# Transaction-based Configuration Management for Mobile Networks

Henning Sanneck, Christoph Schmelz
Siemens Communications – Mobile Networks

Christoph Gerdes, Christian Kleegrewe, Joachim Sokol, Alan Southall
Siemens Corporate Technology

SIEMENS

*5. Würzburger Workshop*
*"IP-Netzmanagement, Netzplanung und Optimierung"*

*18./19.7.2005*

## Outline

- Goal:
  Automated assurance of network-wide configuration data consistency
- Use cases:
  Network optimization and growth
  - Example: cell adjacency management
- Proposed solution:
  Transaction-oriented CM data management subsystem
  - Integration into the element management architecture
- Conclusions

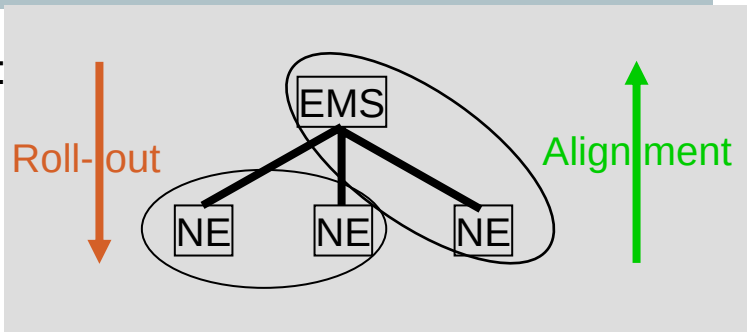
# General problem statement

- Requirement for an element management system (EMS):

  The consistency of configuration data

  - Between NEs and EMS
  - Between NEs (dependencies)

  needs to be assured at all times.




| Issues | Description |
|---|---|
| Non-ideal system components | •O&M network links between the NE and the EMS have limited bandwidth and may have link interruptions<br>•Tradeoff: bandwidth for maintaining the consistency vs. delay to reach consistency<br>•NEs may fail |
| Concurrency | Multiple sources of configuration changes (planning, multiple operators, local changes) |
| Limited roll-out time | Service-affecting configuration changes can only be rolled out during defined time windows (night hours, weekends) |
| Logical errors | Misconfiguration (human factor) |

→(Automated) rollbacks from inconsistent NE/network states must be possible →**Transactions**

# Specific problem statement for RAN Configuration Management (3G evolution)

| *Category* | *RAN CM property* | *Requirements to a full solution* |
|---|---|---|
| Roll-out phase | *Few* dependencies* comprising only *small NE groups*, but *crucial* and existent in *numerous* NE | Assurance of inter-NE consistency with adaptive commit strategy (not just 2PC**) |
| | Current management protocols: inefficient for delta configuration | Transaction-oriented protocol |
| | NEs need to function autonomously ("NE is the master of its data"), but no atomic operation at NE | Transactions at NE (& EMS) level |
| | Lack of speed | Parallelization of transactions |
| Alignment phase | Bulk alignment → reduced up-to-dateness | Delta alignment |
| Non-functional properties | Low O&M link bandwidth (Node B today: 128 kbit/s) | Bandwidth efficiency |
| | O&M link on microwave (Node B); planning / operator / local configuration changes | Robustness, "online" assurance of consistency |
| | Numerous NE | Scalability |
| | Manual work (*NE* configuration) in case of errors (→ downtime) | Efficiency through automation (*network* configuration) |

* Dependencies: cell handover adjacencies, transport connections; future: security information

** 2PC: Two-phase commit: *all* NE of a group signal "ready to commit"; EMS triggers commit

# Use cases in RAN Configuration Management (3G evolution)

Network optimization (Prio 1):

- Large radio network plan update
  - Example: regular plan exchange (monthly), e.g., to improve load balancing among RNCs (radio), minimize leased line expenditures (transport), accommodate changed user requirements due to an upcoming event
- Manual update of radio network covering multiple NE
  - Examples: correct radio configuration deficiency covering several RNCs, reconfiguration of a Node B cascade

Network growth (Prio 2):

- Addition / rehoming of Node Bs(attention of human operator required anyway, support useful)

Assumptions for the evolution of the use cases:

