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SIEMENS

Transaction-based Configuration Management for Mobile Networks

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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

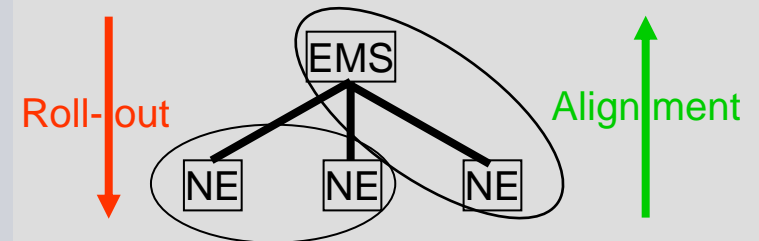
General problem statement

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.



<i>Error sources</i>	<i>Description</i>
Non-ideal system components	O&M network links: limited bandwidth, link interruptions 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 / 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 / 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

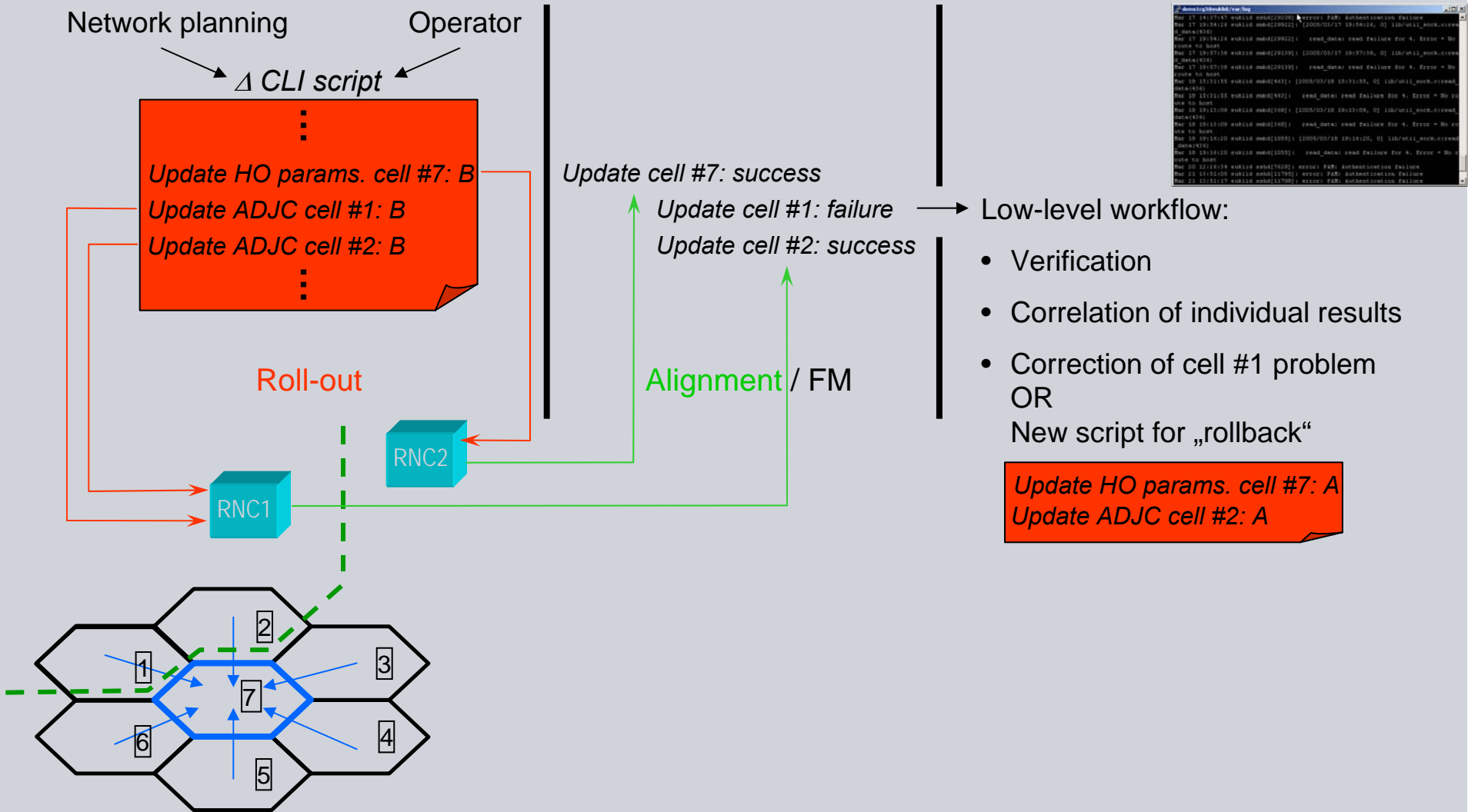
Network growth (Prio 2):

