# Automated Real Time Performance Management for Mobile Networks

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# Motivation

Performance management in todays mobile networks:

- Offline – No possibilities to access recent data
- Large delays – typically >15 minutes
- No real automation – Combination of operator knowledge and handiwork

Goals

- Introduction of an automated, performance management system for mobile networks that exploits real time capabilities
- Direct access to recent performance data
- Parallel monitoring of a large number of network elements
- Long-term objective: Autonomous performance management
- Gain knowledge about upcoming critical situations to be able to avoid them becoming critical

# Agenda

- Motivation
  - What is it all about?
- Basics
  - Introduction into performance management
- System Design
  - Setup of the presented system
- Evaluation
  - Comparison of different performance management schemes
- Conclusion

# Introduction

**PM is based on data originating from three different timescales**

- Long Term: Data collected over a very long period of time (weeks/months)
- Mid Term: Data of several days is analysed
- Short Term: 15 Minutes to several hours
- Usually no real time data is used!

**Why not? Existing limitations that avoid the usage of real time data**

- Processing power
- Bandwidth
- Human limitations

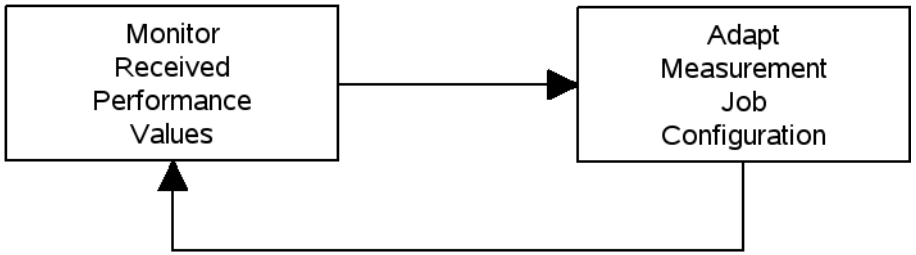
**How to overcome these limitations?**

- PM - Data selection – provide only “needed” data
- Preprocessing and compression of data already at the source
- Dynamic adaptation of PM data rates
- Selective Operator Notifications, improved GUI, reconfiguration proposals

# Basics

**Basic PM Tasks**

- Monitoring of measurement results and derived values
- Adaptation of measurement jobs
- Reconfiguration of network elements
- Very complex interconnected cause and effect dependencies



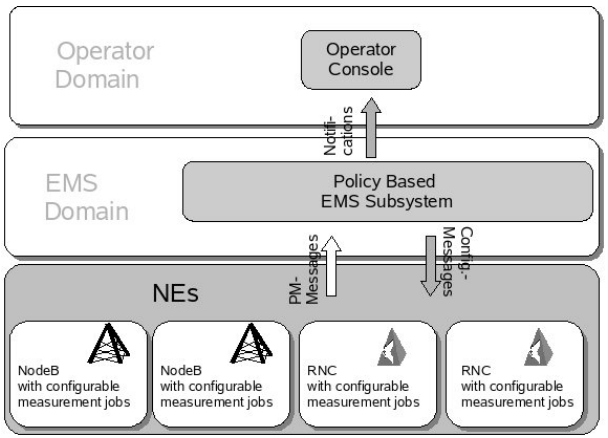

Policy Based Performance Management in Mobile Networks

- Policy approach is very powerful and flexible
- Few abstract policies can suffice for fine grain management of a large number of network elements
- Manual PM-tasks that can be transformed into policies are automation candidates
- Policy design has to care about contradicting policies
- Policy evaluation takes care of the above named cause and effect interconnections

