Experience with Leak Detection System

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Agenda

- Hungarian pipeline networks
- Leak detection system – project history
- Principles of applied technology
- Future developments

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Hungarian crude and product pipeline network

- Crude oil pipelines

Length: 850 Km
Capacity: 23 Mt/year

- Product Pipelines

Length: 1550 Km
Capacity: 12 Mt/year

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Leak detection – what is the reason?

- Operator
  - Driver: safety and cost effective operation ; meet the owner's and authorities expectations
- The authorities
  - Driver: control the industrial player (operator)
- Technology developer/service provider
  - Driver: Business interest

On the other side

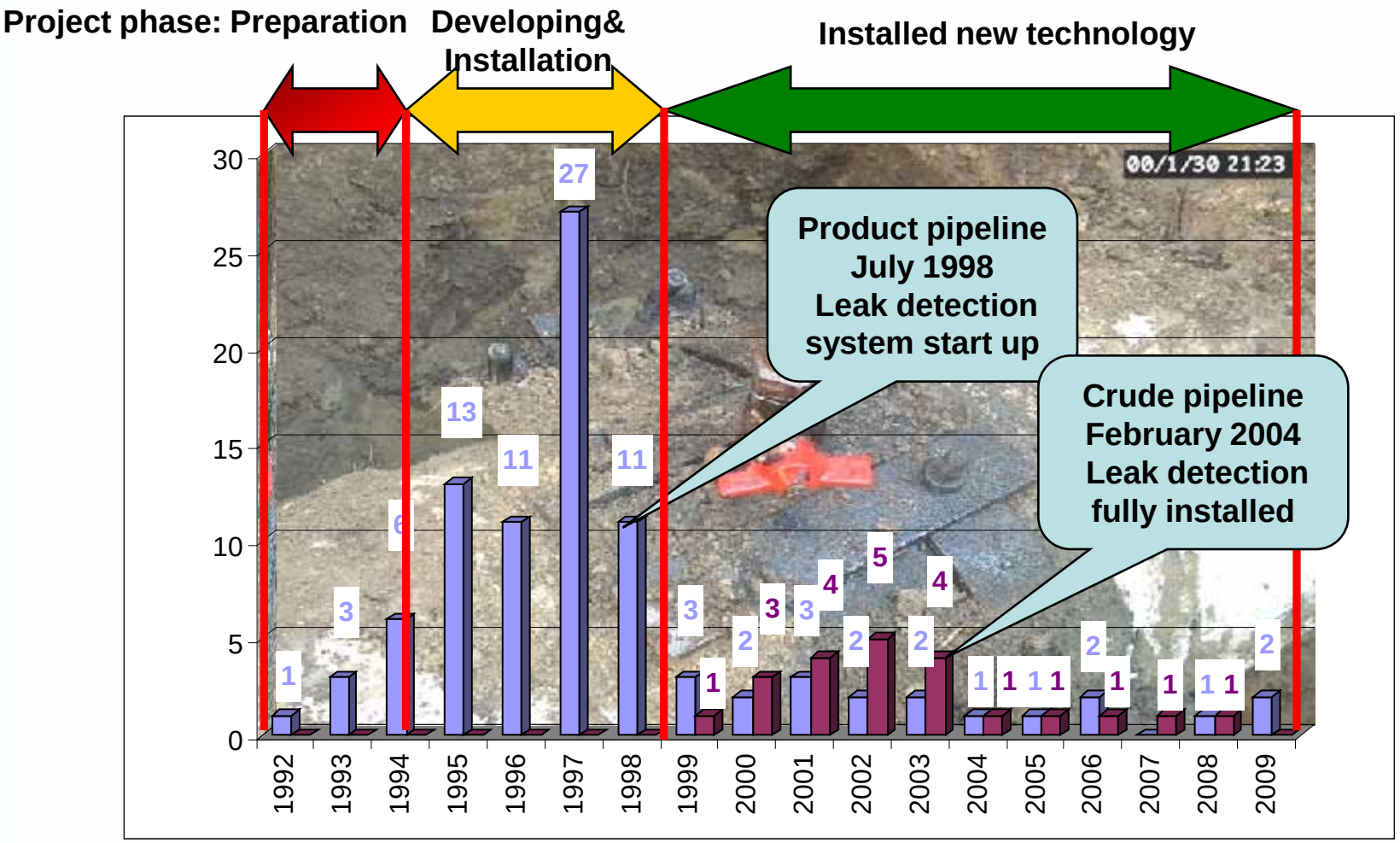
- Thieves
  - Driver: Quick and abundant profit
  - Existence, capability, intentions

Income calculation

- One tapping -> **20 m^3**
- 20 m^3 -> **10 000 €**
- Minimum wage: **250 €**
- 20 m^3 -> income in **3,3** years
  (in one single summer night)

Did not changed in the past 20 years.