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

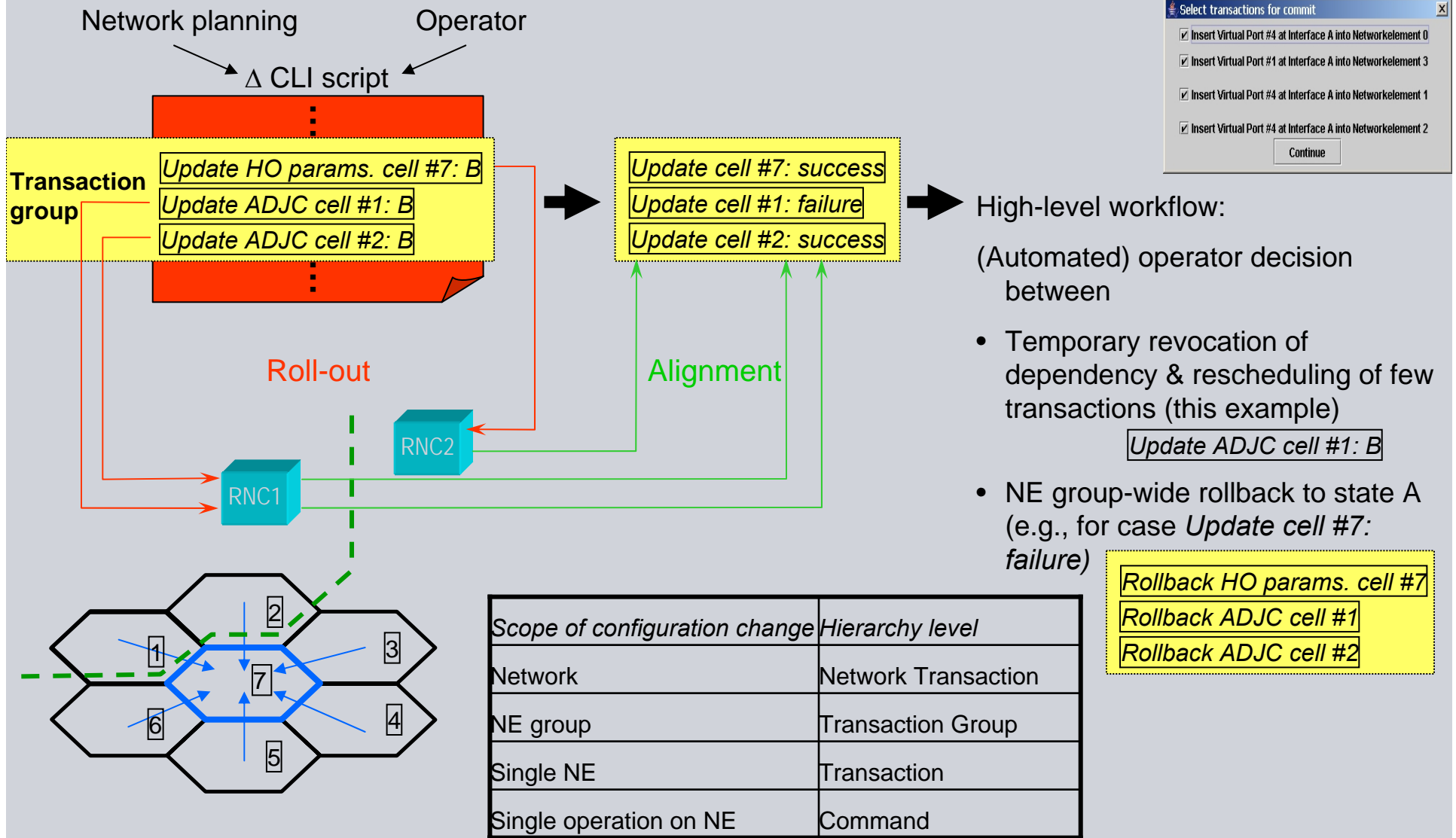
Assumptions for the evolution of the use cases:

- Distribution: numerous NE involved in CM (3G LTE), increasing number of NE
- 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/3G LTE/WiMax)

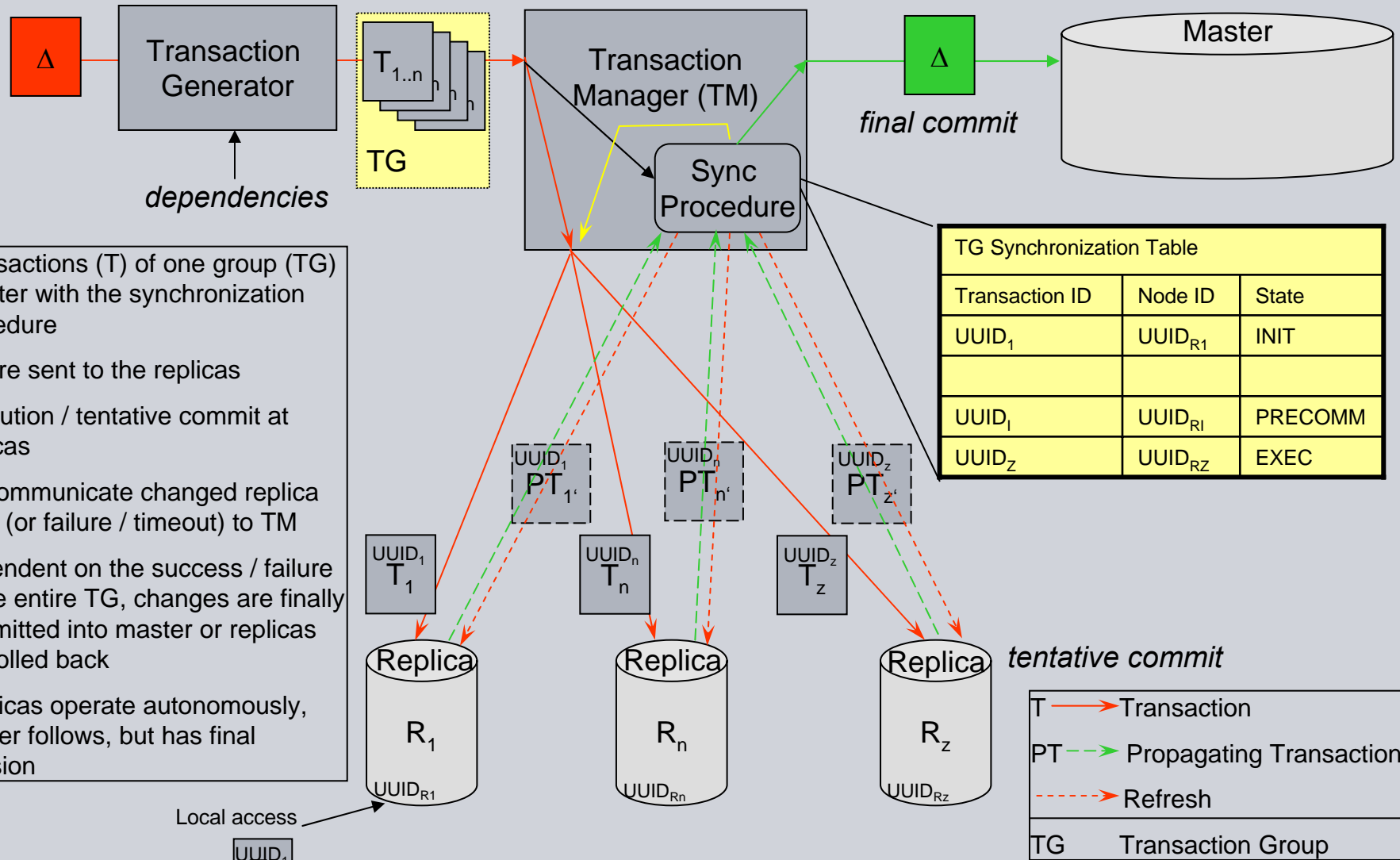
Example workflow for adjacency management: today




