Real time monitoring, modelling and control of combined sewer systems

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SCADA, PLCs and communication with components

- Local PLCs are connected in a PLC network
- SCADA on each WWTP and SCADA for the sewer system
- All components (TAGS) are visible from all SCADAs
- ADSL-communication between all PLCs and SCADA on sewer network – on line with all components and data!
- DIMS virtual servers for each WWTP, the sewer system and DIMS.CORE for RTC on the network – (M)onitoring, (M)odelling and (C)ontrol platform - MMC
RTC – Layers of control

• Layer 3: Global predictive control based on forecasts of rainfall/run-off and hydraulic capacity of WWTPs

• Layer 2: Global control based on level and flow measurements

• Layer 1: Local control based on level measurements

• Layer 0: Local emergency control
RTC – Layers of control and fall back strategy

DIMS.CORE

Short term rainfall forecasts (MAR)

Predicted Run-off (MIKE Urban)

Data validation and filtration
Software sensors: (elevations, flows, max. flows, storage tank filling)

Dynamic Overflow Risk Analysis (DORA)

PID (Flows) at each storage tank

PID (Elevations) at each storage tank

PID output: 0-100% distributed to setpoints for pumps, weirs/gates at each storage tank

WWTP max. hydraulic load

PLC/SCADA Sensors/Actuators

Levels, flows and weir/gate positions

Set-points

RTC – Layers of control and fall back strategy

Prepared enabling change

Aarhus, 21 – 23 , January 2014
Local condition = local restraint
Catchments, WWTPs – focus on Marselisborg North

Location of the City of Aarhus, its wastewater treatment plants and adjacent combined sewer catchments

Satellite view of the city center with sub-catchments and their storage tanks, 5 pcs. = 40,000 m³
User interface – RTC in MMC

MARSELISBORG WWTP-NORTH

RTC-DATA
- Tank volume
- Reduced surface area in catchment
- Used tank volume in m³
- Filling of tank in %
- Used depth of rain in mm
- Available depth of rain in mm
- Mean Area Rain intensity in µm/s
- Flowrate from tank in l/s
- Elevations in m (DVR)
- Position of gates in %

DATA VALIDATION
- Critical elevations CSOs – red
- RT elevations – green/yellow/red
- Varians = Is the measurement alive?
- Critical range for measurements
- Validation by MMC standard functions!

DATA CALIBRATION
- Use of MIKE URBAN sewer model

DIMS.CORE - MMC
Comparison of measured and calculated flow in the sewer system

Calculation of flow using MIKE URBAN sewer network model in Real Time

Red: Upstream level measurement
Green: Downstream level measurement
Light blue: Flow measurement
Dark blue: Flow calculation
Global control configuration of local control handles

SOFTWARE SENSORS AND DATA VALIDATION IN DIMS.CORE - MMC
Distribution of set points using MMC – Ex.: Storage Tank TB

### Trøjborg PID control: Set-points and Regulator parameters

<table>
<thead>
<tr>
<th>Sensor name</th>
<th>Elevation [m]</th>
<th>Flow [l/s]</th>
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</thead>
<tbody>
<tr>
<td>SW/LT-H8718-KOTE_EXPFFILT</td>
<td>-0.35</td>
<td>150</td>
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<tr>
<td>SW/LT-H8725-Q_H8718</td>
<td>0.2</td>
<td>800</td>
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<tr>
<td>SW/LT-H8718</td>
<td>-1.26</td>
<td>0</td>
</tr>
</tbody>
</table>

#### Control of pumped flow Trøjborg bassin
- **PID result [%]**: Minimum 75, Maximum 99
- **Flow**: Minimum 0, Maximum 250
- **Time step [min]**: 1
- **Control active**: No

#### Control of valve/gate Trøjborgvej
- **PID result [%]**: Minimum 0, Maximum 50
- **Opening [%]**: Minimum 0, Maximum 100
- **Time step [min]**: 1
- **Control active**: Yes

#### Control of valve/gate Dr. Margrethesvej
- **PID result [%]**: Minimum 45, Maximum 75
- **Opening [%]**: Minimum 0, Maximum 100
- **Time step [min]**: 1
- **Control active**: Yes

#### Control of valve/gate N/A
- **PID result [%]**: Minimum, Maximum
- **Opening [%]**: Minimum, Maximum
- **Time step [min]**: Yes
- **Control active**: Yes

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*) If Dynamic Risk Assessment is active for the section, then set-point from this is used with FlowPID during rain and shortly after. In dry weather elevationPID is used.
Control handle: Storage Tank
TB-Trøjborg

Aarhus, 21 – 23, January 2014

Effective volume = 16,000 m³
Automatic flushing system

Variable pump flow = 0-250 l/s

Water depth = 12 m
Control handle: Storage Tank TB
Gate 2 – Dr. Margrethesvej

Field verification

Old 400 V actuator

Weir

New UPS

New Cipos 230 V actuator

Prepared enabling change
### Meta data!

<table>
<thead>
<tr>
<th>GATE/VALVE</th>
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<tbody>
<tr>
<td>PI number</td>
<td>SM-TB010</td>
</tr>
<tr>
<td>Description</td>
<td>Valve Dr. Margrethesvej</td>
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<tr>
<td>Component</td>
<td>Knife gate valve DIN 400</td>
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<tr>
<td>Actuator</td>
<td>Sipos 5 PROFITRON</td>
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<tr>
<td>Location</td>
<td>Well road Dr. Margrethesvej</td>
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<tr>
<td>Well number</td>
<td>Q01030K</td>
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<tr>
<td>Elevations (meters)</td>
<td></td>
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<tr>
<td>Terrain</td>
<td>21.24</td>
</tr>
<tr>
<td>Cover lid</td>
<td>21.24</td>
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<tr>
<td>Top of pipe</td>
<td>18.46</td>
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<tr>
<td>Valve movement (meters)</td>
<td>0.285</td>
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<tr>
<td>Valve indication</td>
<td>Opening percentage</td>
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<tr>
<td>PLC valve position address</td>
<td>TB747:DB96,DBDW 454</td>
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<tr>
<td>Underbase/profibus add.</td>
<td>ET 200M/Profibus add. 13</td>
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<tr>
<td>PLC located at</td>
<td>Tø¡borg Basin</td>
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<tr>
<td>SCADA node</td>
<td>Eskelund</td>
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<tr>
<td>SCADA Tag Name</td>
<td>CO-SM-TB010-POS</td>
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<tr>
<td>SCADA error Tag Name</td>
<td>CO-SM-TB010-DRIFTFEJL</td>
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<tr>
<td>Image doc. files</td>
<td>IMG0097; IMG0100</td>
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</tbody>
</table>
Lessons learned!

- A suitable number of control handles and measurement data must be available!
- The SCADA-system must be on line with all major and critical components and control handles!
- A systematic fall back strategy in several layers must be implemented!
- Important to validate and calibrate data during design and operation and test performance during rain events!
- Be aware of the importance of organizing META-data!
- Operational staff has to be deeply involved in design and implementation! Do not create a ”black box”!
Thank You for Your attention!