# System Design

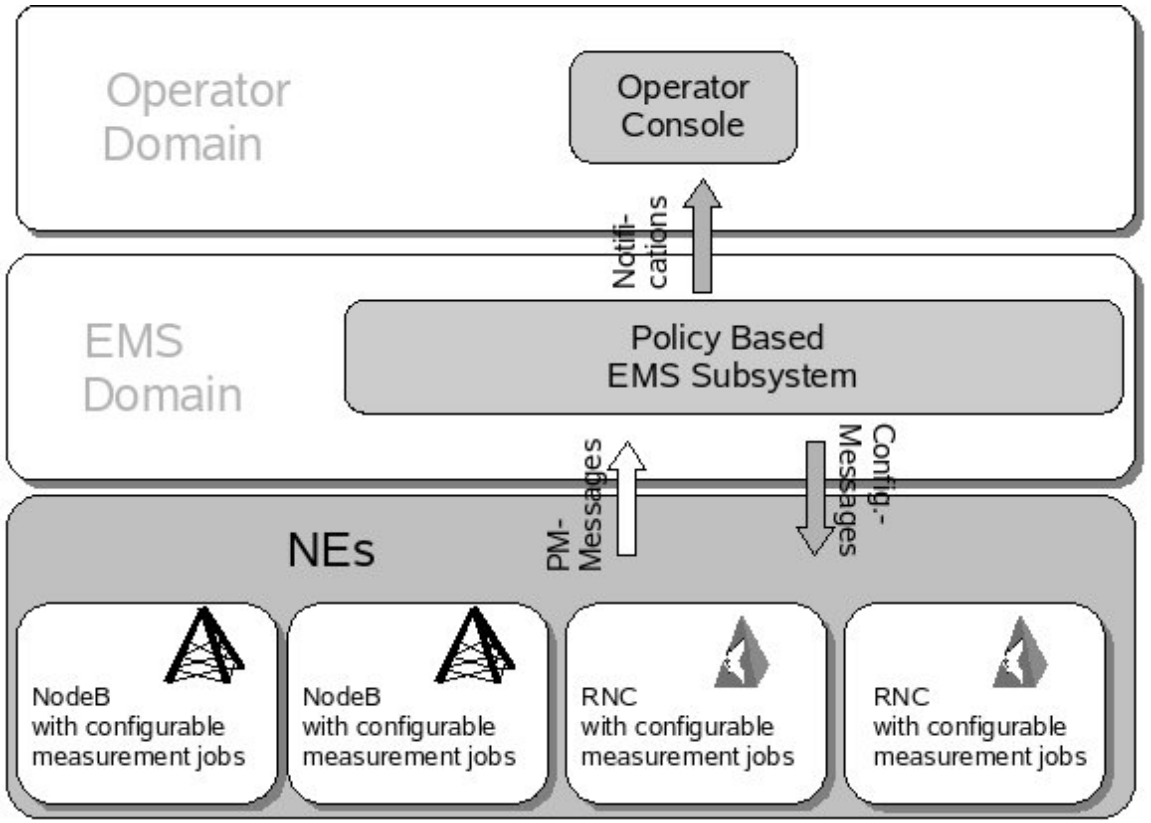
- **Basic assumption:** Configurable measurement jobs are available!
- **Real time data:** Data with a minimal delay between measurement and availability at the EMS Domain

**Integration of the Policy Based Subsystem into the common PM Architecture:**
Policy Based EMS Subsystem!




- Measurement Data of reconfigurable measurement jobs is gathered and analysed.
- Current situation is assessed in case of a critical event, trigger counteractive measures! Here: notify the human operator
- **Main Intention: Reduce resource consumption – increase amount of information available to the human operator in critical situations and reduce information when it is not "needed".**

# Integration into common PM Architecture




- Policy system centrally located in EMS Domain
- Receives PM Data which is analyzed
- Reconfigurations can be triggered
- Operator is notified in critical situations



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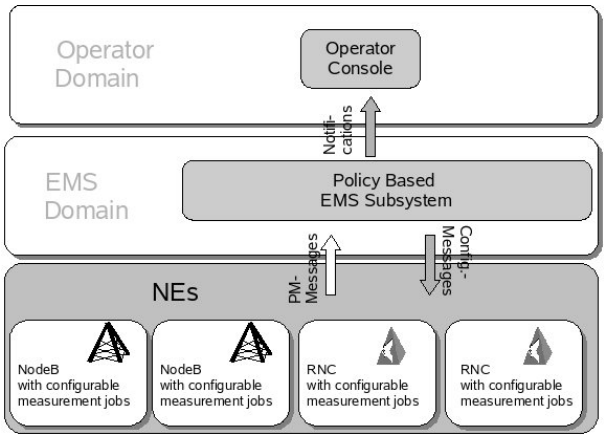