Example workflow for adjacency management: future



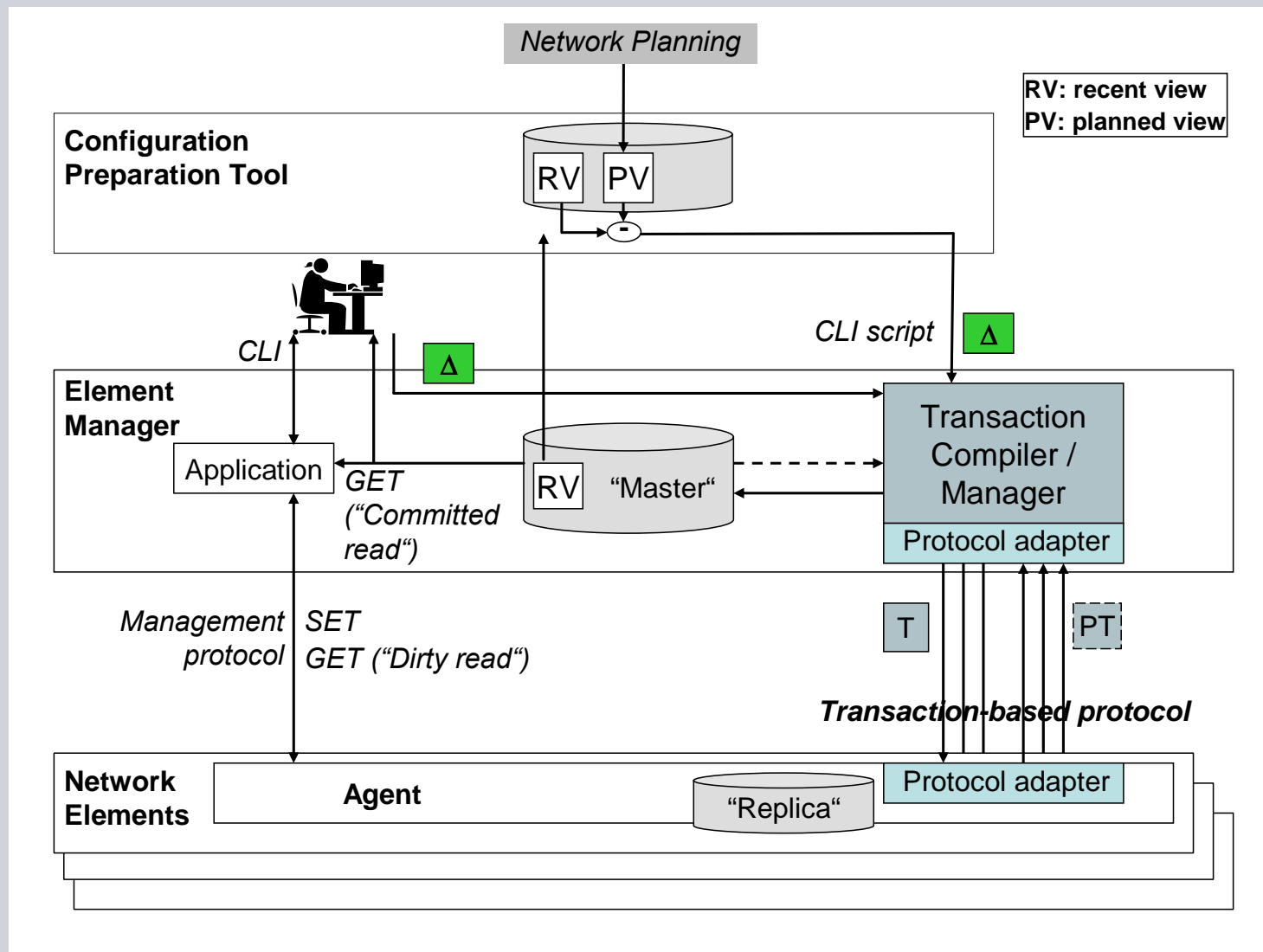
Generic master-replica data management model