Theft attempts against pipelines



Product | Crude

Preparation phase

- *1992-1994 (10 events)*
- Facing the new chalenge and recognition its importance
- Information gathering
- Project preparation
- Tender launching: stress on the leak detection

Preparation phase

- Direct attacks against the pipeline using tank cars. Affordable take risk from the thieves (can not be located) low chance of getting caught.
- Theft method: quickly a lot

Developing and installation

- *1995-1998 (52 events)*
- A core technical content is defined; its *essence realtime perception and exact place location* alongside the lines.Tender starts searching for a best developer and/or service provider. First winner (worldwide known company) failed.

Developing and installation

- Strong efforts to keep the system operability.
- Practically unprotected network exclusively reactive operator actions. Environmental and repairing costs in the skies.
  Severe authority and owner reactions.

New technology operating phase

- *1998-2009 (19 events)*
  - First generation of leak detection system was installed and run reliably. Continuous fine tunning of the system at the beginnig with many blind alarms but existing preventive pipeline protection.
  - Decreasing number of events and environmental costs. Catched thieves by the prepared operator actions.The new system got great publicity in the papers and on TV.
  - Theft method become sophisticated: slowly and long time taking with a small intensity below the system perception level.

Project evaluation

- First phase
  - Recognition of threat and the possible answer
  - Acceptable decision making and tender start time
- Second phase
  - Weak operator cooperation during a planning period
  - Almost two years slip
  - Good common work with the developer
  - Good correction
- Third phase
  - Need of continuous development, fruitful operation

Project evaluation

- All in all the project was successful and we entered into the new phase

- Present status
  - We launched the upgrade of the SCADA system with the third generation of the leak detection technology (competition with the thieves)

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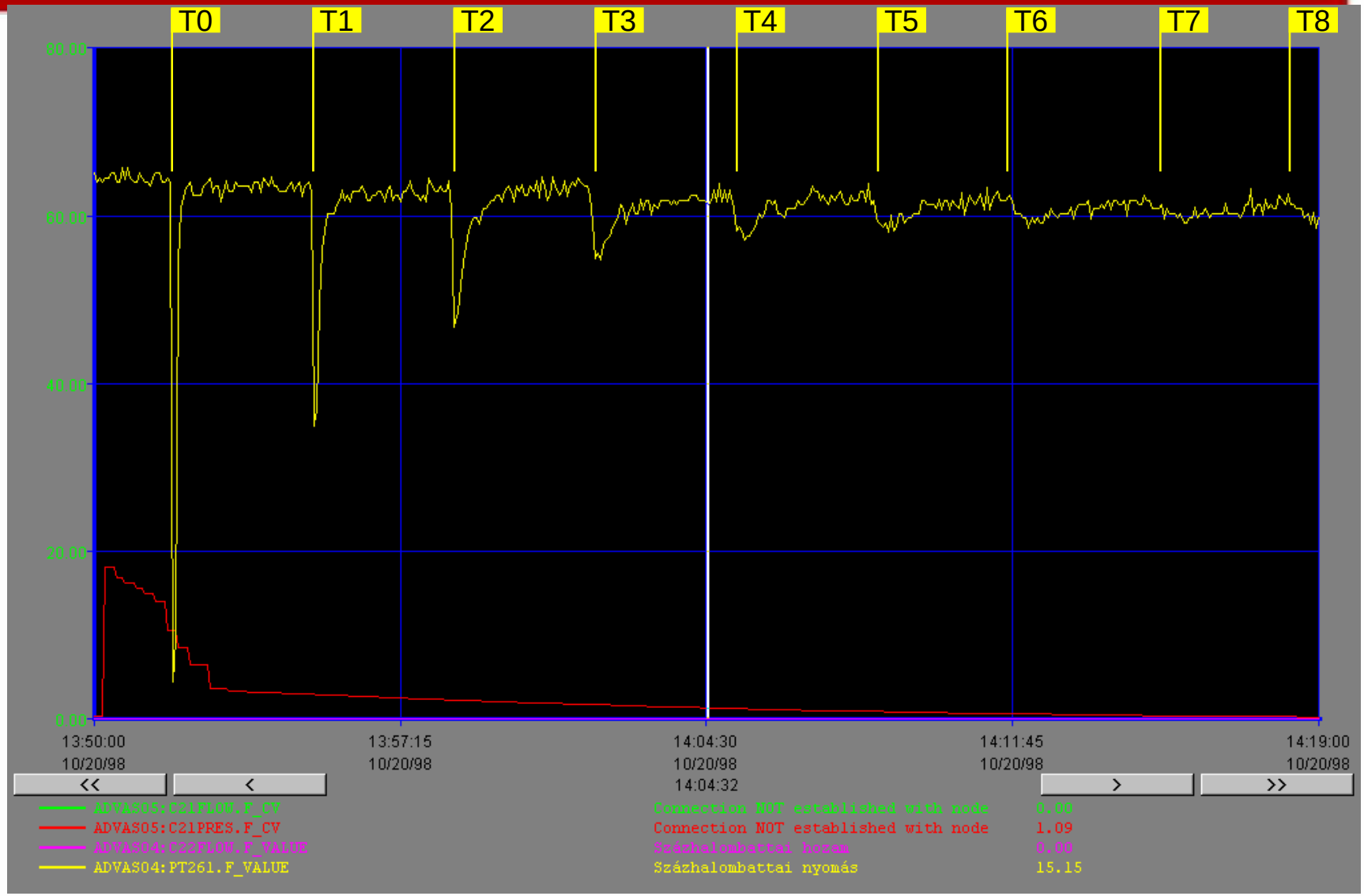
Leak detection - what is it really?