- Distribution: increasing number of NE to maintain coverage
- Dynamics: more frequent reconfiguration of NEs to satisfy changing user demands (enabler: remote electric antenna tilting) → >1 network plan per network, change of plan over time (of day, of year)
- Diversity: integrated heterogeneous access networks (3G/WiFi/WiMax) with numerous NE

# Example workflow for adjacency management: today

Network planning

Operator

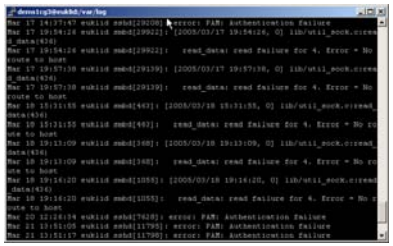
Δ CLI script

*Update HO params. cell #7: B*
*Update ADJC cell #1: B*
*Update ADJC cell #2: B*

*Update cell #7: success*

*Update cell #1: failure*

*Update cell #2: success*



Low-level workflow:

- Verification
- Correlation of individual results
- Correction of cell #1 problem
  OR
  New script for „rollback“

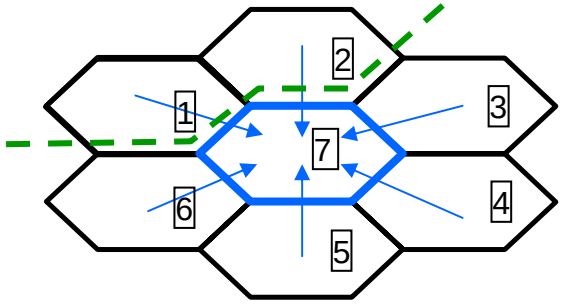
*Update HO params. cell #7: A*
*Update ADJC cell #2: A*