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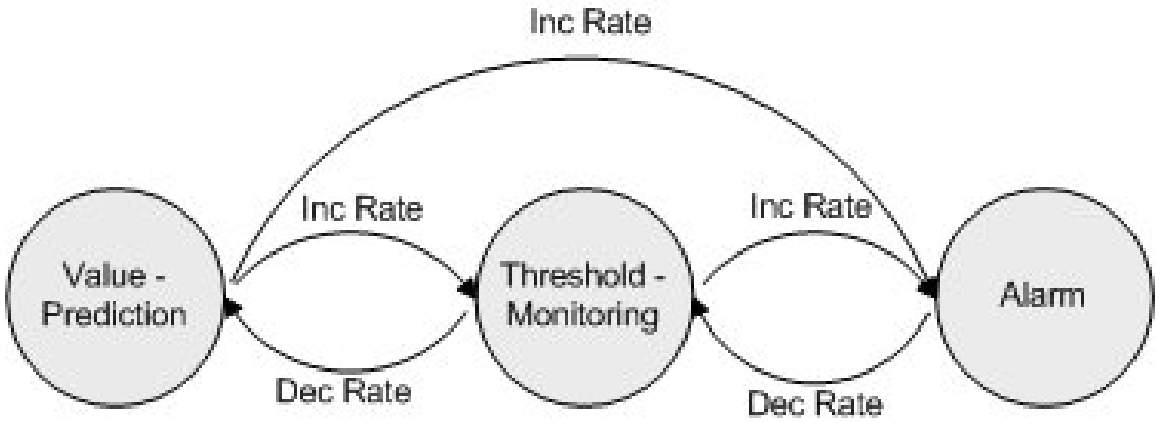
# Basic, Centralized Approach

The policy based EMS Subsystem gathers and analyses all information originating from the network elements.

Functionality can easily be described:




**Value Prediction:** State for non critical situations – minimal amount of information

**Threshold Monitoring State:** Critical situations are indicated – information level is increased

**Alarm State:** Maximal amount of information is generated, operator is notified

# Evolutionary, Distributed Approach

This approach follows the predicted evolution of mobile networks towards a flattened hierarchy with enhanced network elements at the edge

Functionality is distributed from central entities to the network elements

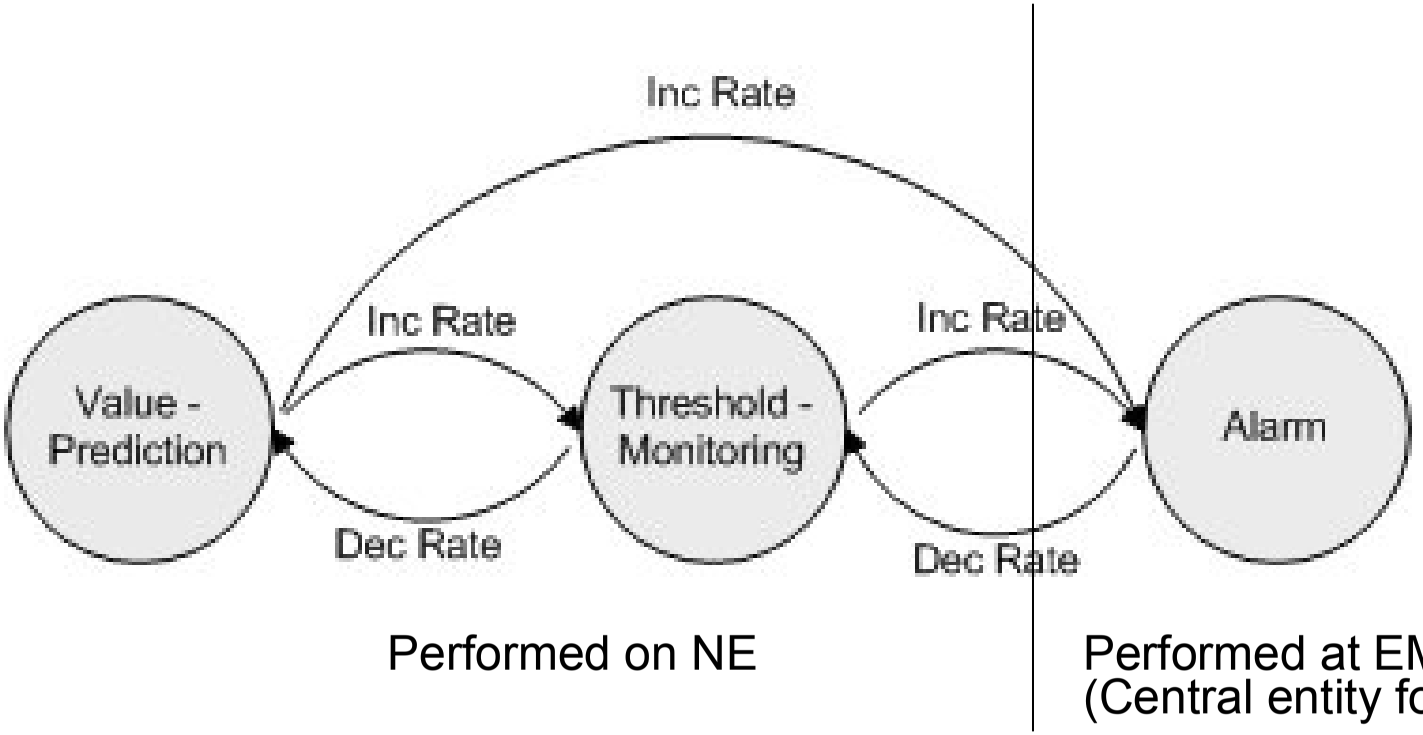
Processing capacity at the network elements is used to furtherly reduce ressource consumption at central entities

