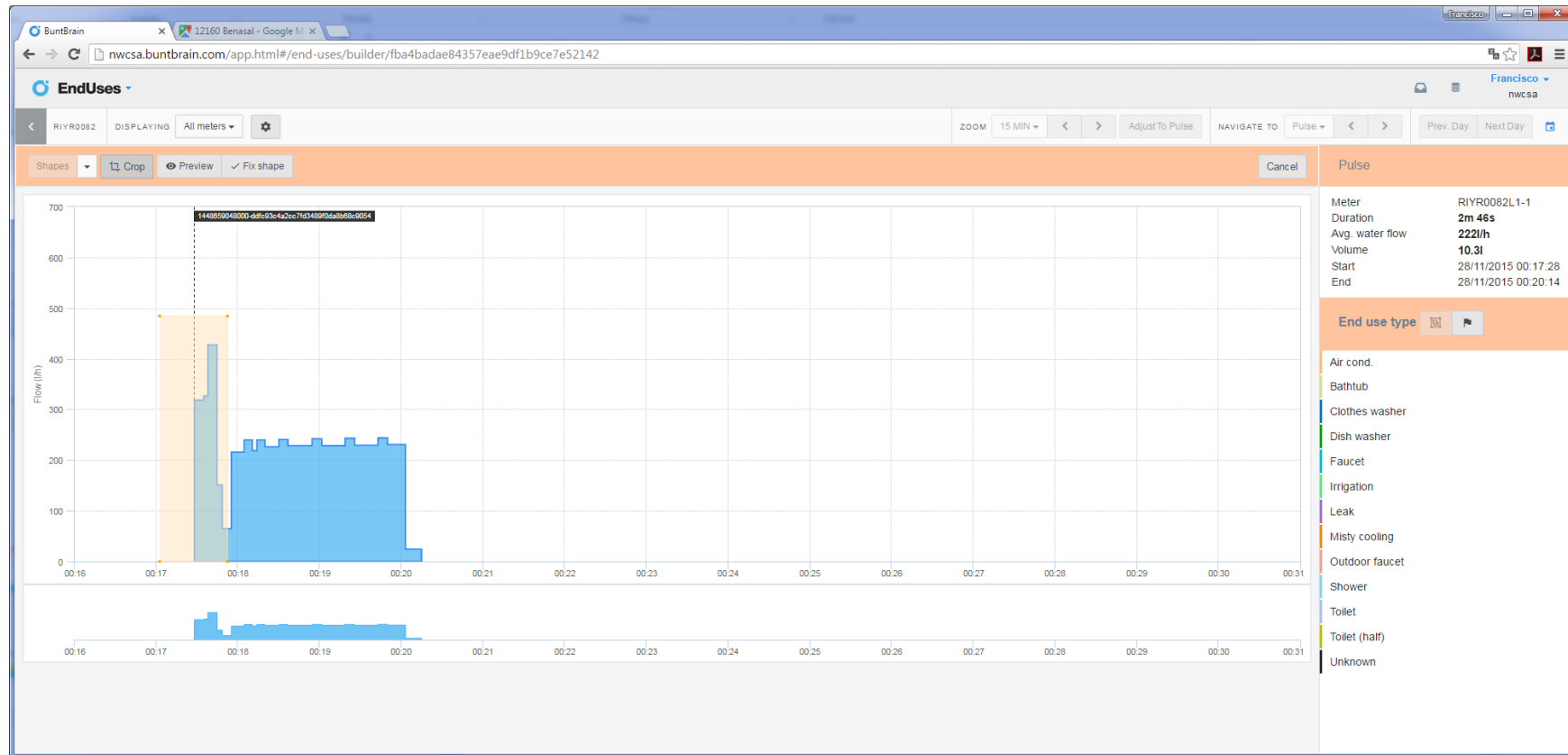
DAMR0002L1-0 DAMR0002L1-1
 No data to display

EDIT PULSES
 Go to last processed date >
 Go to first not processed date >
 Go to first unreliable date >