Roll-out

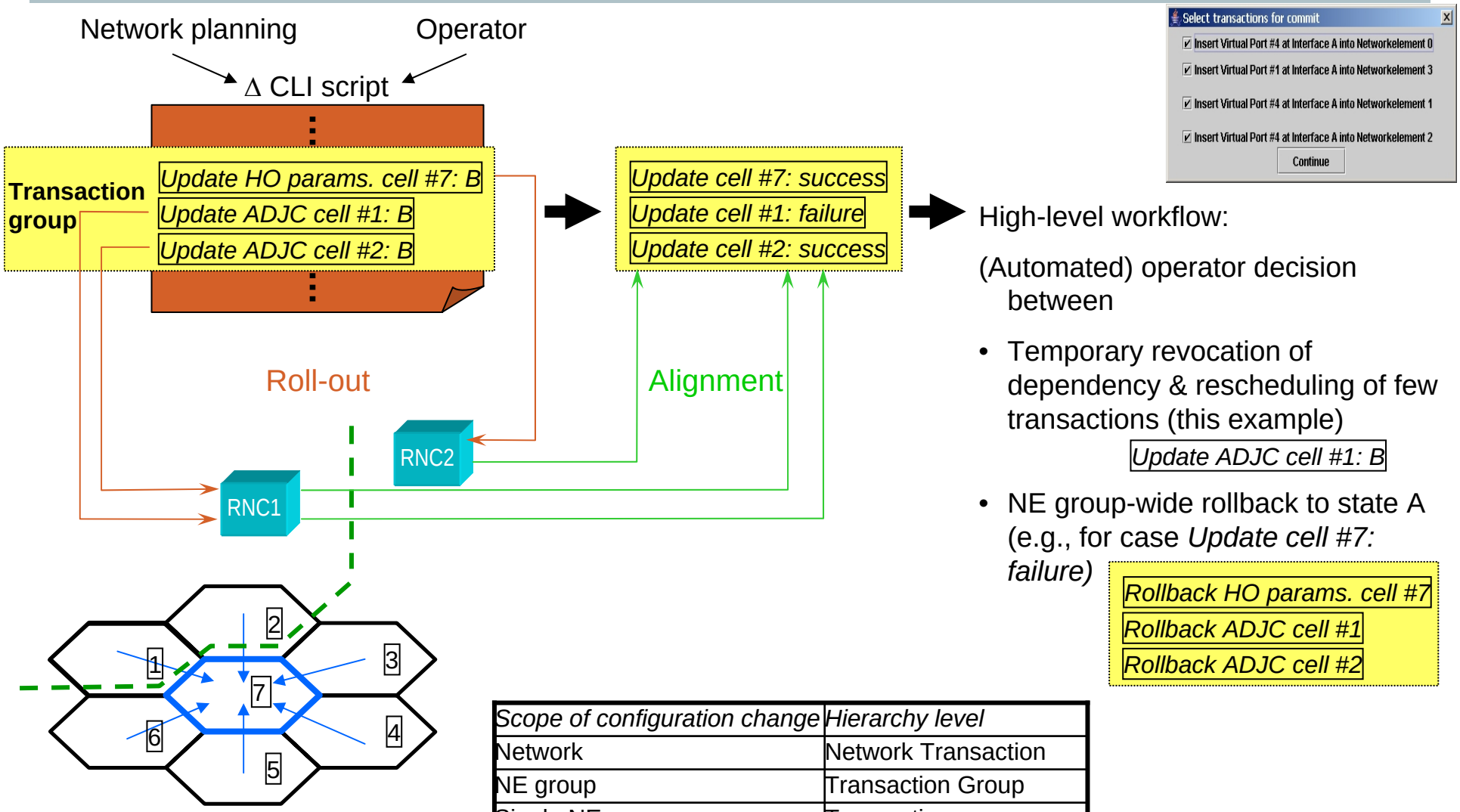
Alignment / FM

RNC1

RNC2



# Example workflow for adjacency management: future







High-level workflow:

(Automated) operator decision between

- Temporary revocation of dependency & rescheduling of few transactions (this example)