- Operator requirements
  - Cost effectiveness
  - Online
  - Continuous
  - Operator friendly
- Developer philosophy:
  - Perception of tiny things from large distance
    - From our side given knowledge: Pressure changes and wave propagation in liquids can be used as an indicator of theft

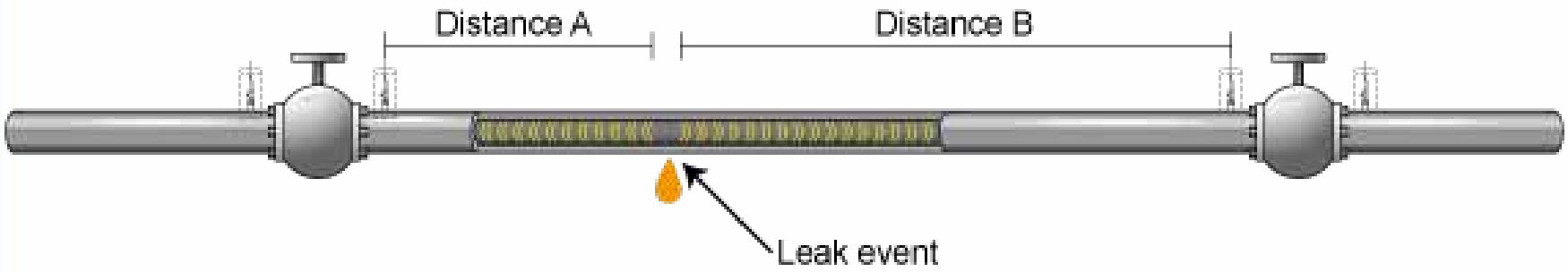
Why hydraulic theft detection is possible?