**In this approach Value Prediction and Threshold Montitoring states are shifted to the network elements**

No message is transmitted until a measurement value crosses a predefined threshold

After this notification the central entity can choose to gain control on the measurement jobs

# Evolution


Inc Rate
Inc Rate
Inc Rate
Value - Prediction
Threshold - Monitoring
Alarm
Dec Rate
Dec Rate
Performed on NE
Performed at EMS
(Central entity for all NEs)

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# Evaluation

The main focus is on the reliabillity in detecting critical situations and the impact on the network links by the messages transferred

- Can all critical situations with a minimal delay be detected?
- Which configurations of the measurement jobs can be supported?

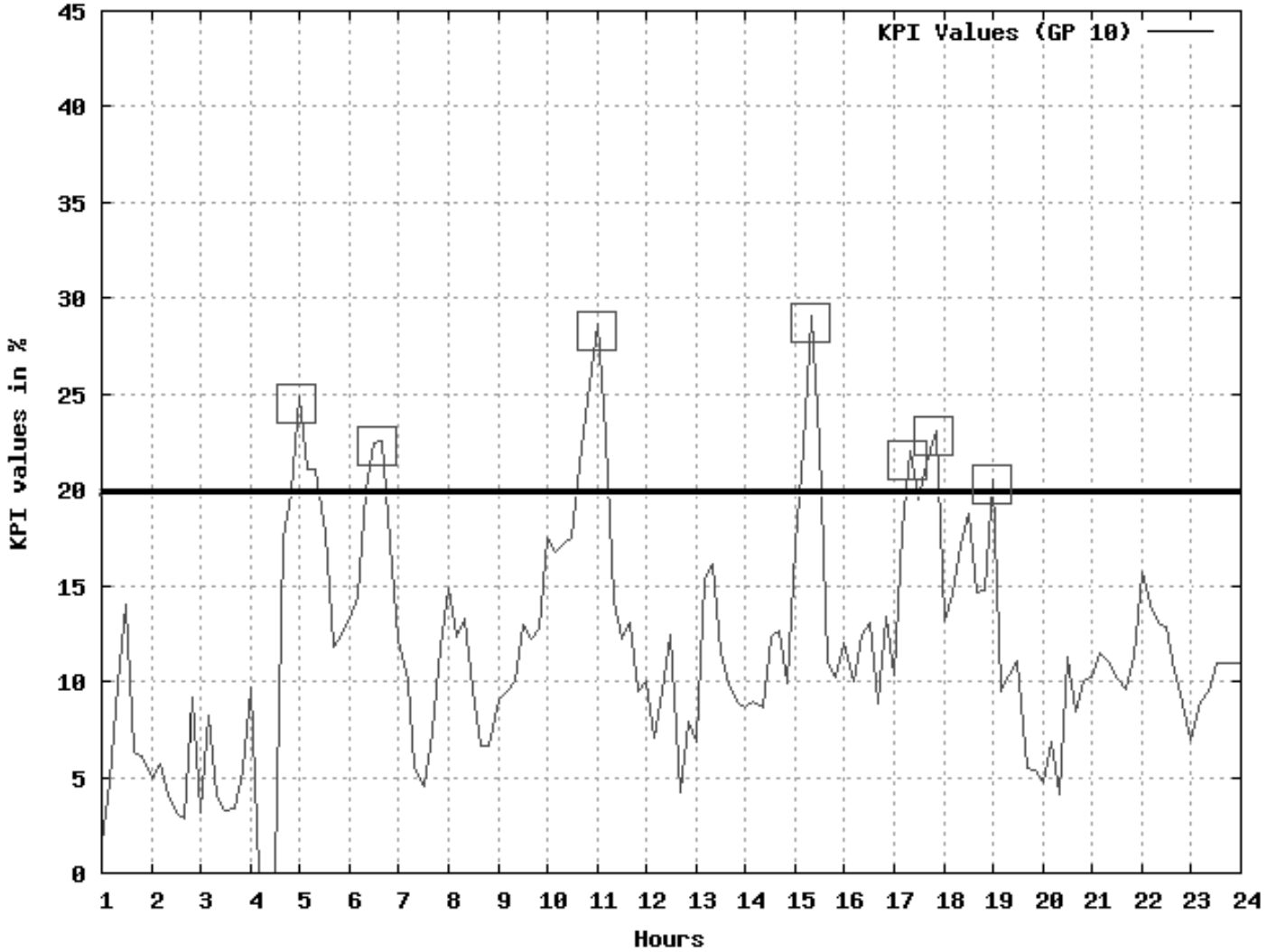
Evaluation is based on a modified tracefile from a 3G network