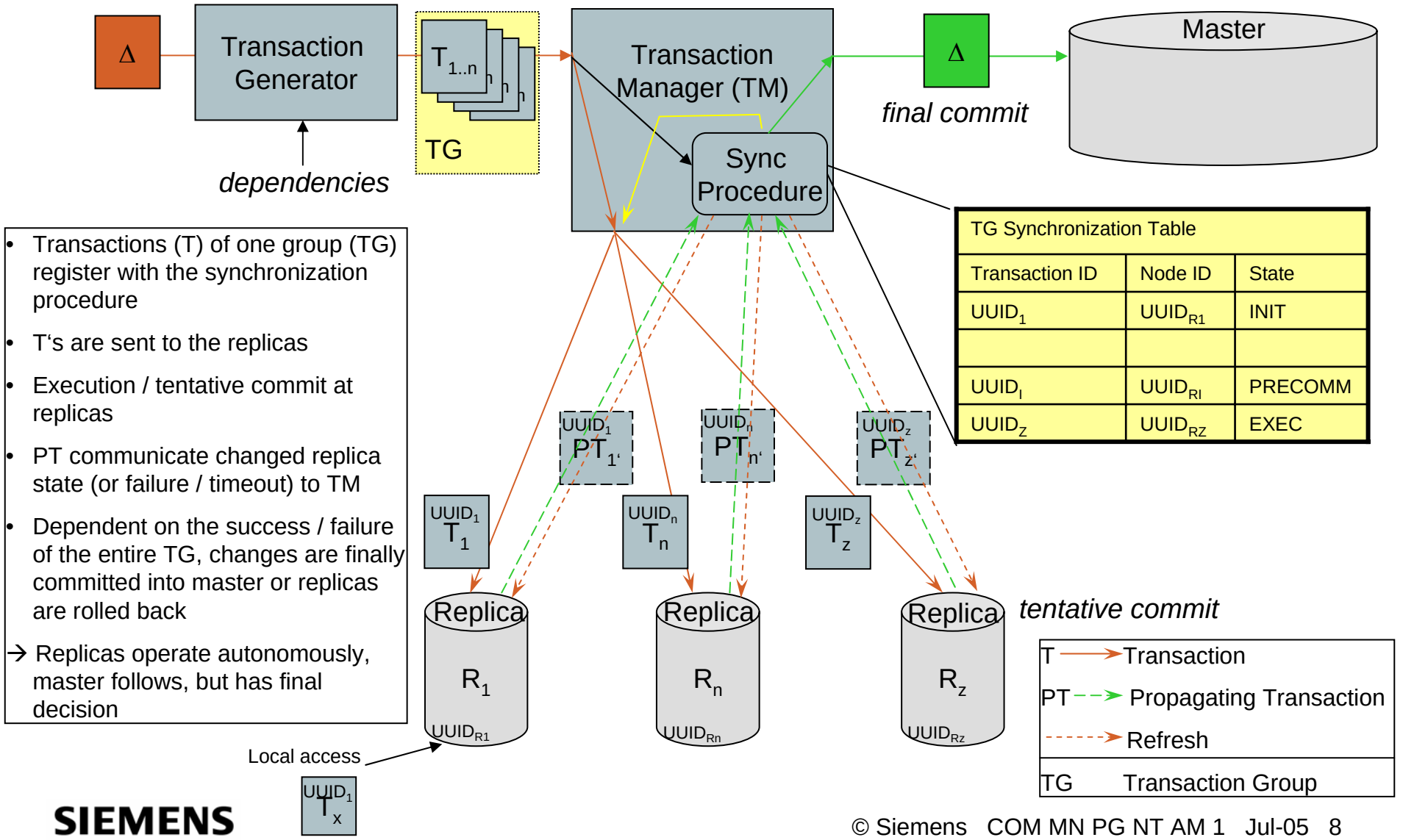
  *Update ADJC cell #1: B*

- NE group-wide rollback to state A (e.g., for case *Update cell #7: failure)*

  *Rollback HO params. cell #7*
  *Rollback ADJC cell #1*
  *Rollback ADJC cell #2*

| *Scope of configuration change* | *Hierarchy level* |
|---|---|
| Network | Network Transaction |
| NE group | Transaction Group |
| Single NE | Transaction |
| Single operation on NE | Command |

# Generic master-replica data management model




- Transactions (T) of one group (TG) register with the synchronization procedure
- T‘s are sent to the replicas
- Execution / tentative commit at replicas
- PT communicate changed replica state (or failure / timeout) to TM
- Dependent on the success / failure of the entire TG, changes are finally committed into master or replicas are rolled back

→ Replicas operate autonomously, master follows, but has final decision

SIEMENS

# Proposed solution: master-replica data management subsystem

| *Category* | *Requirements to a full solution* | *Solution properties* |
|---|---|---|
| Roll-out phase | Assurance of inter-NE consistency | *Middleware (at master = EMS):*<br>• Transaction compiler: generates transactions from delta between recent and planned view (input: dependencies, execution plan)<br>• Transaction manager: rolls-out and monitors transactions |
| | Transactions at EMS level | |
| | Parallelization | |
| | Automation | |
| | Transaction-oriented protocol | *NE sync engine*: transaction-oriented protocol between master / replica (=NE), transactions at replica |
| Alignment phase | Delta alignment | *Middleware* (Transaction manager): controls access to master by replicas<br>*NE sync engine*: delta updates as transactions |
| Non-functional properties | Bandwidth efficiency | *NE sync engine*: delta configuration changes |
| | Robustness, “online” assurance of consistency | *Middleware:* concurrency awareness<br>*NE sync engine*: reliable messaging, transactions |
| | Scalability | *NE sync engine*: several 100 replicas tested |
| | Efficiency through automation | *Middleware*: network (not NE)-level interface |