Pressure waves can be detected after 2000 Km propagation along the pipeline

Hydraulic leak detection

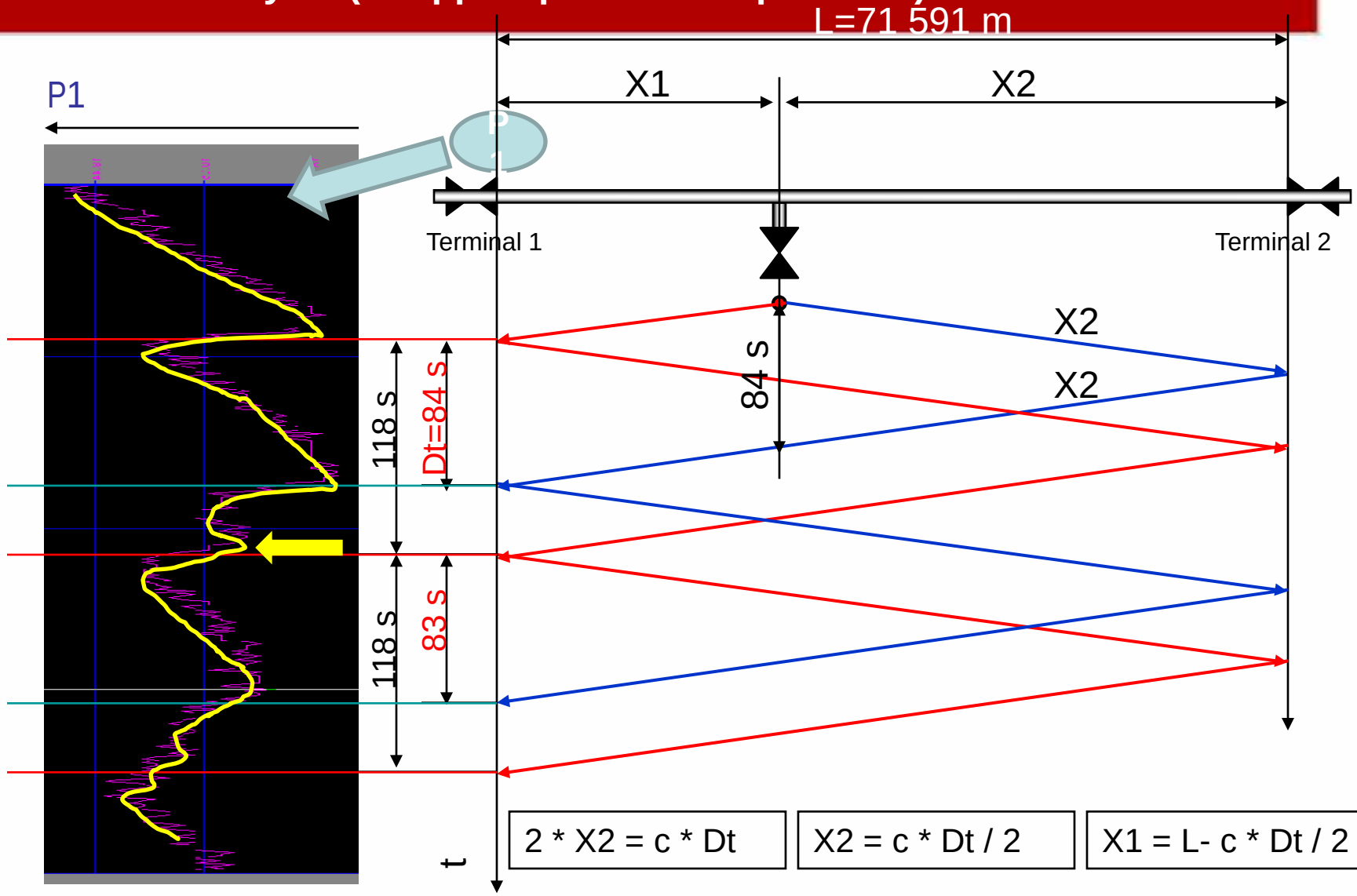
- Protects the whole length of the pipeline
- Robust, cost effective and mobile
  - Fast and easy to deploy
  - Easy to operate
  - Out of the box system
    - Wireless communication
    - Long term battery based operation



Hydraulic leak detection principles

TRANSPORTATION STATUS	LEAK DETECTION	LEAK LOCATION
STEADY PIPELINE	• PRESSURE TREND ANALYSIS • PIPELINE MODEL • Cripple period method* • Wave propagation model*	• HYDOACOUSTICAL METHOD FOR PRESSURES • PRESSURE TREND ANALYSIS • Wave propagation model*
UNDER TRANSPORTATION	• PIPE IMPEDANCE ANALYSIS • PIPE BALANCE • PIPELINE MODEL • Pipeline impedance monitoring* • Wave propagation model*	• HYDOACUSTICAL METHOD FOR PRESSURES AND FLOW RATES • HYDRAULIC METHOD • Wave propagation model*