- One KPI with three SubKPIs was chosen (HandoverFailureRate, Intra NodeB, Inter NodeB, Inter RNC)

Comparison of 4 PM-Schemes

- **Conventional PM:** 30 min GP, transmission of the full set of counters
- **RTPM1:** Fixed 1 minute GP, 4 active measurement jobs, all values are always sent
- **RTPM2:** Variable GP (1, 5, 10 minutes), centrally controlled by policy based EMS subsystem
- **RTPM3:** Variation of RTPM2 but using the distributed approach, high rate messages are requested as soon as the threshold is crossed

# Evaluation – KPI Changes




Seven situations where the KPI value us above the threshold of 20%

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**tb7** Do we need this slide?
Tobias Bandh, 6/6/2007

# Evaluation

Measured Values per evaluated PM scheme:

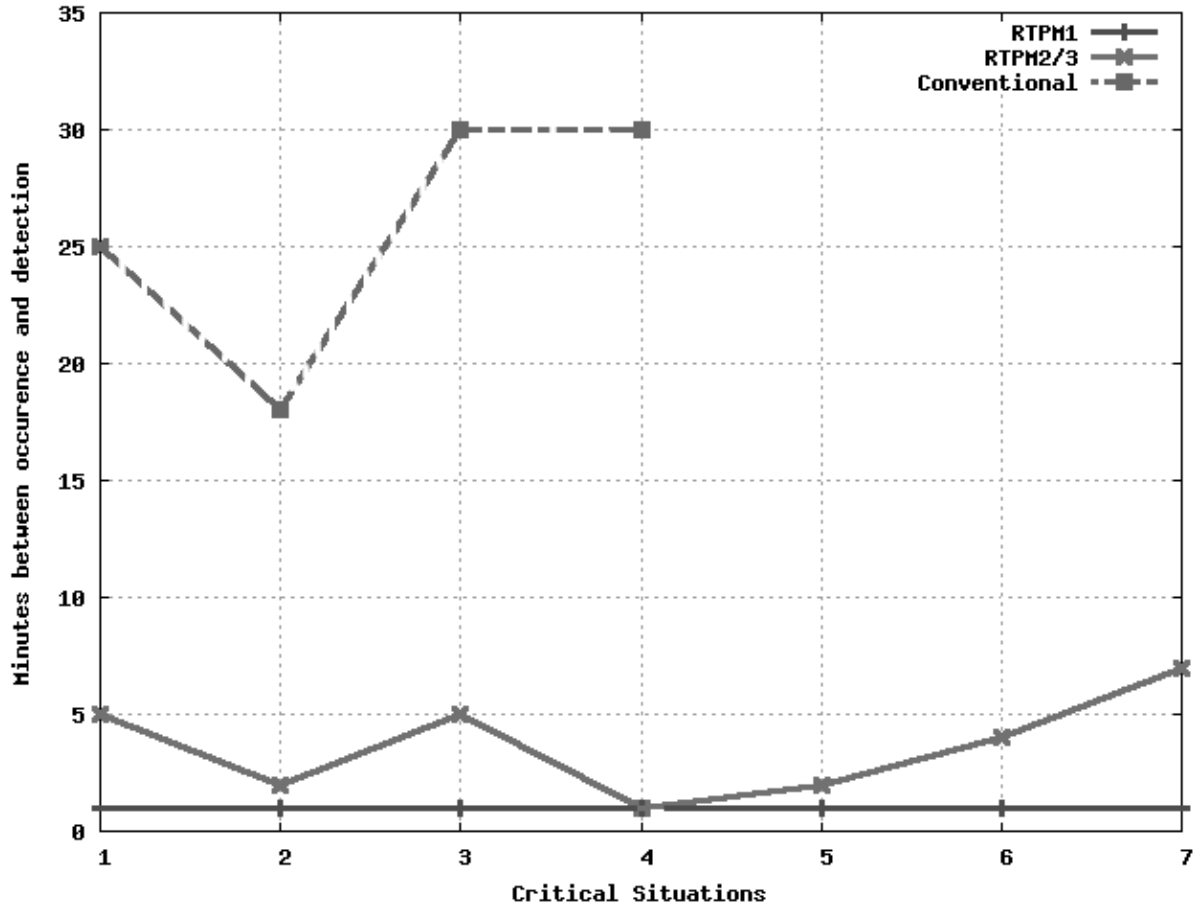
- Total number of messages within 24 hours
- Number of messages sent per hour (min, avg, max)
- Number of detected critical situations
- Delay between occurrence and detection of a critical situation (min, avg, max)
- Number of predicted but not occurred threshold violations

Assessments:

- Detection Reliability
- Improvements in message reduction
- Impact on communication links

# Results

## Detection Reliability and Delay




- **Conventional PM misses four critical situations and has a long delay**
- **Policy based PM has a faster detection with a higher reliability**



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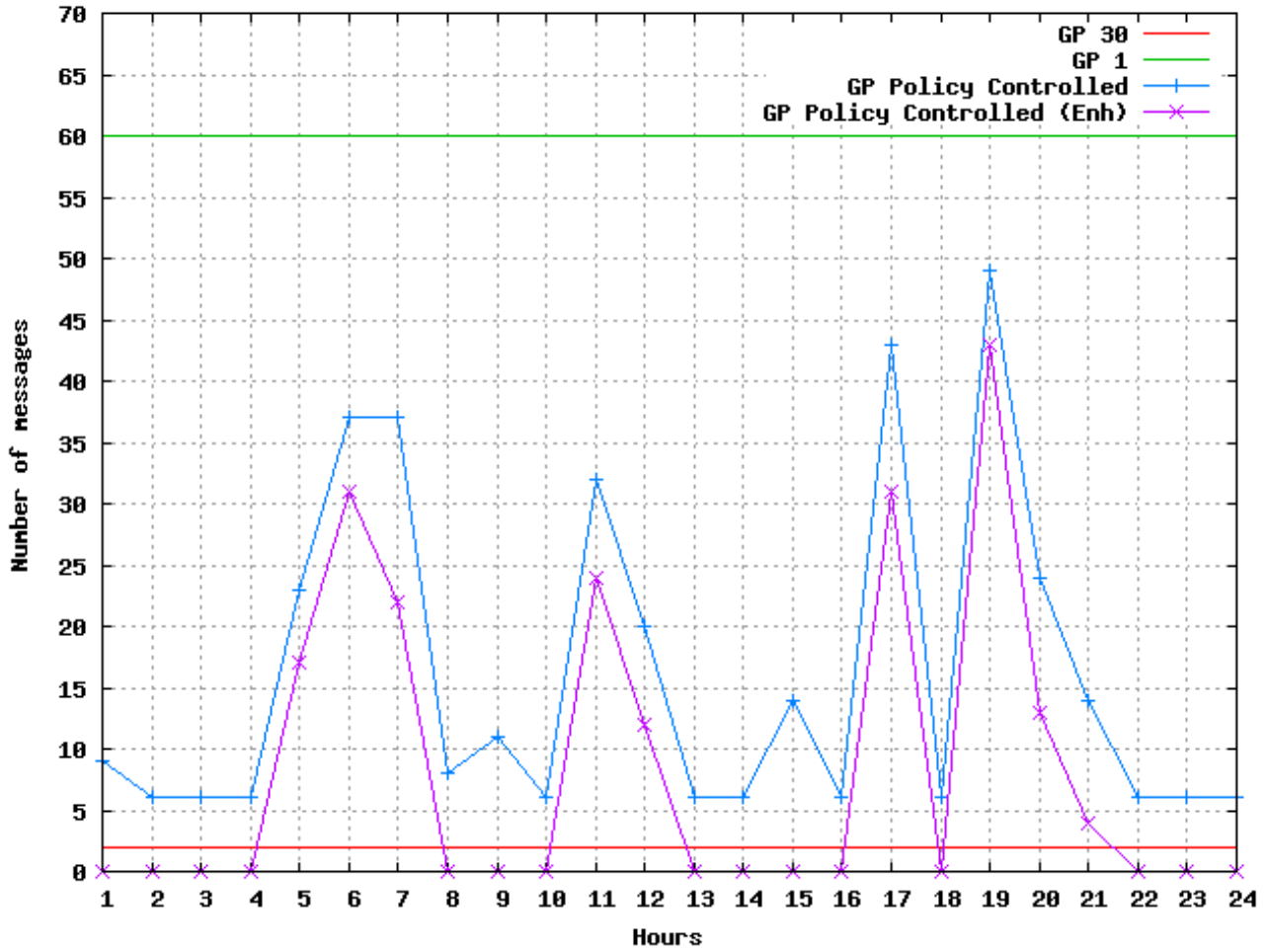
# Results