# Integration into the element management architecture

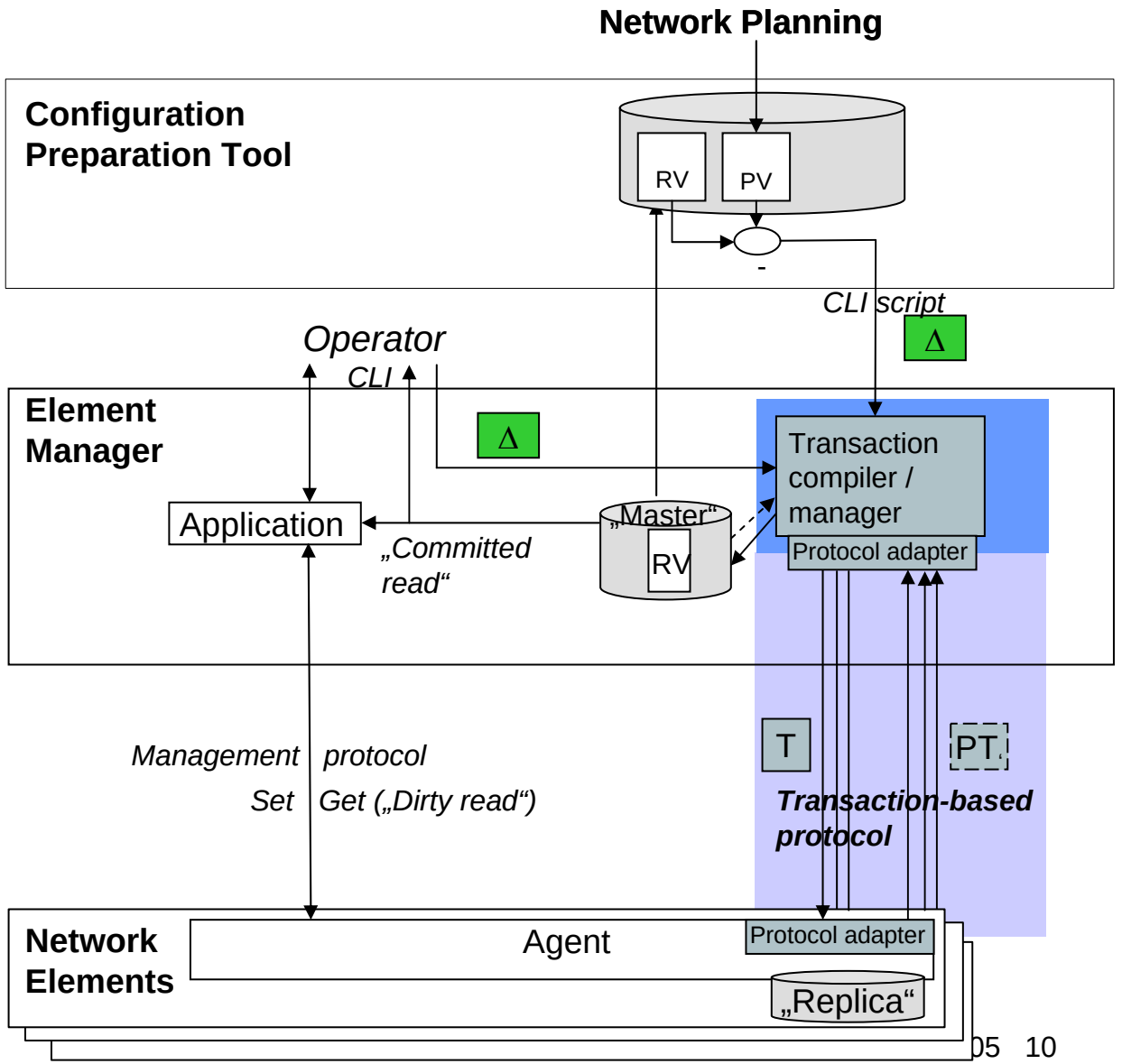
- Configuration preparation tool assures consistency of the (static) view of the network („offline“)
- Middleware + NE synchronization assure consistency of the live network („online“)

Middleware

NE synchronization

**RV: recent view**

**PV: planned view**




SIEMENS

## Conclusions

- Improvement of CM data consistency (NE/EMS & inter-NE), degree of automation
  - Manufacturer: reduced and simplified CM software development:
    - State-of-the-art data management technology can be applied
    - Applications do not need to consider low-level data consistency
  - Mobile Network Operator:
    - OPEX reduction (less (skilled) operational personnel needed)
    - Particularly important for 3G RAN evolution (integration of WiFi/WiMax) → scale
- Parallel operation to legacy CM protocols possible
- Partial introduction possible (transaction manager at EMS only)
- Info model upgrades can be nicely integrated into the roll-out process
- Proof-of-concept implementation has been done at Siemens Communications