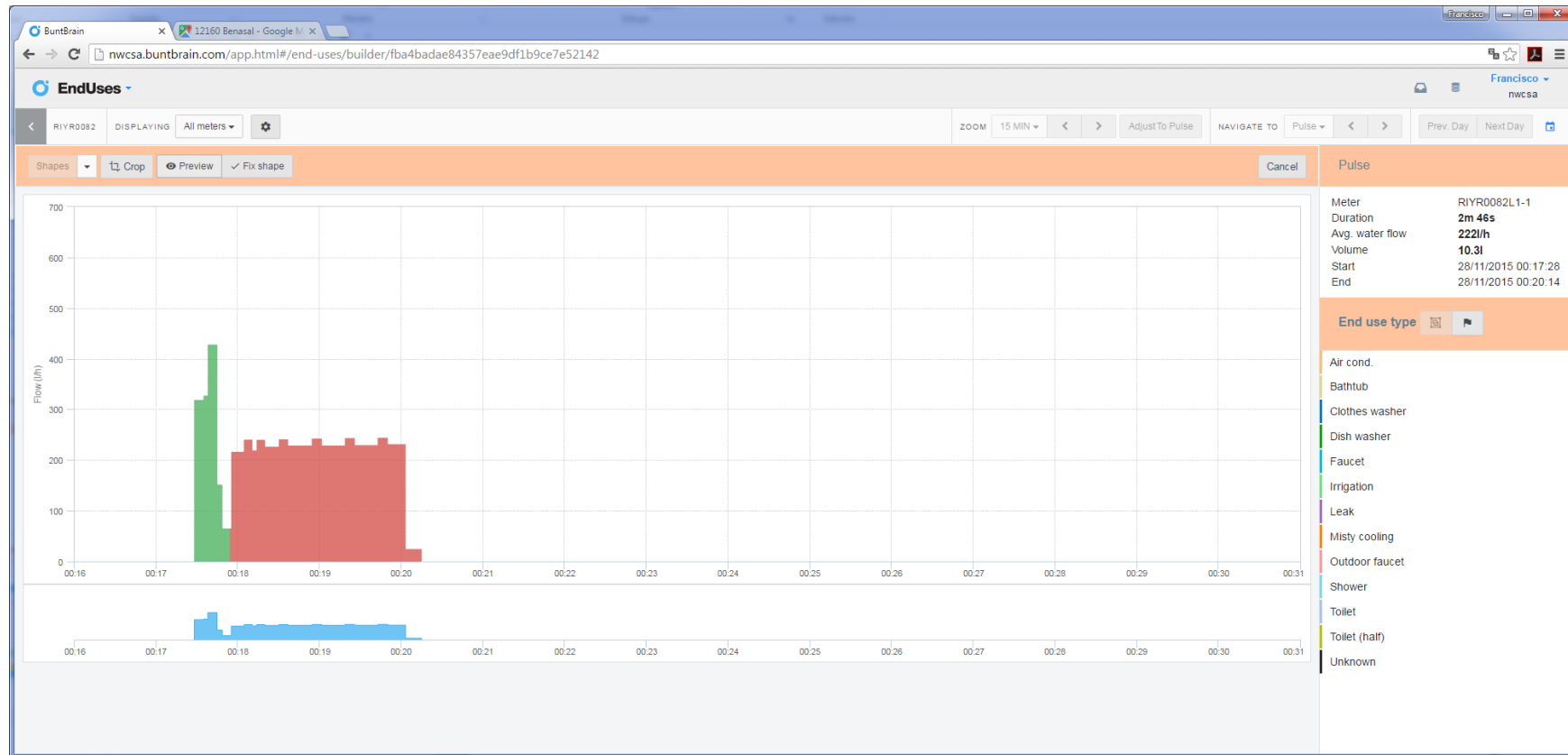
Example: Flow trace disaggregation



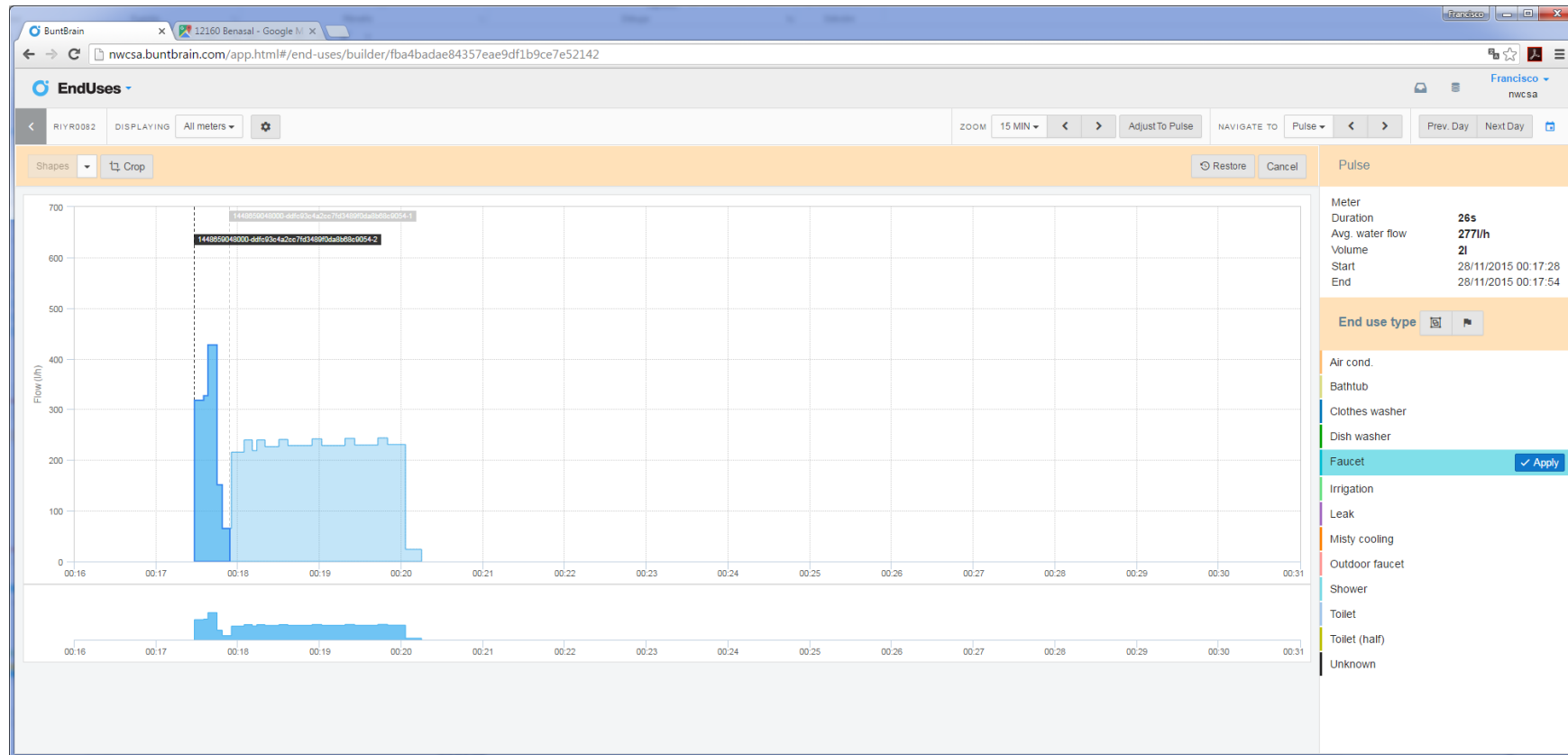
Example: Flow trace disaggregation



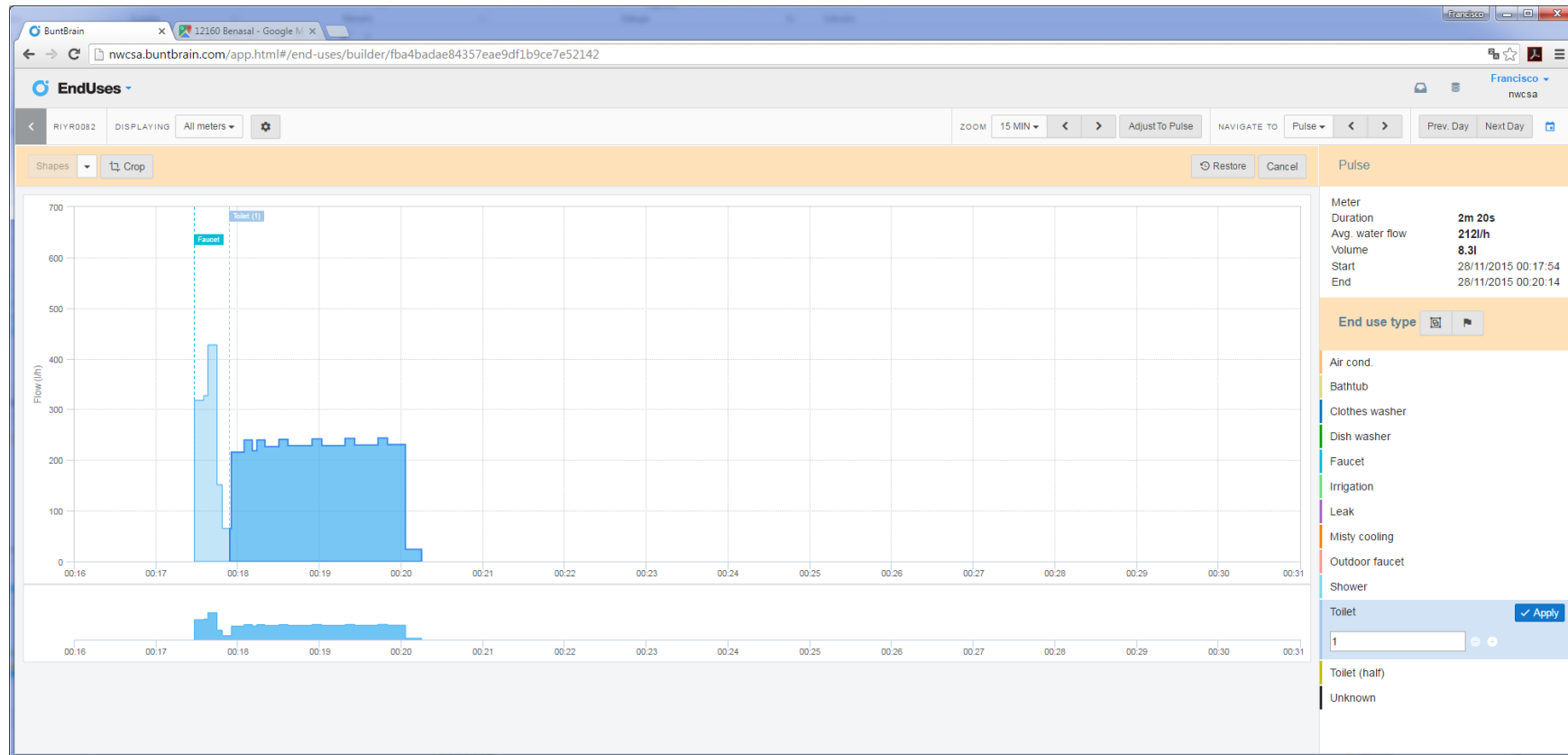
Example: Flow trace disaggregation



Example: Flow trace disaggregation



Example: Flow trace disaggregation



Exporting data for analysis

The screenshot shows the 'EndUses' web application interface. The main content area is titled 'Riyadh Campaign / RIYR0082'. It features a navigation bar with 'Change status', 'View survey data', and 'Export' (which is open, showing 'Raw consumption' and 'Processed pulses' options). There are also 'Edit pulses' and 'NOT EDITED' buttons. The dashboard displays 'Customer overview during campaign' with 'TOTAL DAILY AVG CONSUMPTION' at 308.11 and a 'DAILY CONSUMPTION' line graph. A 'Survey data' section with a 'View survey data' button is also present. The 'End Uses distribution for all meters in customer' is shown as a donut chart and a table.

END USE	DAILY CONSUMPTION
Air cond.	0% 0 l/day
Bathtub	0% 0 l/day
Clothes washer	47.7% 301.3 l/day
Dish washer	0% 0 l/day
Faucet	23.7% 149.6 l/day
Irrigation	0% 0 l/day
Leak	0% 0 l/day
Misty cooling	0% 0 l/day
Outdoor faucet	0% 0 l/day
Shower	19.1% 120.7 l/day
Toilet	9.4% 59.3 l/day
Toilet (half)	0% 0 l/day
Unknown	0.1% 0.9 l/day

Additional required features

The software should be capable of simultaneously working with several signals per customer:



Hot and Cold water

Drinking and Non-drinking water



Non-residential users with several meters

Additional required features

- Pulses should not be recorded as simple rectangular pulses

More sophisticated identification methods can be developed



More accurate results



More storage space is needed



Larger processing capacity



Conclusions

- Technology has made possible continuous monitoring of customers
- New software tools are needed to process the huge volume of data collected
- Often consumption pulses cannot be treated as rectangular pulses



Advance smart metering technologies and software for precise end-use Identification

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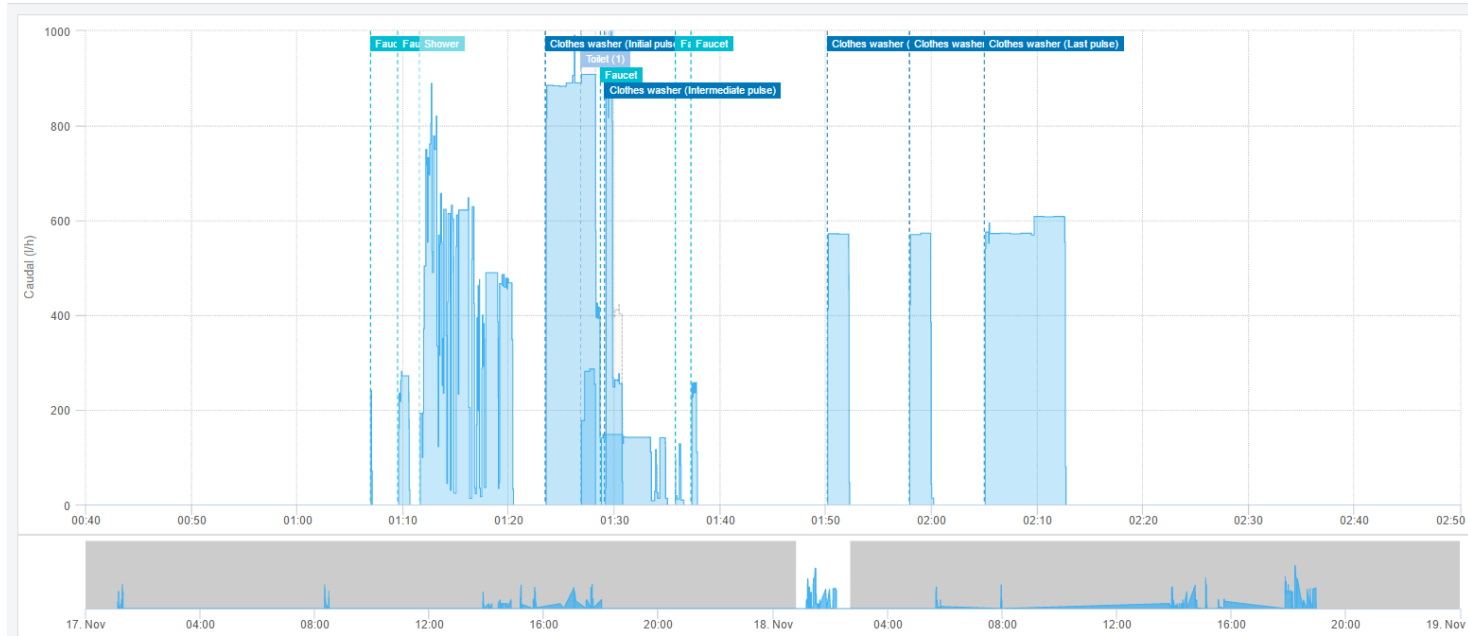
Gestión sostenible del agua urbana



Contador	User1L1-1
Duración	1m 06s
Caudal Promedio	531l/h
Volumen	9,8l
Inicio	15/11/2015 15:10:57
Fin	15/11/2015 15:12:03

Tipo de Uso Final

- Air cond.
- Bathtub
- Clothes washer
- Dish washer
- Faucet
- Irrigation
- Leak
- Misty cooling
- Outdoor faucet
- Shower
- Toilet
- Toilet (half)
- Unknown



Información

Fecha Martes 17/11/2015 23:43:22
Caudal **39l/h**

Leyenda

USOS FINALES

- Air cond.
- Bathtub
- Clothes washer
- Dish washer
- Faucet
- Irrigation
- Leak
- Misty cooling
- Outdoor faucet
- Shower
- Toilet
- Toilet (half)
- Unknown