## Number of messages sent per KPI




- Policy controlled PM transmits noticeable less messages compared to the fixed 1 minute scheme
- Evolutionary approach does not transmit any messages for 15 hours
- Fixed 1 minute scheme has less messages but transfers always any data available

# Results

**Impacts on Communication Links**

Basic Scenario:

- RNC Domain comprising 1000 cells with **absolutely identical behavior**
- 33% of the 2 MBit/s O&M link are available for PM
- 10 basic KPIs are monitored, each of them has 3 SubKPIs

1. Fixed 1 min GP: 100% of the link used for basic monitoring
2. Policy Controlled: 79% link usage for basic monitoring
3. Policy Controlled, min GP in critical Situation 10 seconds: only <25 % of the basic KPIs can be monitored
4. As 2, but additional SubKPIs are activated: 33% of the cells can be monitored

Worst Case Scenarios due to identical cell behavior

# Conclusion and Future Work

- Real-time data combined with a policy based system provides a real enhancement for performance management in mobile networks
- A single policy can match a large number of situations
- Policies introduce flexibility into PM
- Policies can be defined offline which reduces the number of error sources compared to online reaction in critical situations
- Policy based systems free the human operator for other tasks

- Designing optimal policies is a hard task
- No one can assess any possible critical situation
- Policies have to be refined

**Future Work**

- Enhancing the system by including additional knowledge into policies and the prediction algorithm (seasonal trends)
- Dynamic adaptation of the policies based on observed operator behavior after raised alarms
- Self healing …