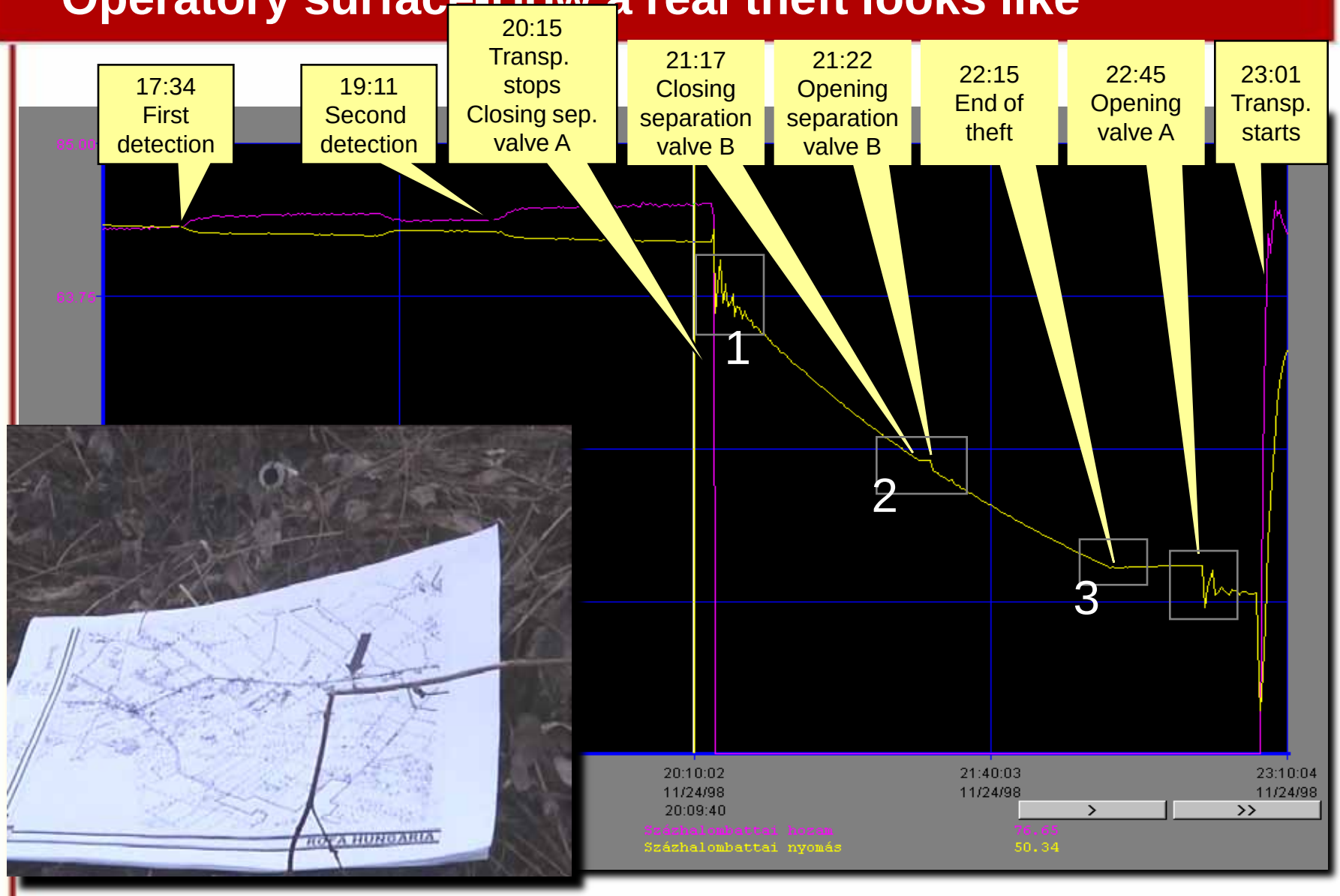
Pressure Point Analysis (“Cripple” period for 1 pressure)



2 * X2 = c * Dt	X2 = c * Dt / 2	X1 = L- c * Dt / 2

X1 = 71 591 - 1 193,3 * 84 / 2 = 21 472 m

Operatory surface-How a real theft looks like



Recent technology limits

In steady state:

- **Sensitivity**: 2 mbar pressure variation at 64 bars
- **Location accuracy**: ± 25 meters
- **Response time**: less than 5 minutes

During transportation

- **Sensitivity**: three times of the pipeline pressure noise.
- **Location accuracy**: ± 50 meters
- **Response time**: within 5 minutes

- **Example**:

Pipeline noise:	10 mbar
Detectable pressure drop:	30 mbar.
Pipeline diameter:	12” (300 mm)
Flow rate:	100 m3/h
Loss detected:	15 liter/min. (0,9%)

Operational philosophy

- Used for qualified thefts not only ruptures
- Objective: fight the thieves
- Produces legal probes
- Supplies alarms, warnings and events
- Supplies hydraulic analysis for human decision

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Future

- Near future
  - Stand alone system
    - Does not rely on
      - SCADA
      - Electric power lines
      - Communication lines
- New developments
  - Consider the pressure wave direction more intelligent application pre-asseses the event

Direction based detection and location

DW 9000
Central server

Dispatcher room
Operator stations

Redundant W-WAN

GPRS APN 1

GPRS APN 2

GPS

DW 4324L
DW 712 UTC
DW918N

GPS

DW 4324L
DW 712 UTC
DW918N

DW 115 GEx

DW 115 GEx

Hydraulic Event 1 - OK

Hydraulic Event 2 - OK

Hydraulic Event 3 - ALARM

Thank you for your attention!

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