- 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

Local access

 June 2006

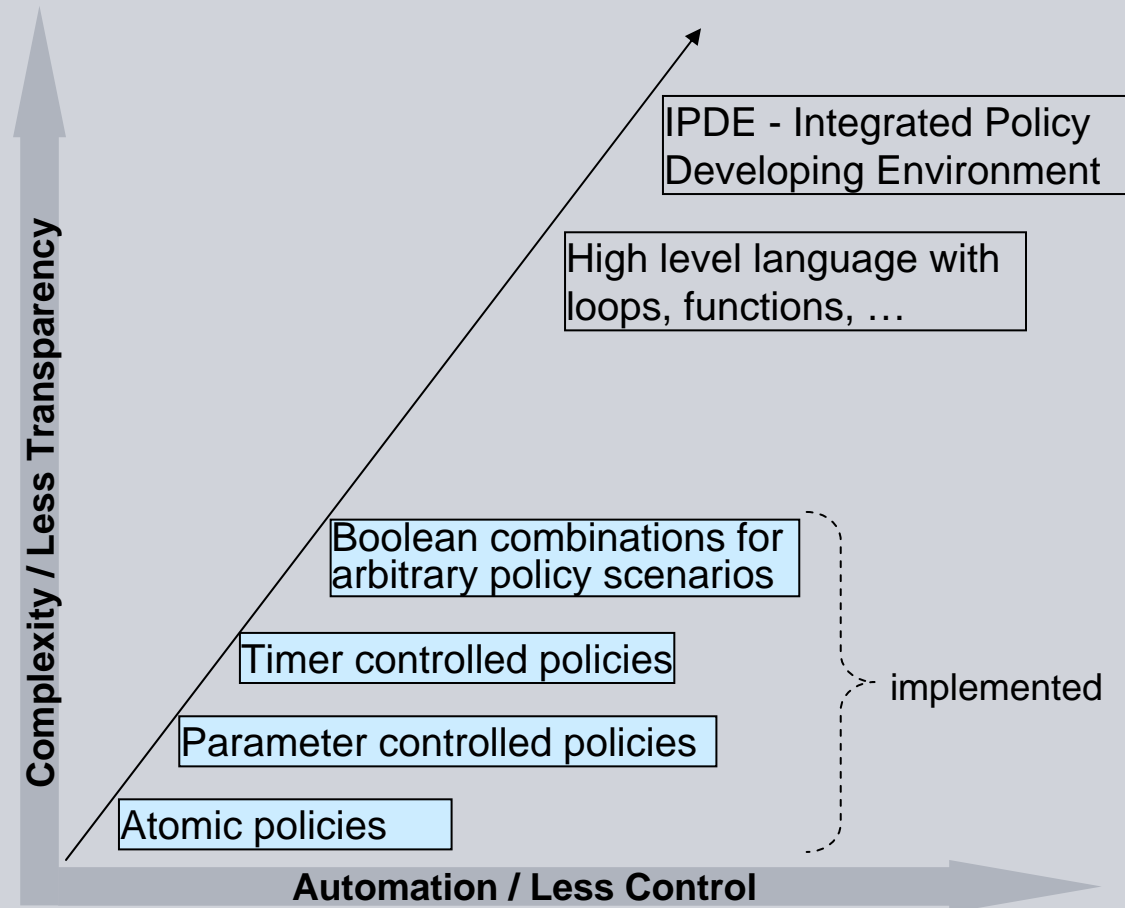
Integration into the element management architecture



Policy Examples for Automated Rescheduling / Rollback

Policy properties:

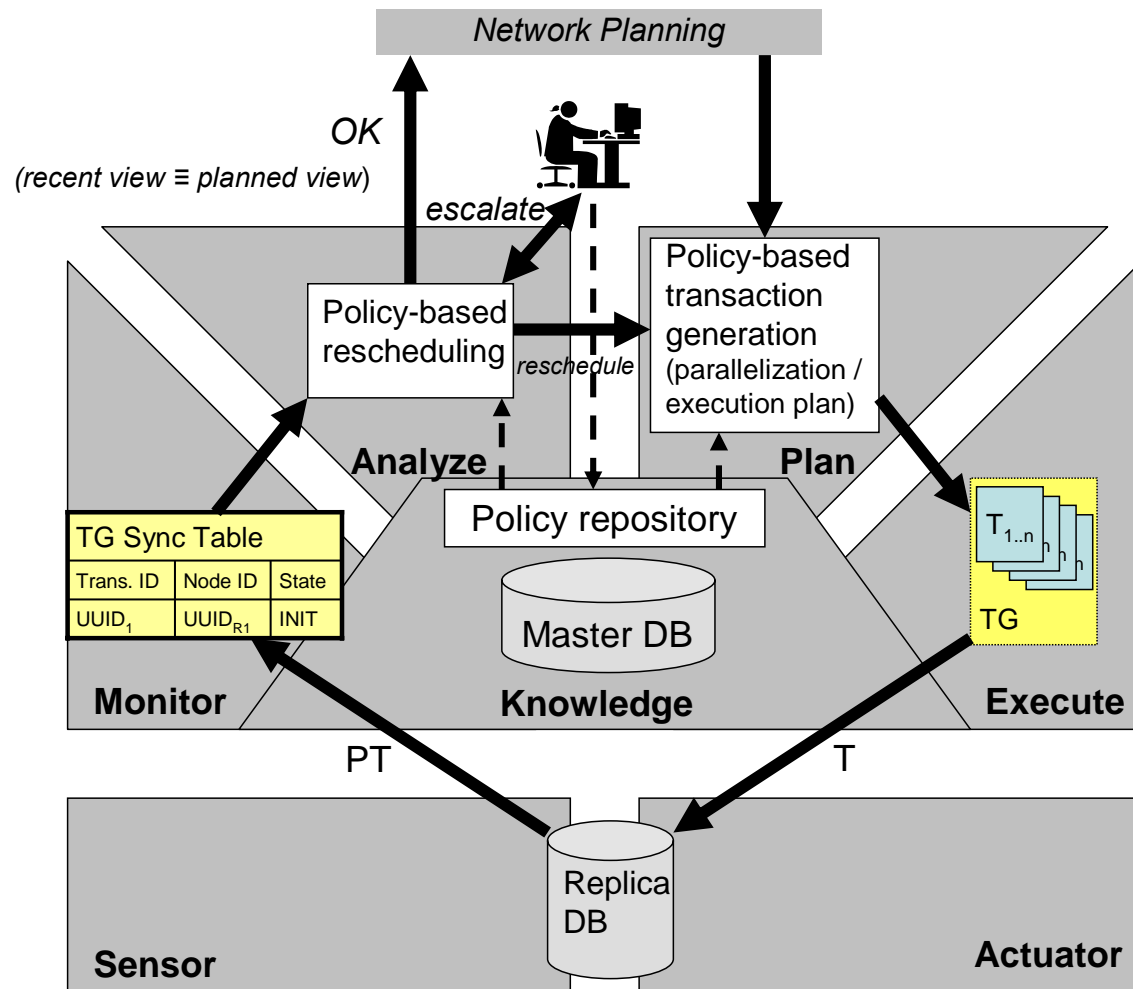
- hierarchically organized (atomic and derived polices)
 - tool-box supporting remote editing
 - optimizing and learning process
 - smooth migration and development possible
 - high-level language necessary (subject for standardization?)
 - monitoring, tracing, evaluation (appropriate GUI requested)
 - complexity vs. automation
 - transparency vs. control
 - potential for OPEX reduction
- policy environments for automated rescheduling and rollback are feasible already now, with IPDE as long-term goal



Proposed solution: master-replica data management subsystem

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

Summary



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)
 - Increasingly important with 3G RAN evolution
- 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

- Future work: policy development process (encapsulating human operator's knowledge) based on operational experience