# Questions?



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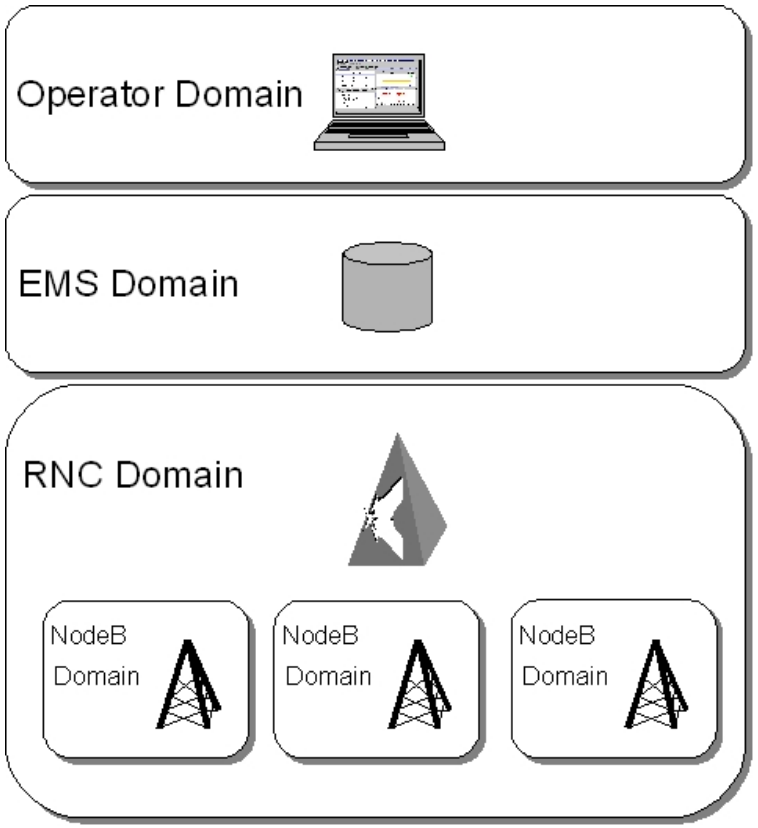
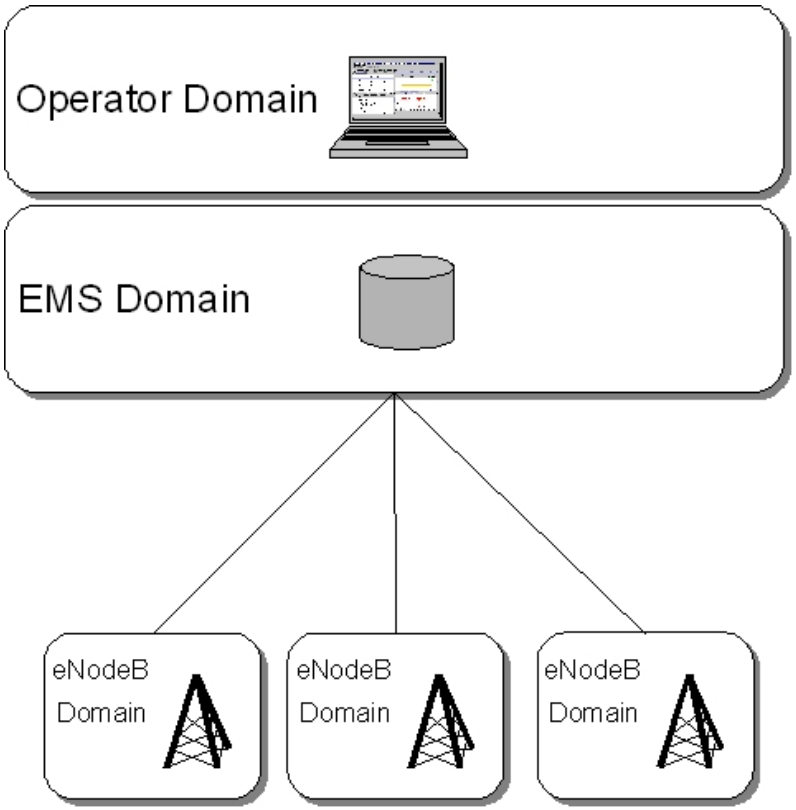
# Backup

# PM Network Architecture




3G Network




LTE Network

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# Key-Performance-Indicators - KPIs

- KPIs combine lowlevel information into more meaningful data
  - Several counter values are used to calculate one KPI value
- KPIs are mostly operator defined
- KPIs can be used to assess the state of the network
- Typical KPIs
  - CallDropRateKPI
  - CallSetupSuccessRate
  - DownlinkCellLoad
  - ISHHOOutFRpCell (auch cs und ps)
  - NoofabnormalRRCRel
  - OutgoingHardHandoverFailureRate
  - RabEstabTypeFR (auch cs und ps)
  - RelocOutFR
  - RRCdropRate
  - SoftHandoverDropRate
  - BranchAdditionFailureRate (auch intra NodeB, intra RNC, inter RNC)

# Delay

- The delay used here consists of three parts:

1. Granularity Period
2. Transmission delay
3. Processing delay